UP NORTH, you don't have to kill all the weeds

How many weeds will customers tolerate? That's a good question to ask when planning control strategies.

by TOM FERMANIAN, Ph.D./University of Illinois

The key to weed control is deciding on a maximum number of weeds that are tolerable and designing a management system to achieve and maintain that goal. It is certainly possible to hold weed populations to about one or two percent of the turf area. For some turfed areas, larger populations of four to 10 percent are more practical.

IPM

Integrated Pest Management is one way to control a variety of turf pests. IPM combines sound cultural practices with occasional herbicide applications to manage weeds. In an integrated program, areas such as mowing, fertilization and irrigation should be designed to maximize the turf's competitive potential and minimize the most troublesome weeds.

Mowing

The most persistent weeds have adapted to low mowing heights and frequent mowing. A mowing strategy should be developed to first minimize its impact on the turf and to reduce weed growth. Adjust and sharpen mower blades to reduce potential stress on the turf.

Adjust mowing frequency to remove less than one third of the leaf blades, and to provide maximum turf regrowth.

Fertilization

Studies show a direct relationship between the development of several weed species and the general availability of soil nutrients. While accurate timely fertilizations will maximize turf development and provide a good competitor, too much fertilizer can promote weed growth.

Annual bluegrass (*Poa annua*), crabgrass and many

TABLE 1. HERBICIDES FOR BROADLEAF WEED CONTROL IN COOL-SEASON TURF

Common Name	Trade Name
2,4-D	AM-40; 2,4-D granular; 2,4-D L.V. ester, solution (Riverdale); 2,4-D amine 4; 2,4-D LV4; SEE 2,4-D LV4 (Riverside/Terra International); Weedone LV4 (Rhone Poulenc);
2,4-D+dicamba	81 Selective Weedkiller (Riverdale); Four Power Plus (Turfgo/United Horticultural Supply); Lawn Weed Killer (Bonide); Triple D Lawn Weed Killer (Rockland)
2,4-D+dichlorprop	2D+2DP Amine; Turf D+DP (Riverdale); Fluid Broadleaf Weed Control (The Scotts Co.); Weedone DPC Ester; Weedone Amine (Rhone Poulenc)
2,4-D+dichlorprop+dicamba	Strike 3 (Riverside/Terra International); Super Trimec (PBI/Gordon)
2,4-D+mecoprop	2D Amine + 2 MCPP (Riverdale); 2 Plus 2 (ISK Biosciences); MCPP-2,4-D (Cleary)
2,4-D+MCPP+dicamba	Bentgrass Selective Weed Killer (Lesco); Brushfire; Brush-out; Brush-Whacker; HS-130; SNSW-2000 (NCH); Granular Broadleaf Weed Killer (Lebanon); MecAmine-D (Turfgo/United Horticultural Supply); Three-Way Lawn Weed Killer (Rockland); Three-Way Selective; Three-Way DG (Lesco); Trimec Bentgrass Formula; Trimec Classic; Trimec Southern (PBI/Gordon); Triplet Selective; Triplet Water Soluble (Riverdale)
2,4-D+MCPP+dichlorprop	Dissolve; Triamine; Triamine Granular; Triamine Jet-Spray; Tri-Ester (Riverdale); Jet Spray 3-Way Weed Control (The Scotts Co.); Three-way Ester (Lesco)
2,4-D+MCPP+MSMA+dicamba	Trimec Plus (PBI/Gordon)
2,4-D+triclopyr	Chaser (Turfgo/United Horticultural Supply); Turflon II; Turflon II Amine (Lesco)
DCPA	Dacthal (ISK Biosciences); Garden, Turf & Ornamental Herbicide 5G; Turf & Ornamental Herbicide (Bonide); HS-110 (NCH); Super Dacthal 686 (Rockland)
dicamba	Vanquish (Sandoz); K-O-G Weed Control (The Scotts Co.)
isoxaben	Gallery (DowElanco)
triclopyr	Turflon Ester (DowElanco; Monterey)
triclopyr+clopyralid	Confront (DowElanco)

All products listed—except DCPA—are labeled for selective, post-emergence control of broadleaf weeds. See label for tolerant turfgrasses and species controlled by each product. DCPA provides selective, post-emergence control of creeping speedwell and pre-emergence control of selected broadleaf species.

other species grow rapidly after receiving high N levels.

Excess fertilizations, particularly with soluble N sources, can injure turf foliage. Even if the injury is short-term, opportunistic weeds can develop before the turf has a chance to replenish the canopy.

Cultivation

Core aerification, vertical mowing, spiking, or slicing provide a more conducive rootzone for turf growth. These allow the turf to better compete with weed populations.

These same practices can also move buried weed seeds to the surface and allow them to germinate. Topdressing might also introduce foreign seed and provide a new avenue to weed infection.

Herbicides

In a well-designed IPM program, each cultural strategy is selected to reduce weeds. Practically, however, some weeds will always survive even your best management. Herbicides—particularly post-emergence herbicides—can be used to reach your desired weed management goals. Many materials are available for direct control of both annual grasses and broadleaf weeds.

The post-emergents

One of the original selective post-emergence herbicides was 2,4-D. This and other similar compounds—such as mecoprop, dichlorprop and dicamba—control a wide spectrum of broadleaf weeds.

Each controls a select group of weed species. Often, they are used in combination, which

TABLE 2. HERBICIDES FOR GRASSY WEED CONTROL: COOL-SEASON TURF AND NON-SELECTIVE

Common name	Trade Names	Uses
bentazon	Basagran T/O (BASF); Lescogran (Lesco)	Selective post-emergence control of nutsedges and some broadleaf weeds.
chlorsulfuron	TFC (Lesco)	Selective post-emergence control of tall fescue in Kentucky bluegrass, fine fescues, bentgrass.
DCPA	Dacthal (ISK Biosciences); Garden, Turf & Ornamental Herbicide (Bonide); HS-110 (NCH, Irving, Texas); Super Dacthal 686 (Rockland)	Selective post-emergence control of creeping speedwell; pre-emergence control of selected broadleaf species.
diquat	Aquatate; HNS-210; Vegetrol; Watrol (NCH); Reward (Zeneca)	Non-selective, post-emergence contact product.
dithiopyr	Dimension (Lesco; Rohm and Haas)	Selective post-emergence control of annual grasses; pre-emergence control of selected broadleaf species.
DSMA	DSMA 4 (Riverside; Terra International); DSMA Slurry (Drexel); Methar 30 (Cleary)	Selective post-emergence control of annual grasses.
ethofumesate	Prograss (AgrEvo)	Selective pre- and post-emergence control of selected annual grasses and broadleaf weeds.
fenoxaprop	Acclaim (AgrEvo)	Selective post-emergence control of annual grasses.
glufosinate-ammonium	Finale (AgrEvo)	Non-selective post-emergence herbicide.
glyphosate	Avail (Lesco); HNS-220; Hoedown; Quick Claim; Trailblazer (NCH); Roundup Dry Pak; Roundup Pro (Monsanto)	Non-selective post-emergence herbicide.
halosulfuron	Manage (Monsanto)	Selective post-emergence control of sedges, such as yellow and purple nutsedge.
MCPA	MCPA-4 Amine (Riverdale)	Selective post-emergence control of annual grasses.
MCPA+MCPP+ dicamba	Eliminate (LESCO); Hat Trick (Turfgo/ United Horticultural Supply); Tri-Power Selective Herbicide (Riverdale)	Selective post-emergence control of broadleaf weeds. See label for tolerant turfgrasses and species controlled.
MCPA+MCPP+ dichlorprop	Triamine II; Tri-Ester II (Riverdale)	Selective post-emergence control of broadleaf weeds. See label for tolerant turfgrasses and species controlled.
mecoprop (MCPP)	Certi-CM; Chemweed 265; HS-167; Milpro 360 (NCH); MCPP (Cleary); MCPP-4 Amine (Riverdale); MCPP-4K (Turfgo/United Horticultural Supply; Mecomec (PBI/Gordon)	Selective post-emergence control of broadleaf weeds. See label for tolerant turfgrasses and species controlled.
MSMA	Crabgrass Killer (Bonide); Daconate 6; Daconate Super (ISK Biosciences); Drexar 530 (Drexel); MSMA (Bonide; LESCO); MSMA Turf (Turfgo/United Horticultural Supply); 912 Herbicde; 120 Herbicide (Riverside/Terra International); Super Crabrass Killer (Rockland); Weed Hoe (Monterey)	Selective post-emergence control of annual grasses.
MSMA+cacodylic acid	Broadside; Moncide (Monterey)	Selective post-emergence control of annual grasses.
sethoxydim	Vantage (BASF)	Selective post-emergence control of annual grasses in fine fescues.

SOURCE: DR. FERMANIAN

allows you to reduce their individual single use rates through a synergistic action. Double and triple combinations of these materials provide effective control for almost any broadleaf species found in turf. Likewise, the materials are formulated either as esters or amine based compounds, to provide more control or a higher level of turf safety (Table 1).

Two particular materials, triclopyr and clopyralid, are broad-spectrum post-emergence herbicides that can be targeted toward a wide range of weeds in many turfs. Triclopyr is often formulated by itself or in combinations with 2,4-D to broaden its effectiveness across a wider group of weeds. Confront is a combination of both triclopyr and clopyralid, which is particularly effective with many tough-to-control broadleaf weeds, such as wild violets and creeping charlie.

Several additional materials are available for a smaller group of weeds or for special uses. Bromoxynil will not injure seedling turfgrasses and is often used as the initial material for cleaning up newly-seeded turf. Several materials such as Basagran, Vantage and DCPA are targeted toward a small group of species. Manage and Basagran can be used effectively for controlling yellow and purple nutsedge.

Grassy weeds

For grassy weeds, particularly annual grasses, several products are available for selective control. Additionally, non-selective herbicides can be used for spot control of both annual and perennial weeds.

Ethofumesate, fenoxaprop and dithiopyr can all be used to control annual grasses after they have emerged. Each material has its own unique spectrum of species it is effective on. In general, each of these herbicides is most effective when applied to young grass seedlings. As with the broadleaf herbicides, the grass seedlings should be actively growing under good conditions.

Non-selective herbicides

For tough-to-control weeds or perennial grasses, non-selective materials such as Roundup Pro or Finale can be used effectively. These products will remove both the unwanted weeds and any underlying turf. They should be made only during periods of the year when the weeds are actively growing and ample opportunity is available for renovating or re-establishing the turf. □

—The author is an associate professor of turfgrass science at the University of Illinois Department of Natural Resources and Environmental Sciences.

DOWN SOUTH, control product tolerance a key

Proper turf nutrition and soil moisture will help you achieve maximum product efficacy.

by TIM R. MURPHY, Ph.D. / University of Georgia

Properly-maintained warm-season turfgrass is a good defense against strong weed competition.

Using correct fertility programs; following water requirements, mowing heights and schedules; and proper insect and disease control products all increase turfgrass vigor. They also improve the tolerance of warm-season turfgrasses to herbicides, and increase a weed control program's effectiveness.

Using herbicides without proper turfgrass management practices may control problem weeds, but will not produce high-quality turf.

Turfgrass managers in warm-season climates have a wide array of pre-emergence herbicides that can be used to control weeds. (See table on page 46.)

Tolerance factors

The single most important factor in selecting a herbicide is the tolerance of the turfgrass to the herbicide. Generally, most pre-emergence herbicides can be used on all established warm-season turfgrasses. There are exceptions. Ronstar is not labeled for use on centipedegrass or home lawns.

There is a dramatic difference in the tolerance of warm-season turfgrass species to post-emergence herbicides. Bermudagrass has good tolerance to MSMA and DSMA; however, carpetgrass, centipedegrass and St. Augustinegrass are severely injured by these herbicides.

Cultivars within a species may also respond differently to the same herbicide.

Post-emergence herbicides should be avoided when turfgrasses and weeds are stressed due to high air temperatures or drought. The tolerance of warm-season turfgrasses to post-emergence herbicides decreases at air temperatures greater than 90 degrees F., when turfgrasses are drought-stressed or when turfgrasses are growing under high soil moisture and high humidity.

Herbicides that contain 2,4-D, mecoprop, dichlorprop, imazaquin, MSMA and DSMA

should not be applied at high air temperatures greater than 90 degrees F. because there is an increased risk of unacceptable turfgrass injury. Always follow the most restrictive warning that is shown on the label.

Application frequency

For some herbicides, particularly post-emergence products, a repeat application is necessary. For example, two applications of MSMA, at a 7- to 10-day interval, are needed to control crabgrass in bermudagrass.

In contrast, one application of Vantage will usually control crabgrass in centipedegrass. Pre-emergence herbicides may be applied either as full rate single applications, or as sequential repeated applications. With the sequential application program, one-half the maximum labeled rate is initially applied, with the remaining half applied 60 days later. With most pre-emergence herbicides, sequential applications tend to improve crabgrass and goosegrass control over the control achieved with a single application.

Application timing

Most pre-emergence herbicides control susceptible weeds during germination of weed seeds. Additionally, most pre-emergence herbicides require about one-half inch of rainfall or irrigation water to move the herbicide into the upper one to two inches of the soil profile.

A pre-emergence herbicide can undergo volatility losses and photodegradation the longer it remains on turfgrass foliage or thatch. Irrigation is advised unless a rainfall is anticipated within four to seven days of application.

Most species of crabgrass initiate germination when soil temperatures at the four-inch depth reach 53-58 degrees F. Depending on the geographical location, this will occur during February through April in the southern U.S.

Goosegrass germinates at a soil temperature of 60 to 65 degrees F., or approximately two to eight weeks later than crabgrass. On warm-season turfgrasses that are not fall-overseeded, pre-emergence herbicides control annual bluegrass and certain annual broadleaf weeds. Annual bluegrass germinates at soil temperatures of around 70 degrees F. Apply the pre-emergence herbicide early in fall.

Post-emergence herbicides should be applied to small, actively-growing weeds. Perennial and annual weeds that grow under good soil moisture conditions at moderate air temperatures are easier to control than weeds that are stressed due to adverse environmental conditions. **LM**

—The author is an agronomist in weed science at the University of Georgia Cooperative Extension Service.

COMMON AND TRADE NAMES OF WARM-SEASON TURFGRASS PRE-EMERGENCE HERBICIDES[1]

Common name	Trade name	Uses
atrazine	Aatrex, others	Annual broadleaf weeds.
benefin	Balan, others	Annual grass; some annual broadleaf weeds.
benefin+oryzalin	XL	Annual grass; some annual broadleaf weeds.
benefin+trifluralin	Team, others	Annual grass, some annual broadleaf weeds.
bensulide	Bensumec, Betasan, others	Primarily controls annual grasses.
bensulide+oxadiazon	Goosegrass/ Crabgrass Control	Annual grass control.
DCPA	Dacthal, others	Annual grass; some annual broadleaf weeds.
dithiopyr	Dimension	Annual grass; some annual broadleaf weeds.
ethofumesate	Prograss	Annual bluegrass control in bermudagrass and overseeded perennial ryegrass.
fenarimol	Rubigan	Annual bluegrass control in bermudagrass-overseeded cool-season turfgrasses.
isoxaben	Gallery	Annual broadleaf weeds. Does not control established perennials; provides residual control of some species that reproduce by seed.
metolachlor	Pennant	Controls yellow nutsedge and annual sedge; some annual grasses.
napropamide	Devrinol	Annual grass; some annual broadleaf weeds.
oryzalin	Surflan	Annual grass and some annual broadleaf weeds.
oxadiazon	Ronstar	Annual grass and some annual broadleaf weeds.
oxadiazon+benefin	Regalstar	Primarily controls annual grasses.
pendimethalin	Pre-M, Pendulum, others	Annual grass; some annual broadleaf weeds.
prodiamine	Barricade, Regalkade	Annual grass; some annual broadleaf weeds.
pronamide	Kerb	Winter annual weed control. May be used 90 days prior to overseeding bermudagrass witha cool-season turfgrass to control annual bluegrass.
simazine	Princep, others	Winter annual broadleaf weeds.

[1] Refer to the herbicide label for a complete listing of tolerant turfgrasses and labeled application sites.

SOURCE: DR. MURPHY

Follow the clues to identify pests

Turf managers who seek to classify insect pests must follow the clues and use the process of elimination.

North

by PATRICIA J. VITTUM, Ph. D./ University of Massachusetts

The keys to successful insect control are: (1) identifying the pest insect; (2) determining when the insect will be in its most vulnerable stage for control; and (3) choosing an insecticide which is best suited for the conditions.

The clues

1) Are there any insects in the area?

2) What do they look like? Insects are able to damage turf when they are in both the adult and immature stages.

3) Are these insects active in the daytime or only at night?

4) Are they found near the surface, well into the thatch or in the soil?

5) Do you find obvious signs of damage?

6) What time of year is it?

7) Are just certain species of turf affected, or all species?

8) Location and soil type. Are sunny areas or slopes affected? How about sandy soils?

Biological controls

In recent years, several biological control agents have been developed commercially, which can be applied to turf settings to reduce insect pest populations.

Bacillus thuringiensis is a bacterium which paralyzes the target insect's gut system. This bacterium exists in several different strains, each of which is effective against certain kinds of insects. *Bt var. kurstaki*—available as Dipel, Javelin, Steward; all trademarks—is used to control caterpillars in turf and ornamentals, as well as in fruit and vegetable production. *Bt. var. israeliensis* is used to control mosquito populations in aquatic settings, and to control fungus gnats in greenhouses. A newly-discovered strain, *Bt. var. japonensis*—of the strain *buibui*—looks to hold some promise for white grub control.

Entomopathogenic nematodes, which cause diseases in insects, can be applied to turf with standard hydraulic sprayers. These nematodes, available as Vector, BioSafe and others, can move short distances in search of their intended victims. The nematodes are sensitive to cool or cold temperatures, and are sensitive to desiccation, so applications must be watered in immediately.

Some perennial ryegrasses and fescues contain endopytes—fungi growing inside the plants—which provide a level of resistance to certain kinds or insects such as chinch bugs, greenbugs, webworms, cutworms or billbugs. These cultivars also tend to be more drought tolerant. So in areas where these insects have been a problem, consider renovating the areas using endophytic grasses.

One chemical product consideration is speed of efficacy, or how quickly the product works. Proxol, Dylox and Triumph begin to affect target insects within a day or two after applications, while others, such as Oftanol and Merit, may take two or three weeks before target insects begin to die.

If an application is made when most of the target insects are very small and there is a chance that some of the eggs have not yet hatched, you should use one of the slower-acting but longer-lasting materials, such as Oftanol or Merit. If an application is made when most of the target insects are already quite large and feeding actively, you probably should use one of the faster-acting materials, such as Proxol, Dylox or Triumph.

Some materials, such as Dursban, are tied up in the organic material in the thatch, and are less likely to penetrate the thatch and reach the rootzone. Such materials are usually very effective against some of the surface feeding insects (cutworms, webworms, chinch bugs), but are not as effective against root insects (white grubs) when used in areas where there is measurable thatch.

Some materials such as Proxol or Dylox are quite soluble in water and move through the thatch quite readily. These materials are good choices for control of white grubs and other soil insects because they can penetrate the thatch, but may be less well-suited to control surface feeders.

Some insecticide applications should be watered in immediately after application,

Japanese beetle grubs feed on turfgrass roots, causing considerable damage.

often to help move the material through the thatch toward the rootzone and to draw the target insects up into the thatch. Other applications should not be watered in or should receive only small amounts of water to move the material off the blades and into the upper thatch. Some materials (for example, Proxol, Dylox, Orthene, Triumph) break down very rapidly when the water pH is greater than 8.0 alkaline.

Most field trials seem to indicate there is no consistent or measurable difference between formulations of the same material. In other words, if a turf manager decides to use "chemical x," the sprayable formulation and the granular formulation should provide the same level of control.

New materials

Several insecticides have been available to the turf market for only a year or two.

Merit has proven to be very effective, particularly on several species of white grubs. However, as with any insecticide, you should resist the temptation to rely on Merit alone, but include that material as one of several in the arsenal.

Several synthetic pyrethroids, such as Tempo and Talstar, have received turf registrations in the past couple of years and appear to be quite effective against a range of surface insects.

Another compound which has been tested in university settings for several years and appears to be nearing registration is *halofenozide* (Mach 2). This compound prevents the target insect from molting from one immature stage to the next. It is relatively specific to certain kinds or insects and has a very low level of toxicity to other organisms such as people, birds, fish or other vertebrates. It looks promising against several species of white grubs. □

Insects and their treatment

White grubs: Feed on roots of turfgrasses. Turf looks like it is in drought stress.

Cultural control: provide adequate moisture to root zone. Do not mow too low.

Biological control: *Bacillus thuringiensis var. japonensis* strain *buibui* (may be available in 1997. *Heterorhabditis bacteriophora,* certain strains (entomopathogenic nematode).

Chemical: Use products which penetrate thatch well (Dylox, Proxol, Triumph) in areas with more than 0.25 inches of thatch. Merit works very well but must be applied before most of the population is in the middle-sized grub stage. Water any material in as soon after application as possible to improve contact with grubs.

Chinch bugs: Suck plant juices from stems. Usually most severe or noticeable in sandy soils or sunny areas. Usually most active in summer months.

Cultural control: Reduce thatch. Avoid drought stress. Use endophytic grasses.

Biological control: Watch for big-eyed bugs, which are natural predators resembling chinchbugs.

Chemical control: Many turf insecticides are labelled and effective. Consider using products that will remain in thatch (e.g. Dursban). Apply in late spring or early summer, if sampling documents need.

Billbugs: youngest larvae feed inside stems. Larger larvae feed near crown of plant and on roots. Areas turn yellow or brown and die. Perhaps the most misdiagnosed turf insect problem in the Northeast.

Cultural controls: Use endophytic grasses.

Biological controls: *Steinernema carpocapsae* (available as Vector, BioSafe and others); an entomopathogenic nematode; water in immediately after application.

Chemical control: Most applications are directed toward adults as they begin to lay eggs, often May or June. Timing of application appears to be critical, and the application window is only two weeks in some areas.

Webworms, cutworms: Caterpillars hide in thatch during the day and feed at night on tender tissue.

May thin or kill patches of turf. Several species, often several generations per year.

Cultural control: Reduce thatch, avoid drought stress and use endophytic grasses.

Biological control: *Steinernema carpocapsae* (available as Vector, BioSafe and others); an entomopathogenic nematode. *Bacillus thuringiensis var kurstaki,* available as Dipel, Javelin, Steward and others.

Chemical: Many turf insecticides are labelled and effective. consider using materials which remain in the thatch (e.g. Dursban) or some of the relatively new pyrethroids. Treat as late in the day as possible. □

Extreme heat compounds insect problems

We can't control the weather, but an understanding of its effects on pests and their control can be useful.

South

by R.L. BRANDENBURG, Ph.D./N.C. State University

Why would a sudden change of weather create unusual insect problems? The answer goes beyond insects being cold-blooded and controlled by temperature.

Some insects simply survive better on stressed turf. At other times, certain insects will become a problem because the unusual weather patterns may allow them to escape their natural controls.

Hot and dry weather favors chinch bugs because a fungal disease that often keeps them in check doesn't perform well under those conditions.

Cool, wet springs may lead to more cutworm problems in the summer.

Unusually hot, dry conditions may result in more armyworms in the turfgrass as other food sources are depleted. This alerts us to potential pest outbreaks, but does not replace the need for turf monitoring and scouting.

Insect forecasting

The term "degree-days" is often mentioned in association with weather and insects. Degree-days are simply an accounting tool for recording how warm it has been. Most living organisms have a threshold—or minimum temperature—during which time development is possible. For insects, a common threshold is 50°F. Temperatures below this ususally mean development does not take place. Insect development is more rapid as the temperature climbs above 50°F.

Developmental models have cumulative degree-day targets that indicate when an important event is likely. For example, if mole cricket eggs are expected to hatch at 2,000 degree-days—and it usually occurs around June 17 in Raleigh, N.C.—we base our prediction on that model. Should we have 1,900 degree-days by June 1, and accumulate about 30 additional degree days thereafter, then we can estimate that egg hatch will occur earlier than June 17. With this information in hand, we know when to begin soap flushes to verify egg hatching.

Once hatching has been verified, we can begin timely and effective control measures.

The effectiveness of various control measures can be dramatically affected by the weather.

Cool weather may render the insects less active and the insecticides less effective. Rainy weather can reduce the effectiveness of insecticides applied for control of foliar pests. However, the hot, dry conditions we had during 1995 often have the greatest impact on control efficacy. The management of soil pests such as grubs and mole crickets is adversely affected in a number of ways. The hot, dry soil surface may cause insecticides to bind to organic matter or to vaporize. Either way, less insecticide is available to the target site.

Control of soil insects requires that the insecticide be moved down into the soil. The longer the insecticide is on a hot, dry surface, the more likely it is to be degraded by sunlight.

Irrigation

Moisture from rainfall or man-made irrigation systems is made even more impor-

How to calculate degree-days

1) Record the maximum and minimum temperature for the day.
2) Add the two numbers.
3) Divide by 2 for an "average temperature."
4) Subtract 50°F (insect development threshold temperature).
5) The sum is the number of degree-days for that day.

A negative number is not used since it means no development occurred. If the minimum temperature for a day was 60°F, and the temperature was 80°F, then the average would be 70°F (80+60=140÷2=70).

Subtracting the 50°F threshold would yield 20. This is the number of degree-days recorded for that day.

SOURCE: DR. BRANDENBURG

A - White grub populations and the efficacy of control can be affected by weather.

B - Natural enemies, such as this beetle larva dining on a caterpillar pupa—can be affected by weather.

C - The hot, dry weather of North Carolina caused sporadic outbreaks of sod webworms, as the moths laid eggs in drought prone areas.

tant by the negative consequences of hot, dry weather. Additionally, hot, dry weather often moves the insects deeper into the soil, and therefore more difficult to control. Many turfgrass managers irrigate sites before treatment. By thoroughly soaking the soil—two to three days in advance for white grubs and one day for mole crickets—two important functions are accomplished. First, the irrigation will cause the insects to move closer to the soil surface and be more susceptible to the control measure. This pre-irrigation also reduces the insecticide binding in the organic matter near the surface. The post-application irrigation is still required immediately after treatment.

Biological materials, such as entomogenous nematodes are just as susceptible (if not more so) to hot, dry conditions as conventional synthetic insecticides.

A good scouting program and attention to detail while applying insecticides can help you manage insect pests through adverse weather conditions. **LM**

TURFGRASS PEST CONTROL CALENDAR

When to scout for insects and mites

Pests	I*	P**	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ants	II	A			S or Gr									
Armyworms and cutworms	III	A						S						
Bees and wasps	II	A							S					
Billbugs	III	D,E,F					S or Gr							
Chinch bugs	III	B						S						
White grubs	I	A			S or Gr					S or Gr				
Green June beetles	I	A				S					S			
Ground pearls	III	A						M						
Leafhoppers and spittlebugs	II	A						S						
Mole crickets	I	G,H			S or Gr					Ba				
Sod webworm	III	C,D,E,G						S or Gr						

*Degree of importance as pest: I= Important pest, frequent occurrence; II= Usually present, but generally not a pest; III= Occasional pest, treat when detected.

**Preferred grass species: A= Centipedegrass, fescue, and many other grasses; B= Saint Augustinegrass; C= Fescue; D= Bluegrass; E= Bermudagrass; F= Zoysiagrass; G= Bentgrass; H= Bahiagrass.

S= Sprays; Gr= Granules; Ba= Baits; M= Maintain the turf in healthy condition, irrigate.

Past experience a guide for new year

North

by JOHN WATKINS, Ph.D. / University of Nebraska

The 1995 growing season was a prime example of the ever-changing environment of the American Great Plains.

For much of the nation—the East and Midwest in particular—the spring weather was cold and wet, followed by a sudden onset of hot, dry weather that lasted the rest of the growing season. Several areas of the country set records for days without measurable precipitation, making it difficult to maintain quality turf.

Putting greens were thinned and did not respond to cultural practices. Residential, commercial, sports and other turfs were stressed to the limit, and irrigation bills were out of sight. In addition, the heat, drought and humidity contributed to leaf spot, melting out, dollar spot, fairy ring, necrotic ring spot, summer patch and nematode injury.

Rare maladies

Turfgrass managers were confronted with diseases that previously had not been problems or had rarely occurred in an area.

Only once in the 21 years

PHOTOS COURTESY DR. WATKINS

Red thread damage, relatively rare in the Midwest, was found on bentgrass greens and ryegrass fairways during summer's heat.

prior to 1995 had I seen red thread. Within a two-week period in May, half a dozen golf course superintendents called to report significant red thread damage to bentgrass greens and ryegrass fairways.

With air temperatures in the 90s and soil temperatures at a two-inch depth in the low 100s, putting greens died merely because the turf did not have a sufficient root system to maintain transpiration and tolerate the heat.

Because of the cold, wet spring, root depths were shallow (two to three inches), and the roots could not supply sufficient water to compensate for water lost to hot, dry, windy conditions. Plants died from drought stress and the greens were thin in areas.

Other factors contributed to the demise of putting greens as well:

- low mowing height;
- nitrogen-starved turf;
- rootzone layering.

Golf superintendents faced with similar problems this year could aerify and topdress with appropriate sand or mixes to overcome rootzone layering and support good root system development going into summer.

A balanced fertility program to prevent starvation and raised mowing heights also would help. These practices may decrease putting speed, but rolling, topdressing, grooming, double-cutting or using plant growth regulators can help regain some speed. Light, frequent irrigation in the afternoon to keep the rootzone moist may inhibit root pathogens and root-feeding nematodes.

Drought strikes

Diseases and plant pathogenic nematodes also injure turf during drought periods.

The symptoms of leaf spot and melting out, which are fungal turf diseases, range from small oval spots on leaf blades to fading out of the turf, to extensive crown and root rotting. The leaf spot stage is most evident during wet weather with temperatures between 70° and 90° F.

At temperatures above 80° F, necrosis of the entire leaf blade causes leaf blight. As leaf blighting progresses, the turf fades to brown. During hot, dry weather, leaf sheaths, crowns and roots become infected, causing thin, open areas in the turf. Plants with severe crown and root rot usually die from the heat and drought stress.

Symptoms on bentgrass differ from those of Kentucky bluegrass and fine fescues. When bentgrass golf greens are infected, they have a smoky blue cast that progresses to a yellowing and, finally, blighting of the leaves and thinning of the turf. Injury to the bentgrass usually is more severe when it is growing under soil moisture stress or when it has been overfertilized with nitrogen.

Unsightly nuisance

The trend in golf green management toward lower nitrogen rates causing the darker green fairy rings were quite visible during May and June. They used the peat in the greens mix as a nutrient base and were abundant because of the extended cool, wet spring.

At that stage, fairy ring on the green is more an unsightly nuisance than a threat to the turf. The real problem comes from the fairy ring mushroom's mycelium that infiltrates the soil below the ring. It is hydrophobic and impervious to water, causing the grass immediately above the ring to die from lack of moisture during droughty periods. Aerifying the green and applying the fungicide flutolanil (ProStar) suppresses fairy ring.

Drought stress also can predispose even well-managed turf to dollar spot. Warm days, heavy dews, dry soils and nitrogen-deficient turf are ideal conditions for dollar spot. Persistent drought periods accentuate dollar spot injury and hinder recovery when control measures are implemented.

In a two-year field trial, we obtained satisfactory control of dollar spot on bentgrass with 4-6 lbs. of N/1000 sq./ft. The nitrogen was a slow-release fertilizer applied monthly from May

Summer patch may appear when wet weather is followed by hot, dry periods.

Nematode damage: a non-descript yellowing and thinning of bentgrass and a decline and death of bluegrass.

through October. Although 6 lbs. of actual N per season is too high for a putting green, it is not too high for residential turfs. In this trial, dollar spot suppression at the 6-lb. N rate was comparable to that obtained by fungicides. This illustrates how a balanced fertility program can manage dollar spot.

Turf destroyers

Necrotic ring spot and summer patch are two of the most destructive, stress-related turf diseases. Necrotic ring spot destroys root systems during cool weather; summer patch destroys them when wet weather is followed by hot, dry periods.

Symptoms of either disease are virtually indistinguishable. Turf will show 6- to 12-inch circular or semi-circular patches, giving the area a pockmarked appearance. The dead grass is light tan and matted, and many of the patches will have a tuft of healthy grass in the center—the "frog-eye" symptom. Diseased roots will appear dark brown.

On established turfs, the most important control is to eliminate plant stresses that favor disease development. Avoid management practices that promote rapid top growth at the expense of root development, and keep adequate moisture in the rootzone by lightly and frequently irrigating.

When you scout for nematodes, take 20 core samples per 1000 square feet.

Keep thatch and rootzones moist. Applying compost materials or organic fertilizers can increase microbial activity, and certain microbes partially inhibit fungus that causes necrotic ring spot or summer patch. Also, other naturally-occurring fungi that compete with the pathogens for food help keep diseases in check. During extended dry spells, beneficial microbe activity is slowed or even suppressed, giving the pathogen a distinct advantage. A moist rootzone helps to reduce the stress of dry spells.

Other practices to control necrotic ring spot or summer patch include a balanced fertilizer program with slow-release nitrogen fertilizers and a fungicide program. Benzimidazole-type fungicides can be applied curatively. Other fungicides can be used preventively in early fall or mid-spring. Apply them with sufficient water to drench them into the rootzone.

If you're establishing new turf, avoid planting pure stands of susceptible Kentucky bluegrasses. Use a blend of improved drought-tolerant cultivars or mix in 15 to 20 percent, by weight, of the newer brown-patch-resistant turf-type perennial ryegrasses with the Kentucky bluegrass blend.

The improved drought-tolerant cultivars will be less prone to stress and thus, less prone to summer patch. Remember, blends or mixtures are only as good as their components, so choose your cultivars carefully. □

SYMPTOMS OF COOL-SEASON TURFGRASS DISEASES

Disease	Key symptoms	Control strategy
Leaf spot/ melting out	1) dark spots on leaves 2) yellow, thinning turf 3) brown roots and crowns	1) use resistant cultivars 2) fertilize properly 3) irrigate properly 4) apply fungicides
Dollar spot	1) bleached lesions on leaves; reddish-brown margins 2) four- to six-inch patches of straw-colored turf 3) silver dollar-sized, bleached spots on bentgrass greens	1) use resistant cultivars 2) increase the nitrogen level 3) irrigate properly 4) apply fungicides
Fairy ring	1) circles of dark green grass some with dead areas in the ring	1) remove infested sod and soil; replace with clean soil and reseed 2) aerify and irrigate 3) spot treat with flutolanil
Necrotic ring spot	1) pockmarked circular depressions in turf with healthy tufts ofgrass in centers 2) brown to black roots and crowns	1) use resistant cultivars 2) raise mowing height 3) use light, frequent irrigation 4) apply organic fertilizers 5) aerify 6) apply fungicides
Nematodes	1) yellow, wilted, thinning turf 2) reduced root system with brown lesions on roots	1) sample the affected area, obtain a nematode analysis 2) fertilize properly 3) irrigate properly 4) raise the mowing height 5) apply a non-fumigant nematicide, if available

SOURCE: DR. WATKINS

For warm-season disease control: know your turf!

South

by BRUCE MARTIN, Ph.D. / Clemson University

Diseases can seriously limit the successful culture of warm-season turfgrasses. Fungi are most of the living causal agents of disease in warm-season grasses, but nematodes are a problem, too, particularly in sandy soils.

Successfully managing diseases in warm-season grasses depends on knowing the requirements of the particular grass in question, the biology of the pathogens, and good turf horticultural practices. Pesticide applications are valuable in an overall integrated pest management system, but they must be used responsibly.

Brown patch

A major disease of cool-season grasses, brown patch also commonly attacks warm-season grasses, including bermudagrass, St. Augustinegrass, centipedegrass and zoysiagrass. The primary causal agent is *Rhizoctonia solani*, but the strain which causes the disease differs from those encountered as pathogens of cool-season grasses.

Brown patch symptoms appear in the spring, as the turfgrass is breaking dormancy, or in the fall, as the turfgrass approaches dormancy. Individual disease patches may be 20 or more feet in diameter. Shoots along the outer border of patches usually are yellow due to rotted leaf sheaths near the soil surface.

Dollar spot

This disease occurs on all of the warm-season turfgrasses, but gets severe in bermudagrass

and zoysiagrass. Best conditions for dollar spot are warm, humid weather. Dollar spot can be more severe on nitrogen-deficient turf or turf that has become drought stressed before rain or high humidities occur.

Symptoms differ depending on the grass's height of cut. On turf cut low, patches of about one to two inches in diameter develop. On higher-cut turf, patches may exceed five inches in diameter. Characteristic leaf lesions are a bleached tan with distinct reddish brown or purplish margins. Leaves may become girdled. In early morning, it is not uncommon to see a gray mycelial growth.

Spring dead spot

Spring dead spot of bermudagrass occurs in transition zone areas of the U.S. It is common in the Piedmont and mountain areas of the Carolinas and Georgia, but rare in the coastal regions. Hybrid bermudagrasses are particularly susceptible, but common types may also be afflicted. Several fungi probably cause this disease. All are relatively slow-growing, root-colonizing fungi.

Symptoms include dead circular areas of turf, two or three feet in diameter, found in spring as bermudagrass breaks dormancy. Patches of diseased turf may persist for several years. Older patches develop a "frog-eye" symptom with healthy grass in the center.

Generally, spring dead spot develops in turf that is three to six years old. Excessive thatch, late-summer nitrogen applications, and low temperatures in winter predispose turf to spring dead spot.

Gray leaf spot

Gray leaf spot is caused by *Pyricularia grisea*, a very common disease of St. Augustinegrass occurring in hot humid weather. It is more severe in new turf, in shady locations with poor air movement.

Infections occur on leaves and stolons, first as small brown spots with a distinct brown color, to a purple border around the infected tissue. Lesions may become very numerous and expand to completely consume leaves and girdle stolons. Severe infections may leave turf with a scorched appearance. The disease is sometimes called "blast" due to this symptom.

Leaf spot

Bipolaris sorokiniana causes leaf, crown and root diseases of bermudagrass and zoysiagrass during warm, wet weather in mid-summer. The diseases start as leaf spots, and may progress to crown and root rots. *Exserohilum rostrata* has been reported to cause a leaf spot of St. Augustinegrass and bermudagrass. However, these diseases are rarely severe where these grasses are cultured in open, sunny locations, with good soil drainage. If they occur, it may be a sign of other stresses to the turf that can be managed culturally.

On bermudagrass or zoysiagrass, small dark brown lesions appear on leaf blades and sheaths and may expand to larger, irregular, straw-colored lesions. Stolons and roots may develop a dark, or dry rot. The turf may brown and thin, over a period of weeks or months.

Pythium diseases

More of a problem in cool-season grasses, some Pythium species cause general decline by infection of roots.

St. Augustinegrass is susceptible during prolonged warm, wet periods. Poor surface and subsurface drainage favors pythium fungi, and encourages algae in areas where disease has weakened the grass.

Fairy ring

Symptoms appear as rings or arcs of green, stimulated turf which may be accompanied by declining grass and mushroom formation. Problems develop when mushroom mycelia accumulate in the soil and dry it out. Fairy rings may persist and increase in diameter over years. The fungi may colonize old roots, stumps, or thatch, or may be mycorrhizal on living trees. Newly-constructed putting greens may develop infestations after only a few months or years.

Nematodes

Turf infested with damaging nematode species appears unthrifty; weeds invade weak or dead areas. Infested areas tend to wilt prematurely, even when adequate soil moisture is available. In most cases, nematodes occur in very sandy soils. **LM**

CONTROL PRODUCTS FOR WARM-SEASON TURF DISEASES

Brown patch	Eagle WSP; Daconil 2787F; Daconil 90WDG; Daconil Ultrex; Prostar 50 WP; Bayleton 25 WP; Banner 14.3EC; Rubigan AS; Chipco 26019 50WP; Chipco 26019 23.3%F; Fore 37%F; Fore 80WP; Terraclor 75 WP; Turfside 10G; Curalan 41.3% F; Curalan DF; Cleary's 3336 50WP; Cleary's 3336 46%F; Sentinel 40WG
Dollar spot	Eagle WSP; Daconil 2787 F; Daconil 90WDG; Daconil Ultrex; Banner 14.3 EC; Bayleton 25WP; Curalan 50WP; Curalan DF; Rubigan AS; Chipco 26019 50WP; Chipco 26109; 23.3%F; Fore 80WP; Cleary's 3336 50WP; Cleary's 3336 46%F; Vorlan DF; Vorlan Flo; Sentinel 40WG
Spring dead spot	Rubigan AS; Eagle WSP
Gray leaf spot	Daconil 2787F; Daconil 90WDG; Daconil Ultrex; Banner 14.3%EC; Sentinel 40WG
Leaf spot	Daconil 2787F; Daconil 90WDG; Daconil Ultrex; Chipco 26019 50WP; Chipco 26019 23.3%F; Banner 14.3%EC; Curalan 50WP; Curalan Flo; Vorlan DF; Vorlan Flo; Fore 37%F; Fore 80WP; Eagle WSP
Pythium diseases	Aliette 80WP; Koban 30WP; Subdue 2E; Subdue 2G; Banol 6E
Fairy rings	Prostar 50WP
Nematodes	Mocap 10G; Nemacur 10G; Nemacur 3E

Note: each product has specific use rates and intervals. Read labels and follow specifications as listed on label.

SOURCE: DR. MARTIN