How turfgrasses respond to *mowing*

By Dr. Doug Linde

One Saturday evening when I was 16 I had had enough with the slow putting greens at my father's golf course. I slithered into his maintenance shop and lowered the height of cut on the triplex greens mower. Although I had no idea how much I lowered the height, the test cut on the practice green seemed pretty good to me. The next few days golfers were commenting to my father on how fast the greens played. His investigation included seeing some scalp marks and asking his mechanic if he'd touched the cut height, and he soon determined what I had done. I was then given one of my first lessons on how mowing affects turf!

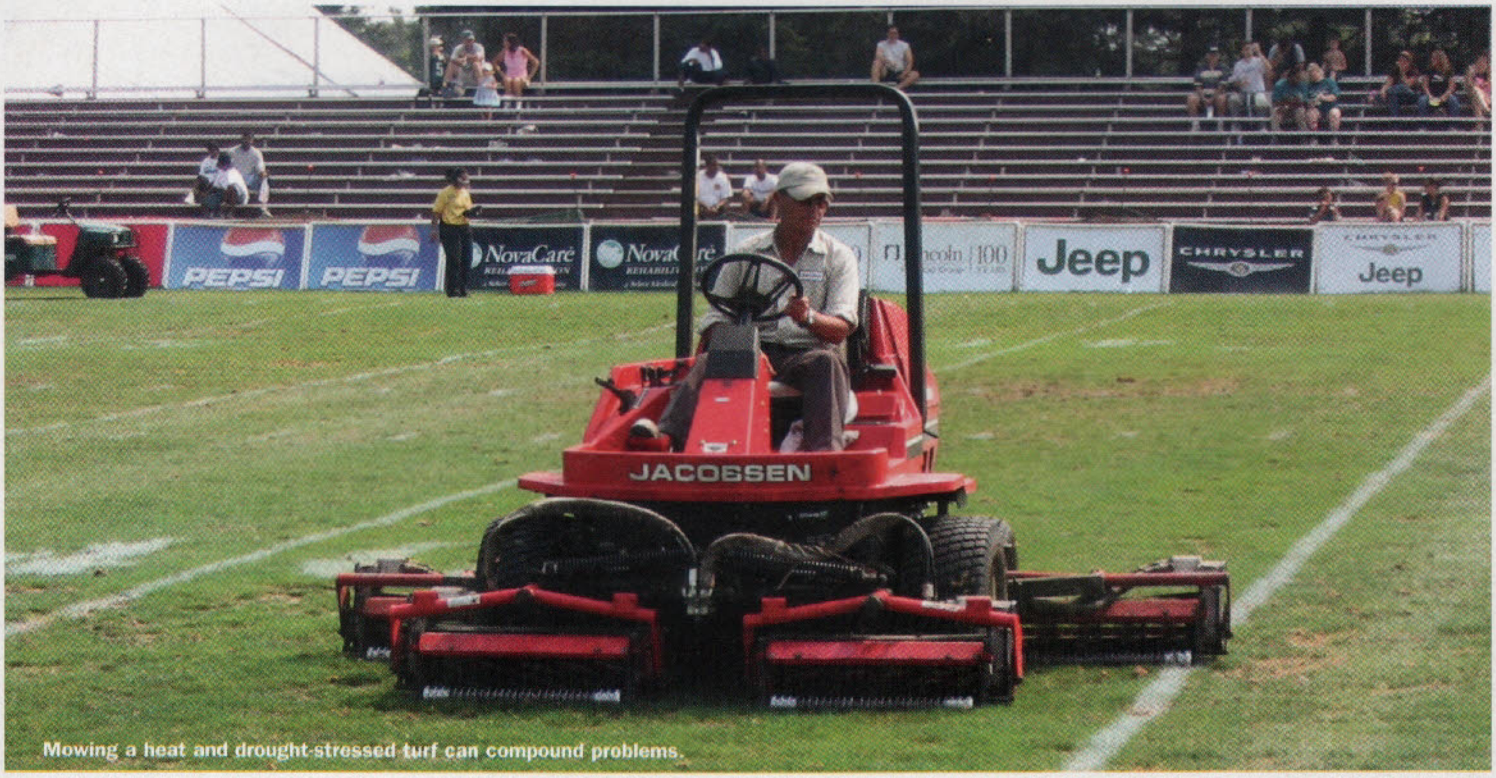
Here I'll share that lesson and others I've learned about the effects of mowing on turf:

Plant's response to each mowing

Mowing causes plant stress! Fortunately, turfgrasses are well adapted to this stress. There are a variety of responses that occur every time a single turfgrass plant is cut. One response is fluid exudes from the cut leaf–this includes water and organic compounds. The odor of a freshly cut turf is evidence that organic compounds are leaving the plant through the wound.

Another plant response after being cut is to repair the wound. Like a flesh wound in humans, the open wound becomes an entrance for disease-causing organisms and it's important the plant repairs it as soon as possible. Stored energy (carbohydrates) is used in the repair.

Stored energy is also used in the next plant response to cutting which is to replace the cut leaf tissue by growing new leaf tissue. Simultaneously, the plant is using extra energy for repair and regrowth while it is producing less energy for itself via photosynthesis because part of the plant's energy generator (the leaf) has been removed. As a result, an energy "dip" occurs after each cutting. The plant attempts to replenish its energy reserves as soon as its leaf tissue becomes sufficient again. Scalping, excessive defoliation, and environmental stresses can slow the replenishment and weaken the plant.



Mowing a heat and drought-stressed turf can compound problems.

Despite being well adapted to cutting, turfgrass plants are still under some stress after being mowed. In addition, when energy reserves are adequate the plant can better tolerate cutting and other stresses. When reserves are inadequate, the plant is weakened by cutting and more prone to problems, especially if under other stresses such as wear, drought, heat, disease, etc.

A final plant response to cutting is root growth stops for a period. The regeneration of new leaves takes priority over root production and energy is diverted to repair and grow the leaf.

Plant's response to regular mowing

When a turfgrass plant is subjected to regular mowing, it causes three responses. First, the plant produces more tillers that increase the density of the turf stand. This response alone is the reason to mow a stand of young seedlings as soon as possible. Second, the plant and all its parts get smaller in size. This dwarfing of the plant leads to the third response of lowering the crown closer to the soil surface.

These responses may take weeks to fully occur thus it's important to follow the "one-third rule" to determine mowing frequency. Removing no more than one-third of the leaf surface at any one mowing induces the desired responses described above without placing excessive stress on the plant. Following the "one-third rule" also reduces clippings, decreases the severity of the energy "dip" after mowing, and minimizes scalping.

Plant's response to closer mowing

The plant's response to closer mowing depends on whether or not the lower height of cut is within the plant's tolerance range. Each turfgrass species has a cutting height range it can tolerate and still produce an adequate turf cover. When mowing closer within that tolerance range, the plant becomes smaller, the rootzone shorter, tillering and density increase, leaf texture gets finer, and carbohydrate production and storage decrease.

Most of these responses result in a plant that is less tolerant to environmental and disease stress. When mowing closer but below the plant's tolerance range there are some additional responses such as scalping and/or a weakening because the plant doesn't have sufficient tissue for photosynthesis. A turf stand of these plants can become thin and overtaken by weeds. Therefore, set cutting heights within the species tolerance range.

The most significant response listed above is a smaller plant. Smaller plants produce less energy and have a shorter rootzone. Fewer roots are needed to support the smaller shoots. A turf with a shorter rootzone has a decreased capacity to absorb water and nutrients from the soil, thus making it necessary for more frequent irrigation and fertilization.

As my father taught me, lowering the height of cut on a mower

Plants that are scalped take more time and energy to recover.

Clumps of clippings can smother the turf.

is rather easy and inexpensive to do, but mowing a turf closer can become expensive. For example, lowering the height of cut of a Kentucky bluegrass baseball field from 2 inches to 1.25 inches would result in the following additional costs: If the "one-third rule" is followed, at least one additional mowing per week would be needed. Assuming it takes 2 hours labor to mow and clean-up, $15/hr labor cost, and a 6-month growing season; it would take an additional 48 hours per year and cost $720.

That's only the direct cost however; there are numerous indirect costs. As mentioned earlier, a smaller plant requires more frequent irrigation and fertilization. In addition, a smaller plant is more susceptible to disease, thus fungicides may need to be applied regularly. Finally, a smaller plant requires a higher level of expertise to maintain. These indirect costs can be high, especially if the field has no irrigation system, no sprayer available for fungicides, and limited expertise. This is what I learned when I lowered the height of my father's greens mower.

Plant's response to the mower

Mowers cause plant stress! Not only do mowers cause a cutting-induced response in the plant but can cause the entire turf stand to respond in a variety of ways. For example, excessive clippings can smother the turf, dull blades lead to chewed leaves, mowing too fast can lead to bobbing and a washboard turf appearance, mowing through active fungal mycelium or seed-producing weeds spreads disease and weeds, and uneven terrain and/or thatchy turf can lead to scalping.

There are also various mowing situations and management practices that lead to additional stress. They include mowing when the plant is drought stressed, mowing when the turf is excessively wet, tire wear when turning, bedknife wear, hydraulic oil leaks, improper mower setup, grain, frost injury, triple mowing, and use of heavy mowers. These are all undesirable responses or situations. Fortunately, most are related to management issues and can be easily corrected.

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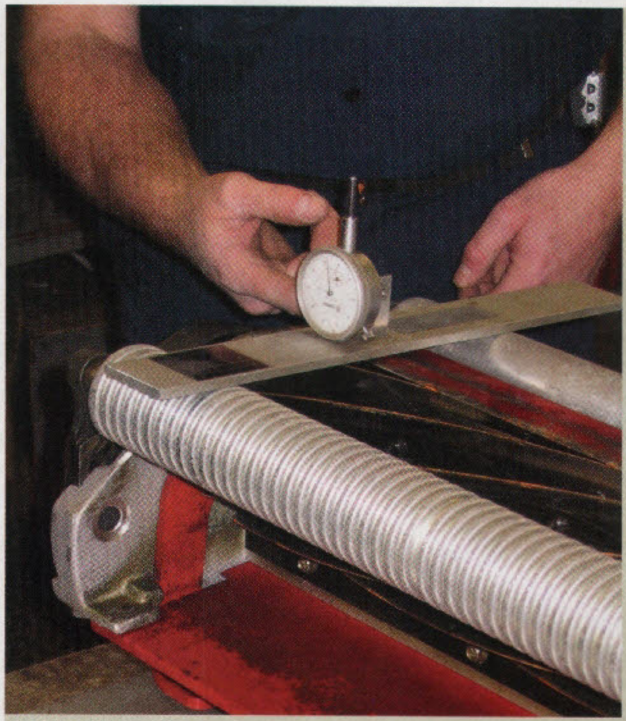

Although lowering the height of cut is easy and inexpensive, mowing a turf closer can get expensive.

Recommended mowing practices

Turf managers that can incorporate as many of these practices as possible into their management program should be able to produce a more playable and aesthetically pleasing turf at a lower cost:

1. Regularly sharpen and adjust mower.
2. Operate mower properly.
3. Set cutting height within plant's tolerance range.
4. Follow the "one-third rule."
5. Limit double & triple cutting.
6. Avoid mowing when:
   - Disease is active and turf is wet.
   - Turf is drought and/or heat stressed.
   - Turf is saturated and heat stressed.
   - Turf has a frost.
7. Raise cutting height just before environmental stress periods.
8. Lower cutting height in small increments.
9. Mow a stand of young seedlings as soon as possible.
10. Use lightweight mowers.
11. Reduce thatch.

Much Ado About Adjuvants

By Scott McElroy, PhD

"There is nothing either good or bad–thinking makes it so."

Adjuvants, or spray additives, are oft-misunderstood chemicals. End-users either expect too much from the addition of an adjuvant, do not fully respect the need for an adjuvant, or are duped into buying with unproven promises. All of these problems can be solved with a short review of what adjuvants are and how they work.

"To be or not to be that is the question."

The first step in understanding adjuvants is clear definitions. First as stated previously, adjuvants are simply spray additives that have beneficial properties of enhancing performance of the active ingredient or improving the performance of the spray solution. From this definition we see that adjuvants really are the overarching term for all additives to an agrichemical spray solution.

Within the classification, there are essentially two groupings–activator and utility adjuvants. Activator adjuvants enhance the performance of active ingredients of pesticides while utility adjuvants have some beneficial effect on the spray solution, but do not directly affect active ingredients performance. Let's first explain utility adjuvants.

Utility adjuvants have numerous uses, but they basically improve the ease of applying the spray solution. Examples of utility adjuvants includes compatibility agents, defoamers, drift control agents, deposition agents, water conditioning agents, acidifiers, buffers, and colorants. Definitions of utility adjuvants are presented in Table 1. If a herbicide does not mix well, if you have hard water, or if you have to spray at a high rate of speed, utility adjuvants can be added to the spray solution to improve performance.

Activator adjuvants have a beneficial effect on the active ingredient. If you are applying a herbicide, this is the most important group of adjuvants. Without this group of adjuvants many herbicides will simply not work. Types of adjuvants include wetting-spreading agents, sticking agents, humectants, absorption agents, safener, synergist, and extender. In order for an activator adjuvant to improve the activity of an active ingredient it must affect one of three areas–absorption, translocation, or metabolism (the exception is extender adjuvants). Absorption is the movement of the active ingredient through the plant cuticle, translocation is the movement of the active ingredient throughout the plant vascular system, and metabolism is the breakdown of the active ingredient. By increasing absorption or translocation, or decreasing metabolism, an adjuvant can increase the activity of an active ingredient. The opposite effect would occur if the opposite occurs.

"What's in a name? That which we call a rose."

One term that has not been mentioned thus far is surfactant. "Surfactant" is often used synonymously with the term adjuvant; however, these terms are not the same. Adjuvant refers to any additive to an agrochemical spray mixture; surfactant is a term describing a classification of chemicals.

Surfactants

Surfactants, shortened from surface-active agent, is a classification of chemicals that produce physical changes in the interface of two dissimilar liquids- primarily hydrophobic (water-hating) and hydrophilic (water-loving) liquids. Hydrophobic liquids such as oil are primarily non-polar molecules that do not mix with water or other polar, hydrophilic liquids. Surfactants bridge the polarity gap by virtue of their own chemical structure.

Surfactants have both hydrophilic and hydrophobic portions to their chemical structure that allow them to bridge between dissimilar liquids. The hydrophobic portion is a long, hydrocarbon chain often referred to as the tail. Whereas, the hydrophilic portion is a short, carboxylic group referred to as the head. The tails of the surfactant molecules imbeds itself into the oil droplet forming a micelle while the head interacts with the water allowing the oil molecule to dispense in the water.

Due to his chemical action, many surfactants function as adjuvants, primarily activator adjuvants. Surfactants can decrease the surface tension of water allowing the spray droplet to spread and wet. Surfactants can also promote interaction of the spray droplet with the hydrophobic leaf surface allowing for greater active ingredient absorption.

"There was never yet philosopher that could endure the toothache patiently."

To completely complicate the situation, much of what we have covered about adjuvants thus far you will not find on the adjuvant label. Instead you will find terms like "non-ionic surfactant," crop oil concentrate," or "modified seed oil." This is because many of the spray activator adjuvants you purchase are really what can be classified as emulsified oils (see common adjuvants listed in Table 3).

These emulsified oils are a mixture of a 50-90% oil base with a surfactant added. Oil-based adjuvants such as these are the most common adjuvant type and are often wetter-spreaders with some sticker properties as well. The oil portion of the adjuvant improves interaction of the plant cuticle, while the included surfactant aids in interaction of the spray solution with the oil. This interaction improves overall uptake of the active ingredient.

So which adjuvant should you buy? That question is not easily answered. First, when you read the active ingredient section of an adjuvant label two words often appear, "proprietary blend." Companies simply do not divulge the contents of their adjuvant because they do not want competitors to have their information.

Second, the *Compendium of Adjuvants* lists 523 spray adjuvants available for purchase from 39 companies in 2006. Trying to sort through such a vast number of products is impossible.

"What is decreed must be."

So the best answer to which adjuvant to buy is often the one that is recommended on the herbicide label. Herbicide companies want their product to work, so they are going to tell you exactly how to use it. Research is conducted to determine exactly how much herbicide needs to be applied for weed control and desirable plant/turf safety.

Another answer to which adjuvant you should buy is to simply understand how the active ingredient works. If you are applying a foliar absorbed active ingredient with effective translocation, you do not need an adjuvant that extends soil life or that improves translocation. Most likely, the herbicide label will recommend an adjuvant to improve foliar absorption.

"Et tu, Brute?"

As stated before, the best adjuvant to use is the one recommended by the pesticide manufacturer on the pesticide label. Manufacturers extensively research to determine the exact dose with the proper adjuvants to use. No more, no less. So beware of any salesman or adjuvant claim that says you can reduce the pesticide rate if you use a given adjuvant. Buyer beware. Adjuvants are helpful, but they are not magic potions. ■

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Table 1. Definitions of common utility adjuvants.

Compatibility agents: Improves the mixture and uniformity of the application liquid.
Defoamers: Eliminates or reduces foam in the application liquid.
Drift control agents: Reduces the driftable portion of the application liquid once sprayed.
Deposition agents: Improves the ability of the applied liquid to apply to the target.
Water conditioning agents: Reduces the interaction of ions in the spray solution to interact with the active ingredient.
Acidifiers: Lowers the pH of the spray solution.
Buffers: Aids the spray solution by preventing change in pH when other chemicals are added to the mixture.
Colorants: Changes the color of the spray mixture. Also referred to as dyes or paints used for marking spray patterns and areas.

Table 2. Definitions of common activator adjuvants.

Wetting-spreading agents: Lowers surface tension of the spray droplet increasing droplet coverage of the leaf surface.
Sticking agents: Viscous materials that improve adhesion of spray droplets to leaf surface.
Humectants: Reduce evaporation speed of the spray droplet on the l eaf surface potentially improving active ingredient absorption.
Absorption agents: Improve movement of the active ingredient through the leaf surface. Improves absorption by softening or dissolving epicuticular wax or improving stomatal infiltration.
Safener: Reduces phytoxicity to desirable plants. Potentially increases metabolism of the active ingredient, reduces translocation, or reduces absorption of the herbicide.
Synergist: Increases the activity of the active ingredient. Potentially decreases metabolism of the active ingredient, reduces translocation, or reduces absorption of the herbicide.
Extender: Increases the longevity of the herbicide in the soil often by decreasing microbial activity.

Table 3. Common terminology seen on adjuvant labels.

Non-Ionic Surfactant: Surface active agent having no polar end groups.
These surfactants are beneficial because they are effective in hard water.
Crop Oil Concentrate: An emulsifiable petroleum-based adjuvant containing 80% phytobland oil and 5 to 20% surfactant.
Vegetable Oil Concentrate: An emulsifiable vegetable oil-based adjuvant containing 80% vegetable oil and 5 to 20% surfactant.
Modified Seed/Vegetable Oil: An emulsifiable oil-based adjuvant containing 5-20% surfactant and the remainder chemically modified vegetable oil.

Environmental turf craft

By Kevin Trotta

At the intersection of the natural world and the human world lies the athletic field. It is the integration of nature's raw materials (grass) and man's propensities to play and to shape his surroundings. As a blending of man and environment it serves as a natural-cultural resource. It provides an opportunity for people to be outside, where our species evolved, naturally linked to the dynamic green and blue complexity around us.

In this time of heightened environmental awareness, the challenge for those of us who manage these fields is to find cleaner, more sustainable, "greener" means of doing so. Environmental Turf Craft represents an approach to this challenge as it seeks to reconcile turf management and environmental stewardship.

A craft is a marriage of art and science. The requisite goal of the sports turf manager here in the eco-conscious 21st century, is to become a master craftsman, responsibly and expertly practicing this kind of art informed by science.

Environmental Turf Craft is a convenient name for a hybrid system that incorporates the most effective and sustainable aspects of Integrated Pest Management, organic systems, conventional management, and environmental Best Management Practices. As in modern integrative medicine: if it works, use it. The objective is balance: to maximize the well-known benefits of turfgrass while minimizing negative impacts.

Big picture proactivity

This proactive mindset provides the perspective to better evaluate the "big picture" ramifications of our operations. We can review our management decisions in ways that transcend purely agronomic criteria. Some typical turf craft considerations might include:

- Is our 30-year-old tractor negating the turf's air quality benefits?

- Are unreasonably low cutting heights sustainable?
- Can we use some natural organic fertilizers in our programs, a practical answer to a question of waste?
- Is our equipment tuned for peak performance?
- Does continuing education allow us to accurately identify turf problems and their causes?
- Shouldn't pesticides be comparatively scrutinized before selection?
- Aren't there special considerations in the sand-based rootzones of some sports fields?
- How and where is our mowing equipment washed?
- Is fertility mismanagement canceling out the water purifying benefits of turf?
- Are we addressing a pest issue with chemical intervention when a cultural modification will do?
- Has an irrigation audit enabled the most efficient use of a natural resource?
- Are the attitudes and actions of our industry visible and recognizable as those of environmental stewards?

Environmental Turf Craft is a balanced approach that relies on science to steer the course. It's more than an amalgam of tools and techniques. When our daily management decisions are guided by the underlying principles of environmental responsibility, our strategies and procedures are subtly and positively influenced. We abandon the clumsy, product based, heavy-handed practices left over from turf management's infancy in the last century. We become aware of our roles as navigators and pilots within the environmental movement. We take our place as leaders in this new kind of pragmatic environmentalism where social and economic as well as ecological objectives are balanced.

We become active caregivers in the process of earth's healing: as toxic, abandoned mining sites become oxygen generating golf courses; as landfills are sealed and reborn as health promoting athletic fields; as people get out of their homes and offices and, seeking recreation and life sustaining fresh air, join us on our turf.

It's unfortunate that some misguided critics of turfgrass see us as an environmental problem when obviously, we're part of the solution.

What could be greener than grass?

This article originally appeared in the 2007 Rutgers Turfgrass Proceedings. ■

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