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Selecting Pesticides for Sports Fields

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Introduction

Sports fields provide some of the most challenging situations in growing managed turfgrass because of the amount of traffic they receive, the regular mowing at close cutting heights that provide optimal playing conditions, the expectations of the field users about its playability, and a variety of environmental and pest stressors that further complicate field management. Predictable athlete footing and ball bounce are paramount to a safe playing surface (Figure 1). Since there are so many possibilities of athlete/playing surface interactions from running, sliding, and tackling on fields, the selection and use of appropriate pesticides receives even greater scrutiny. But pesticides are an extremely valuable tool in improving field safety and playability characteristics when handled and applied properly.

Before even considering a pesticide application, consider these factors: 1) what is the pest (i.e. get it correctly identified) and does it warrant a pesticide application? and 2) are there potential side effects of the pesticide (concerns for athletes and field use, non-target organisms affected by the application, the ability for the field to recover, etc.). that might alter your use and/or selection of a pesticide? The Virginia Cooperative Extension provides several resources at the county office with your local agent and support staff and university levels with disease, weed, and insect identification laboratories that will help you properly identify pests, determine if their appearance and/or populations warrant treatment, and develop the best pest management program for your situation.

Figure 1. The clumpy ryegrass on this dormant bermudagrass field presents safety concerns for athlete footing and a predictable ball bounce.

Selecting a Fungicide

For a disease to occur the “disease triangle” must first be completed. There are three components of a disease triangle: 1) a susceptible host (the turfgrass), 2) a virulent pathogen (most of the time, a fungus), and 3) a suitable environment. The pathogen is almost always present in nature, so the reasons we do not constantly encounter diseased turfgrass include superior turfgrass genetics from breeding efforts that impart greater tolerance to the disease and/or an inappropriate environment for the disease to develop. When conditions warrant a fungicide application, a series of informed decisions must be made by the sports field manager in choosing the best control strategy for the pest in terms of fungicide selection, the environment, the budget, etc.

Classifying Fungicides

There are numerous ways to classify fungicides, so a review of some terminology is important for making the best selection when planning a treatment.

Consider how a fungicide can move on or within the plant – its **phytomobility**. Knowing how a fungicide does or does not move in or on the plant allows one to make informed decisions regarding spray volumes for application, whether or not to irrigate after an application, and anticipate how long control might be as affected by mowing and so forth.

Contact protectants are not absorbed by the plant and they only protect the part of the plant that is covered with the fungicide. These fungicides are typically cheaper, must thoroughly dry on leaves before irrigation or a rainfall event to maintain activity, and offer control lengths of typically 7 to 14 days. The length of activity with contact fungicides depends a great deal on the mowing regime. Mowing removes most of the fungicide from the plant. The most important contact fungicide by far is chlorothalonil.

The **penetrant** fungicides are absorbed into the plant but their level of translocation within the plant and modes of action vary widely. *Localized penetrants* move into the leaf tissues and remain near the point of entry. Some examples of this group are cyazofamid, fludioxonil, iprodione, polyoxin D, pyraclostrobin, and trifloxystrobin. **Acropetal penetrants** are absorbed into the plant and translocated in the xylem of the plant, so movement is solely upward in the water stream. Most labeled fungicides are acropetal penetrants. Examples are azoxystrobin, fluoxastrobin, flutolanil, isofetamid, mefenoxam, metconazole, myclobutanil, penthiopyrad, propamocarb, propiconazole, thiophanate-methyl, triadimefon, and triticonazole. The penetrant fungicides offer both protective and curative activity, since they are absorbed, and some are even translocated within the plant. Consider how an acropetal penetrant can provide "whole plant" control if it is appropriately watered in so that it is translocated through the xylem from the base of the plant to the leaves. For acropetal penetrants to be effective throughout the plant, they must enter through the roots for upward translocation. Research has shown that certain acropetal penetrants are more effective against root pathogens when irrigated immediately afterwards with ⅛″ to ½″ of water. Soil wetting agents have also been shown to enhance fungicide distribution, which may allow for improved fungicide efficacy against root diseases. Penetrants are typically more expensive, maintain their potency better if an unexpected rainfall event occurs after application, and offer control periods of 21 to 28 days. The control period for the penetrants is also affected by maintenance programs and the climate. The only **truly systemic** (moves bidirectionally within the plant) are phosphonate materials such as fosetyl-Al. Control with truly systemic fungicides, however, is typically limited to Pythium diseases and other water molds.

These "expectations" for performance of contacts and penetrants are, of course, generalizations, and the reader should be aware that performance aspects of individual chemicals can vary considerably.

Other ways to classify fungicides include their mode of action and Fungicide Resistance Activity Committee (FRAC) code found on the label. All pesticides now list these codes, but fungicides were the first category of pesticides to have these codes. This was because a concerted effort was made to mitigate fungicide resistance due to how quickly resistance can occur given the rate at which fungi can reproduce so rapidly and prolifically. In product selection, be sure to vary modes of action based on FRAC numbers seen on the label to reduce the likelihood of resistance.

Figure 2 is presented to show how to properly choose fungicides and avoid the development of fungicide resistance. The two chemicals listed on the top row in the figure have different active ingredients (pyraclostrobin, trade name Insignia on the left and azoxystrobin, trade name Heritage on the right), but note that these fungicides belong to the same FRAC grouping (11, the quinone outside inhibiting (QoI) grouping commonly called strobilurins); these products should not be applied in sequence due to the increased likelihood of fungal pathogens developing resistance to strobilurins. Incorporate another labeled fungicide for the targeted disease into the treatment program from a different FRAC grouping, such as triticonazole (trade name Trinity, FRAC group 3 of the demethylation inhibitor (DMI) class) shown on the bottom left. For situations where the active ingredient is such an industry standard for how well it controls certain diseases (for example, azoxystrobin listed on the top right is an exceptional

brown patch treatment) and you wish to keep that chemistry in your treatment plan, follow up with a fungicide combination product that adds a different FRAC grouping to the control such as the azoxystrobin + difenoconazole (Briskway, FRAC groups 11 and 3) pictured on the bottom right. For these reasons, there are many fungicide combination products on the market, expanding both the spectrum of disease control and reducing the likelihood of fungicide resistance.

Figure 2. When developing a disease control program, choose fungicides with different FRAC groupings to minimize fungicide resistance.

The **multi-site** fungicides have little to no resistance potential, but their activity is relatively short-lived (7-14 days). Chlorothalonil (FRAC M05) has been widely used as a stand-alone fungicide since the 1960s and because of its multi-site activity it also is mixed in a variety of combinations with fungicides from other classes (different FRACs) to improve the spectrum of disease control and reduce the likelihood of fungal resistance.

A chemical class that has been around since the 1960s is the **benzimidazoles** (FRAC 1) and there is one product still used in this category that has been a standard fungicide for many years: thiophanate-methyl, a product with a very broad spectrum of disease control activity, but also one for which there is confirmed dollar spot resistance. The **demethylation inhibitors (DMIs)**, (FRAC 3) came on the market in the late 1970s and new DMIs are still being registered in the twenty-first century. These are single-site mode of action products that inhibit sterol biosynthesis (they disrupt the production of the plasma membrane in fungal cells). These products are acropetal penetrants (they move upward in the xylem), have very broad-spectrum fungal activity, and there is known resistance in dollar spot and gray leaf spot. Five popular DMIs labeled in sports turf management are propiconazole, triadimefon, myclobutanil, metconazole, and triticonazole.

The **QoI** class (also called **strobilurins**, FRAC 11) appeared in the 1990s and this class remains very popular because of its broad-spectrum disease control, particularly regarding brown patch. These fungicides inhibit fungal respiration. Strobilurin fungicides are either local or acropetal penetrants, depending on active ingredient. Standard strobilurins used in sports turf management include azoxystrobin, fluoxastrobin, pyraclostrobin, and trifloxystrobin. Several of the QoIs also have appreciable activity on Pythium diseases. As a class, they are considered to be weak on dollar spot with the exception of mandestrobin which is very active on dollar spot and weak on brown patch. There is confirmed resistance to QoIs for Pythium and gray leaf spot. Note the large number of combination products that feature a strobilurin with an active ingredient from another class; these are some of the most effective fungicides on the market in terms of their spectrum of control.

The **SDHI** (succinate dehydrogenase inhibitors, FRAC 7) class of fungicides act by blocking energy production in fungal cells. The five labeled SDHI class fungicides for sports fields are fluopyram, flutolanil, fluxapyroxad, isofetamid, and penthiopyrad. All these fungicides are acropetal penetrants, but SDHIs have highly variable activity with flutolanil known especially for brown patch control and isofetamid for spring dead spot suppression. Fluxapyroxad and penthiopyrad are noted for having much more broad-spectrum activity than other SDHIs.

There is now only one **dicarboximide** (FRAC 2) fungicide labeled in sports turf, iprodione, which has been around for decades. This is a very broad-spectrum fungicide and there are many instances of confirmed disease resistance to this class.

The most popular biological fungicide is polyoxin D (FRAC 19), a natural antibiotic compound produced by *Streptomyces* spp. and it is noted in particular for its activity on *Rhizoctonia*. There is a current emphasis on plant-health-promoting products in the

turf industry. Specifically, acibenzolar-S-methyl (FRAC P1) is added to several common active ingredients (denoted with *Action®) to promote plant defense against biotic and abiotic stresses. Several non-classified host plant defense inducers are available for turfgrass uses, such as mineral oils and phthalocyanine pigments (FRAC PNC).

Do not include illustrations if they are not legible or helpful. If an illustration or diagram is provided as a jpg file, please refer to the guidelines above for photographs. Alt text must be added to all files that are added to the publication.

Table 1 lists fungicides labeled for use in sports turf and the diseases they can control. This table can help in making better fungicide selection choices. However, the information presented is not to be interpreted as all-inclusive, and it is important to note that there can be a wide range of efficacy between fungicides listed as providing control of select diseases. It is also likely that in some situations certain chemicals not noted in this table would provide satisfactory results.

Selecting a Nematicide

An expanding category of sports field pests that are often linked with turfgrass pathology and disease management are plant-parasitic nematodes (PPN). These microscopic roundworms feed on plant tissues by puncturing the plant with a syringe-like structure called a stylet and sucking the moisture and nutrients out of the plant, which can lead to eventual plant death. The vast majority of PPN in turfgrasses feed on the roots, so they are typically classified as root pathogens. When high enough populations of PPN feed on roots, the turfgrass plant will eventually collapse and die from drought stress due to its compromised root system. Therefore, controlling PPN populations is crucial for growing healthy turfgrasses.

There will always be nematodes in the soil and most of them are beneficial in nature, feeding on bacteria and fungi. However, there are some species that can become problematic to both cool- and warm-season turfgrasses due to their feeding habits on roots and stems. Nematode damage symptoms often look like ‘drought stress’ of thinning turf, which makes sense because a great deal of the damage is likely being done to the roots. But how do you know nematodes might be a problem? You have to conduct a nematode assay (Figure 3) through a facility like the Virginia Tech Nematode Assay Lab to determine what type and number of PPN are present, and whether or not they warrant treatment.

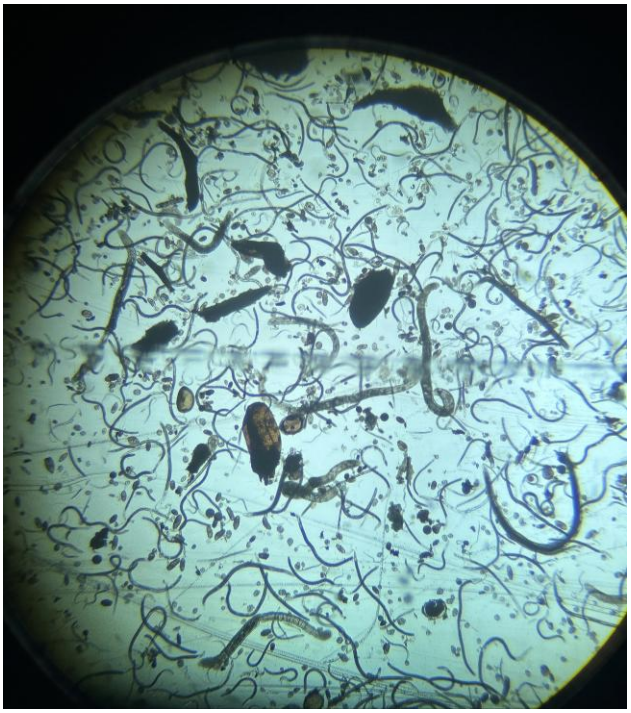

Figure 3. A large population of lance nematodes are shown in this microscopic image of a soil sample taken from a sand-based sports field. (Photo provided by Aaron Tucker)

Plant-parasitic nematodes can damage turfgrasses grown in all soil types, but they are especially an issue on turfgrasses grown in sandy soils. The primary reason PPN are a common issue in sandy soils is because there are plenty of macropores in sand-based soils that allow for easy mobility of PPN populations. Many sports fields have sand-based rootzones, so PPN can be a severe problem to sports fields that must be managed to achieve healthy turfgrass.

Table 1. Common chemical and trade names and anticipated disease control activity on the primary diseases of sports fields.[a]

Fungicide[b]		Diseases Controlled														
Common Chemical Name	Common Trade Names[a]	Brown Patch/ Large Patch	Dollar Spot	Gray Leaf Spot	Leaf Spot Complex	Pythium Blight	Rusts	Spring Dead Spot	Snow Mold	Seedling Damping Off	Red Thread/ Pink Patch	Summer Patch	Necrotic Ring Spot	Bermuda grass Decline/Take-All Root Rot	Fairy Ring
Azoxystrobin	Heritage	X		X	X	X	X		X		X	X		X	X
Azoxystrobin + acibenzolar-S-methyl	Heritage Action	X		X	X	X	X		X		X	X		X	X
Azoxystrobin + chlorothalonil	Renown	X	X	X	X	X	X		X		X	X		X	X
Azoxystrobin + cyazofamid	Union	X		X	X	X	X		X	X	X	X		X	X
Azoxystrobin + propiconazole	Compendium, Headway	X	X	X	X	X	X	X	X		X	X	X	X	X
Chloroneb	Fungicide V, Terraneb					X				X					
Chlorothalonil	Daconil Ultrex, Daconil Weather Stik	X	X	X	X		X				X				
Chlorothalonil + acibenzolar-S-methyl	Daconil Action	X	X	X	X		X				X				
Chlorothalonil+ propiconazole + fludioxonil	Instrata	X	X	X	X		X		X		X	X			

Cyazofamid	Segway					X				X						
Fludioxonil	Medallion	X			X				X			X				
Fluopyram + trifloxystrobin	Exteris Stressgard	X	X	X			X		X		X					
Fluoxastrobin	Fame SC, Floxcor	X	*	X	X	X	X			X	X	X				X
Fluoxastrobin + flutriafol	Tarvecta	X	X	X	X	X	X			X	X	X			X	X
Flutolanil	Pedigree	X							X		X					X
Fluxapyroxad	Xzemplar	X	X		X											X
Fluxapyroxad + pyraclostrobin	Lexicon	X	X	X	X	X	X	X	X		X	X	X	X		X
Fosetyl-AL	Fosetyl AL, Signature Xtra Stressgard					X				X						
Iprodione	26 GT	X	X		X				X		X					
Iprodione + thiophanate methyl	26/36	X	X	X	X		X		X		X					
Isofetamid	Kabuto		X					X					X			
Mandestrobin	Pinpoint	*	X				X									
Mefenoxam	Subdue Maxx					X				X						
Metconazole	Tourney	X	X				X		X			X				X
Myclobutanil	Eagle	X	X				X	X				X	X			
PCNB	Turfcide 400	X							X							
Penthiopyrad	Velista	X	X		X			X			X	X	X			X
Phosphonates	Resyst, Alude, Fiata					X				X						
Picarbutrazox	Serata					X				X						
Polyoxin-D	Affirm	X			X						X					*
Propamocarb	Banol					X				X						

Propiconazole	Banner MAXX	X	X	X			X	X	X		X	X	X			
Pyraclostrobin	Insignia	X	*	X	X	X	X		X		X	X			X	X
Pyraclostrobin + triticonazole	Pillar SC	X		X	X	X	X				X	X			X	X
Thiophanate-methyl	3336 F	X	X	X			X		X							
hiophanate-methyl + flutolanil	SysStar	X	X	X			X		X		X					X
Triadimefon + trifloxystrobin	Armada, Tartan Stressgard	X	X	X	X		X		X		X	X			X	X
Trifloxystrobin	Compass	X		X			X		X							
Triticonazole	Trinity	X	X				X		X		X	X				X

There are dozens of PPN species that can damage turfgrasses, but the three primary PPN that are most problematic to turfgrasses in Virginia are sting nematode (*Belonolaimus longicaudatus*), lance nematode (*Hoplolaimus galeatus*), and root-knot nematode (*Meloidogyne* spp.). Damage thresholds can vary greatly between these PPN species, with sting nematode having the lowest damage threshold. It is important to note that damage thresholds are relative and are greatly affected by other turfgrass stressors such as traffic, nutrition, and plant available water. For example, well-fertilized turfgrass that is properly irrigated, receives adequate sun, and is exposed to little traffic will require a much higher PPN population to cause damage than a poorly managed, heavily trafficked turf.

The best way to avoid PPN damage is to grow a healthy turfgrass by following proper cultural management practices such as proper fertility, irrigation, mowing, etc. However, even with proper cultural practices, PPN damage can still be an issue that requires chemical control measures with nematicides. Nemacur (fenamiphos) was the standard nematicide in turfgrass systems for many years until it lost its registration in the 2000s. Since then, new nematicides have entered the market to take its place. The current market-available synthetic nematicides for turfgrass are 1) Divanem (abamectin), 2) Indemnify (fluopyram), 3) Nimitz (fluensulfone), and 4) Curfew (1,3-dichlorpropene) soil fumigant. There are also promising new synthetic nematicides in development to watch for and there is a lot of interest in bionematicides.

One of those products garnering a great deal of attention is Zelto (Burkholderia spp. strain A396). The bionematicides have varying activities depending on the PPN species they are targeting. Therefore, the optimal approach is to make nematicide decisions based on the PPN populations present at a given turfgrass facility and rotate modes of action regularly to avoid selecting for nematicide-resistant PPN populations.

Selecting an Insecticide

Before chemical controls are considered, the pest must be properly identified so be sure to use all resources available to you to determine what the pest is and whether it warrants treatment. If you determine an insecticide application is warranted, consider the following factors in selecting the best and safest product for your situation.

1. In today's world, safety must always be a predominant concern. Humans and animals have more closely related biological pathways to insects than to weeds and fungi, so a great deal of care must be taken when using insecticides to ensure that only the pests are affected. Major improvements in target-specific toxicity from this class of pesticides have been made in the twenty-first century, but insecticides still require very special attention regarding potential nontarget effects. There is virtually no risk to humans or animals if pesticides are properly applied, but misapplication can result in serious problems for the environment and its inhabitants.

Always keep in mind the potential effects of an insecticide on the surrounding environment. Be mindful of scheduled use of the sports turf after application and ensure that application data are properly and visibly posted and that all reentry intervals (REIs) detailed on the label are strictly followed. Consider whether nearby water sources could be contaminated by off-site movement of an insecticide and plan/make applications accordingly to protect water quality.

Given the potential consequences of insecticide use (not to mention the cost), a wise field manager will apply such chemicals only when it is necessary to prevent or reduce significant turf damage. Before specifying an insecticide, ask whether there's another product that does the same job with less environmental impact. How does it impact pollinators? This is a very important factor in selecting an insecticide in the 21st century with a field manager’s focus always being on reducing potential non-target effects of a pesticide application, especially among our pollinating insect populations. Insecticides often have a Bee Advisory Box (Figure 3) on their label detailing strategies to either eliminate or effectively mitigate the potential for non-target effects on pollinators. This notification provides specific instructions on how to apply the product in a manner that minimizes exposure to foraging pollinators. In most cases, one of the simplest ways to minimize pollinator exposure to a potentially troublesome insecticide is to mow the turf before chemical application to remove any flowers. The latest generations of insecticides are quite specific to target pests, have very low water

solubilities, and some are modifications of naturally occurring compounds.

PROTECTION OF POLLINATORS

APPLICATION RESTRICTIONS **EXIST FOR THIS PRODUCT BECAUSE OF RISK TO BEES AND OTHER INSECT POLLINATORS. FOLLOW APPLICATION RESTRICTIONS FOUND IN THE DIRECTIONS FOR USE TO PROTECT POLLINATORS.**

Look for the bee hazard icon in the Directions for Use for each application site for specific use restrictions and instructions to protect bees and other insect pollinators.

This product can kill bees and other insect pollinators.
Bees and other insect pollinators will forage on plants when they flower, shed pollen, or produce nectar.
Bees and other insect pollinators can be exposed to this pesticide from:
- Direct contact during foliar applications, or contact with residues on plant surfaces after foliar applications
- Ingestion of residues in nectar and pollen when the pesticide is applied as a seed treatment, soil, tree injection, as well as foliar applications.

When Using This Product Take Steps To:
- Minimize exposure of this product to bees and other insect pollinators when they are foraging on pollinator attractive plants around the application site.
- Minimize drift of this product on to beehives or to off-site pollinator attractive habitat. Drift of this product onto beehives or off-site to pollinator attractive habitat can result in bee kills.

Information on protecting bees and other insect pollinators may be found at the Pesticide Environmental Stewardship website at: http://pesticidestewardship.org/PollinatorProtection/Pages/default.aspx.
Pesticide incidents (for example, bee kills) should immediately be reported to the state/tribal lead agency. For contact information for your state, go to: www.aapco.org/officials.html. Pesticide incidents should also be reported to the National Pesticide Information Center at: www.npic.orst.edu or directly to EPA at: beekill@epa.gov

Figure 4. The Bee Advisory Box provides important information on how to safely apply insecticides that might have unintended effects on foraging pollinators.

2. What formulation of insecticide will work best? Does a granular or spray formulation fit best for the situation? Several granular insecticides are now utilizing a fertilizer carrier for the chemical, similar to the popular “weed-and-feed” products that deliver fertilizers and herbicides. Other recent developments in application technology that are proving to be highly effective and environmentally friendly include injection methods that slit-inject insecticides into the soil or apply it through high-pressure liquid injection.

3. It's also important to ask whether watering will be necessary following the insecticide application; depending on the feeding habit of a problem insect, it might be. For shoot-feeding insects, irrigation or rainfall is usually counterproductive, but for soil-borne insects, the product must be watered in to reach the pest. Be sure irrigation is available, or rainfall is in the forecast when insecticides need to be moved into the soil. And, just as lack of water can be a problem with optimizing activity, too much water can also result in poor control and other off-site problems by washing the insecticide away or diluting its effective concentration. Be careful of making insecticide applications prior to forecast thunderstorms or other rainfall events where predicted rainfall exceeds ½ inch.

4. Remember, problem insects are not the only creatures that might be killed with an insecticide application. Small mammals and fish can be sensitive to insecticide applications, and their poisoning, even if unintentional, is not acceptable.

5. Reduce the potential for pest resistance by considering the IRAC (Insecticide Resistance Activity Committee) code on the label and be sure to alter insecticide modes of action to prevent the buildup of a tolerant insect population.

Several insecticides remain particularly toxic to earthworms, a creature that is Mother Nature's tool in cultural management. These soil-dwelling animals are tremendous decomposers of thatch and improve soil porosity and aeration through their constant channeling underground.

Classes of Insecticides

The following represent the chemical classes of insecticides that contain products that are labeled for athletic field use.

1. **Organophosphates.** A category of insecticides that has been around since the 1950s that has been mostly phased out in use because of environmental and mammalian safety concerns. Organophosphate insecticides are very broad spectrum in activity, and this should be considered for possible effects on mammals and other vertebrate animals. Trichlorfon is a very broad-spectrum organophosphate insecticide that remains labeled for athletic field use.

2. **Carbamates.** Broad-spectrum insecticides that can have substantial undesirable nontarget impact on earthworms, honeybees, and other beneficial organisms if misapplied. Carbaryl (common trade name Sevin) is the standard carbamate still available on the market.

3. **Pyrethroids.** Synthetic derivatives of the naturally occurring insecticidal compound pyrethrum. They tend to be less stable in the environment, and a chronic problem has been rapid photodegradation (breakdown when exposed to sunlight), but active ingredients like bifenthrin, beta-cyfluthrin and lambda-cyhalothrin, permethrin, have a long track record of success in athletic field insect control, demonstrating more stability in sunlight and remaining active for several days. Synthetic pyrethroids are not so much of a threat for mammalian toxicity as they are for fish, so they warrant special attention regarding any site that has potential to affect water.

4. **Neonicotinoids.** Long considered as a standard in grub control is imidacloprid, and other chemistries in this class include clothianidin, dinotefuran, and

thiamethoxam. This chemical is applied at low use rates and stays active in the soil for up to four months, making it an outstanding grubworm control chemical. It is less toxic to earthworms and other beneficial insects than other insecticides. It is common for imidacloprid to be formulated on a fertilizer carrier to apply pesticide and nutrient simultaneously. Thiamethoxam (common trade name Meridian) and clothianidin (trade name Arena) offer broad-spectrum grub control activity as well as caterpillar control, and both have reduced toxicity to earthworms, mammals, and the like. One area of concern with neonicotinoid use is a possible link between this family of chemistry and declining honeybee populations. The potential problems associated between neonicotinoids and pollinators are ones that can mostly be solved by following the label, and when those instructions are not adhered to, unintended consequences can occur.

5. **Phenylpyrazoles.** One of the most popular insecticides in this class is fipronil and its strength in activity is in fire ant control. Fipronil is applied at extremely low rates through slit-soil applications or liquid injections because its water solubility is so low it is hard to move it into the soil following an application. While the injection technology means it is typically more expensive to apply fipronil than many other insecticides, the excellent insecticide activity and limited potential for nontarget movement are highly desirable. Fipronil has also been extremely successful in the control of mole crickets in southern turfgrasses.

6. **Molt-accelerating compounds (i.e., insect growth regulators).** Azadirachtin offers the unique mode of action of triggering a premature molt of the insect, resulting in its death within one to three weeks. The compound is considered very safe for the environment, and since its mode of action is so unique, it is highly unlikely that local populations will demonstrate resistance to this insecticide. It must be applied to nymphs, young larvae and bermudagrass mite, respectively.

7. **Anthranilic diamides.** Chlorantraniliprole was registered as a “reduced risk” insecticide by the Environmental Protection Agency (EPA) in 2008. This compound offers preventative and early curative control of all major white grub species, plus activity on billbugs and caterpillars. It is applied at very low application rates, has very low water solubility, and is less toxic to honeybees than many other similar use products. A recent entry into the market from this class with similar characteristics is cyantraniliprole.

8. **Oxadiazine.** Indoxacarb has the novel mode of action of being metabolically converted inside the insect into a more active compound. It has a broad range of activity on caterpillars, mole crickets, and fire ants depending on labeled product.

9. **Specialty class.** Spinosad is a unique insecticide that is a fermentation-derived product from a soil-borne bacterium. It is effective on caterpillars and fire ants, having activity as a contact insecticide, but possessing even greater efficacy when ingested by the pest after foliar treatment. While it possesses desirable features like very low use rates, very low mammalian toxicity, no special handling or use restrictions, and safety to numerous beneficial predatory insects, Spinosad is toxic to honeybees and marine mollusks.

10. **Formulated mixtures of active ingredients.** It is likely that formulated mixtures of insecticides that broaden the spectrum of insect control will continue to increase in availability and popularity. Mixtures of clothianidin and bifenthrin or imidacloprid and bifenthrin are labeled for use on athletic fields, offering the fast action of a contact material with the pyrethroid insecticide and the longer-term preventive insecticide activity of the neonicotinoids.

Table 2 lists some of the most common insecticides that are currently registered for sports field use, their chemical classification, and some comments specific to their chemical family.

Selecting an Herbicide

Given the diversity of weedy plants that can occur on sports fields and the fact that surfaces are grassed possibly in warm-season, cool-season, and even combinations of those grasses, there are lots of decisions to be made in selecting a herbicide that is both safe and effective. Knowing what turfgrass you are managing and what weed(s) are being targeted at the level of determining if the pest is an annual or perennial grass, broadleaf, or grass-like weed are first steps in developing a chemical weed control program.

Table 2. Common chemical names, trade names, and chemical classifications/discussion of activity of standard insecticides used in sports field management.[a]

Common Chemical Name	Common Trade Name	Chemical Class and Comments
Azadirachtin	Azatrol, Aza-Direct, other names	Botanical insecticide with specific insect growth regulator activity; disrupts molting process when applied to young larvae and nymphs of caterpillars and bermudagrass mite before turf damage is visible
Beta-cyfluthrin	Tempo Ultra	Pyrethroid; fast, broad-spectrum insect control and unique formulation characteristics of this particular product extends its residual control of both surface and sub-surface insect pests
Carbaryl	Sevin	Carbamate; Very broad-spectrum insecticide with low mammalian toxicity
Chlorantraniliprole	Acelepryn	Anthranilic diamide, a newer class of chemistry with lower environmental impact and non-target insect concerns; can be applied earlier in turf growing-season for season-long grub control and has broad activity on many turf caterpillars as well
Clothianidin	Arena	Neonicotinoid; broad-spectrum activity with general acceptance that this was the first insecticide class to provide preventive white grub control; this chemical class is under specific public and private scrutiny due to possible effects on non-target pollinators
Clothianidin + bifenthrin	Aloft LC	Neonicotinoid + pyrethroid; Combined modes of action reduce resistance possibilities and increase spectrum of insects controlled. Mole crickets are a particular pest targeted by pyrethroid chemistries.
Cyantraniliprole	Ference	As for Chlorantraniliprole classification described above
Deltamethrin	Deltagard	As for Beta-Cyfluthrin classification described above
Dinotefuran	Zylam	As for Clothianidin classification described above
Fipronil	Top Choice	Phenylpyrazole; used primarily in slit soil injections for mole crickets or as a broadcast application for fire ants, fleas, and ticks; much more toxic to insects than to mammals
Imidacloprid	Merit, other names	As for neonicotinoid classification described above
Imidacloprid + bifenthrin	Allectus	As for neonicotinoid + pyrethroid classification described above
Indoxacarb	Provaunt	Oxadiazine; extremely active on mole crickets and many turf pest caterpillars at very low use rates; very rapid pest control and minimal impact on non-target organisms
Lambda-cyhalothrin	Scimitar	As for Beta-Cyfluthrin classification described above
Permethrin	Astro, Perm-Up	As for Beta-Cyfluthrin classification described above
Spinosad	Conserve	Spinosyn; defined as a biorational, it is a fermentation-derived insect control agent with particular activity on turf caterpillars and a drench for fire ant mounds

Tetraniliprole	Tetrino	As for Chlorantraniliprole classification described above
Thiamethoxam	Meridian	As for Clothianidin classification described above
Trichlorfon	Dylox	Organophosphate; this chemical class provides very broad-spectrum surface and subsurface insect control but many nonagricultural uses are being pulled from labels in this chemical class
Zeta-cypermethrin + bifenthrin	Talstar Xtra	As for Beta-cyfluthrin classification described above

a The trademarked or proprietary products listed are only to be used as examples, and their inclusion does not constitute a guarantee or warranty of the product by the authors, nor does it imply its approval to the exclusion of other suitable products. For all products listed, consult the label for a complete listing of tolerant turfgrasses and application sites and levels.

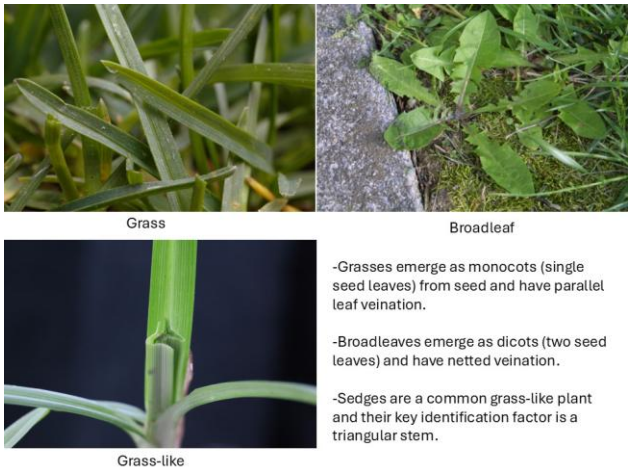

Figure 5. Basic identification features of grass, broadleaf, and grass-like weeds.

Classifying Herbicides

One of the first methods of classification describes when the herbicides are applied: **preemergent** (PRE) herbicides are applied before the target weed emerges from the soil, and **postemergent** (POST) herbicides are applied after the weed has emerged.

Preemergent herbicides are typically applied when the stand of turf cannot tolerate any weeds at all – as on a grass tennis court – or when the turf has a history of heavy weed infestation (see Table 3). Preemergent herbicides must be watered into the soil following application, so they will pass into the soil profile and form a chemical barrier where weed seeds are germinating. Failure to water these herbicides into the soil within the time indicated on the label will substantially reduce their effectiveness as they can be photodegraded. Pay special attention to the label directions regarding the use of PRE herbicides in relation to establishing turfgrasses, especially from seed. Most standard PRE treatments are not selective in control between weed or turfgrass seed. When properly used, PRE herbicides should cause little to no turfgrass discoloration. Table 3 provides a listing of some of the most common PRE herbicides labeled for use on sports fields. However, their use should always be considered in terms of the grass(es) on the field, how much traffic the field receives, and the potential or need for turfgrass recovery or re-establishment as at best recovery or establishment can be delayed, and at worst it can be eliminated by a PRE herbicide application. **Heavily trafficked fields in need of constant re-seeding to restore turf density generally do not fit a PRE herbicide program.**

Postemergent herbicides are applied onto the foliage of existing weeds, and they work best on weeds that are young and actively growing (see Tables 4 and 5). The effectiveness of POST herbicides is often increased by adding a **surfactant** to the solution. Surfactants are chemicals that improve the performance of the herbicide by distributing it more uniformly over the leaf surface and ultimately increasing absorption of the material into the plant. The pesticide label will give specific information about the type and concentration of surfactant to include in the spray tank.

Another method of herbicide classification breaks them into those with **selective** and **nonselective** action. Many herbicides have the specific ability to control one specific weed or a group of target weeds with minimal effect on the desirable turfgrass. These herbicides are described as having **selective** action, and most herbicides used in weed control programs are of this category.

Herbicides that are classified **nonselective** kill all plant tissues that they contact (see Table 6). These herbicides are used primarily for renovation purposes (to kill all vegetation in a specific area), or in special situations where any vegetation at all is undesirable (like the skinned areas of baseball fields or fence lines around athletic fields). A common fumigant that was long the standard for soil sterilization, methyl bromide, has been phased out of use. Applications of one of the most widely utilized nonselective herbicides in the world, glyphosate, are now receiving extra scrutiny as well. This herbicide has been on the market since 1974 but high-profile lawsuits regarding its safety indicate that sports field managers should pay very close attention to its use at their sites and have a firm grasp on both the perception and the science-based reality about using this herbicide.

Table 3. Common chemical names, trade names, and general use comments for preemergent herbicides used on sports fields.[a]

Common Chemical Name[b]	Trade Name(s)	Comments
Atrazine	Aatrex	Use on warm-season turfgrasses except for seashore paspalum; primarily for winter broadleaf weed control in dormant bermudagrass turf; also has activity on annual bluegrass; low cost/acre: no more than two applications/year; do not use around trees or ornamentals. Groundwater concerns have caused several restrictions on use near water and on sandy soils.
Benefin	Balan	Typically cost-competitive, good crabgrass control, weak on goosegrass. Reseeding of cool-season grasses after 6 weeks when used at low rate and not until 12–16 weeks for higher levels used for Poa annua control.
Benefin + trifluralin	Team	Annual grass control; some broadleaf weeds. Reseed after 6 weeks at low rate and 12–16 weeks at higher rates.
Bensulide	Bensumec,	Crabgrass, annual bluegrass and many annual grass and broadleaf weeds; not strong on goosegrass. Don't reseed turfgrass for four months.
Bensulide + Oxadiazon	Goosegrass/crabgrass	Broad-spectrum annual weed control with oxadiazon providing excellent goosegrass activity.
Bispyribac sodium	Velocity PM	POST control of annual bluegrass and activity on Roughstalk bluegrass in tall fescue, perennial ryegrass, some cultivars of Kentucky bluegrass, and dormant bermudagrass.
Dimethenamid	Tower	Different mode of action than most PREs; limited residual on crabgrass but excellent on sedge and some broadleaves. Alsu used in landscape ornamentals.
Dimethenamid + pendimethalin	Freehand	Annual weed control. Longer residual on crabgrass and more broadleaves controlled. Also used in landscape ornamentals.

Dithiopyr	Dimension Ultra, Dithiopyr 40WSB	Excellent annual grass control, some broadleaf weeds; has early POST activity on crabgrass until the 3–4 leaf stage; very popular choice for sports fields in the transition zone and northward more so than Deep South. Also used in landscape ornamentals.
Flumioxazin	SureGuard	Dormant warm-season turf only; excellent on annual broadleaves, some residual for crabgrass and goosegrass; POST activity on annual bluegrass and broadleaves; can't seed or sprig for 3 months. Also used as a directed spray in woody landscape ornamentals.
Indaziflam	Specticle FLO	Primarily used on warm-season turfgrasses; residual weed control can be exceptional to the point of being a concern with turfgrass recovery or reestablishment on heavily trafficked fields. Also used as a directed spray in woody landscape ornamentals.
Isoxaben	Gallery	Excellent annual broadleaf weed control; no grass control. Also used in landscape ornamentals.
Metolachlor	Pennant Magnum	Annual grass and broadleaf control in warm-season grasses and landscape plantings; PRE activity on yellow nutsedge is a special niche. Also used in landscape ornamentals.
Oxadiazon	Ronstar FLO, Ronstar G	Excellent grass control (particularly goosegrass) along with some broadleaf weeds. Granular form can be used in cool- and warm season turf. The sprayable formulation (FLO) can only be used in dormant warm-season turf or during sprigging or plugging of bermudagrass but must be quickly and thoroughly watered to reduce potential turf injury. Shoot absorbed rather than root absorbed. Also used in landscape ornamentals.
Oxadiazon + prodiamine	RegalStar II	Annual grass control; some broadleaf weeds
Pendimethalin	Pre-M, Pendulum AquaCap,	Excellent grass control with some broadleaf weed activity; price competitive. Also used in landscape ornamentals.
Prodiamine	Barricade, Regalkade	Excellent grass control with some broadleaf weed activity; low use rates; limited mobility in the soil can be desirable when there is concern about possible off-site movement. Also used in landscape ornamentals.
Prodiamine + quinclorac	Cavalcade PQ	Selective POST and PRE activity on a wide variety of grassy and broadleaf weeds
Simazine	Princep	Use on warm-season turfgrasses except for seashore paspalum; primarily for winter broadleaf weed control in bermudagrass turf; also has activity on annual bluegrass; low cost/acre: no more than two applications/year; do not use around trees or ornamentals.
Sulfentrazone + prodiamine	Echelon	PRE and POST control of crabgrass, annual grass, and broadleaf weeds from the prodiamine (PRE) and sedge control (POST) from sulfentrazone; labeled for most sports turfgrasses.

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[b] There are other premixed combinations to consider than just those listed here.

Table 4. Common chemical names, trade names and general use comments for postemergent herbicides for broadleaf weed control on sports fields.[a]

Common Chemical Name[b]	Trade Name	Comments
2,4-D[b]	Many available	The standard in broadleaf weed control for many years; popular in mixtures with other broadleaf herbicides; repeat applications may be necessary; use low pressures to avoid drift onto desirable broadleaf plants; avoid use when temperatures exceed 85°F, particularly for ester formulations of 2,4-D. Weak on white clover when applied alone. One of the few herbicides available for wild garlic and wild onion control.
2,4-D + clopyralid + dicamba	Millennium Ultra 2	Very broad-spectrum broadleaf weed control; consider comments for 2,4-D and dicamba in its selection and use. Clopyralid in this product adds rapid clover control and improved control of difficult perennials. Grass clippings should not be composted as clopyralid impart residual activity in the resulting compost.
2,4-D + fluroxypyr + dicamba	Escalade 2	Very broad-spectrum broadleaf weed control; consider comments for 2,4-D and dicamba in its selection and use. Fluroxypyr is a powerful active ingredient that improves control of difficult weeds and generally increases the number of species controlled.
2,4-D + MCPP + dicamba	Trimec, Three-Way	Long-time standard in broad-spectrum broadleaf weed control; consider comments for 2,4-D and dicamba in its selection and use.
2,4-D + MCPP + dicamba + sulfentrazone	Surge	Labeled on most grasses, offering very broad-spectrum broadleaf weed control plus many sedges and kyllingas; consider comments for 2,4-D and dicamba in its selection and use. Accurate use rate is important in cool-season turf and avoid mixing with fertilizers or specialized adjuvants.

2,4-D + MCPP + quinclorac + carfentrazone	Q4 Plus	Broad-spectrum and rapid burndown control of broadleaves plus crabgrass control; labeled for most cool-season grasses but use only on dormant bermudagrass; consider comments for 2,4-D.
Amicarbazone	Xonerate	Good activity on many annual broadleaves but used primarily for annual bluegrass control in cool-season grasses in the spring; 2-week reseeding interval and sequential applications likely needed.
Bentazon	Basagran	Sedges and certain broadleaf weeds.
Carfentrazone	Quicksilver	Fast-acting contact broadleaf herbicide with excellent safety on newly established grasses; excellent activity on silvery thread moss (Bryum argenteum). Controls only seedling broadleaves but discolors and suppresses mature broadleaves and aids other herbicides in their control. Provides same-day symptoms on target weeds when mixed with any broadleaf herbicide.
Carfentrazone + 2,4-D + MCPP + dicambab	Speedzone	Rapid, broad-spectrum broadleaf weed control in most sports turfgrasses due to synergism of carfentrazone with other compounds.
Carfentrazone + MCPA + MCPP + dicamba	Powerzone	Rapid, broad-spectrum broadleaf weed control in most sports turfgrasses due to synergism of carfentrazone with other compounds; replacement of 2,4-D by MCPA provides more flexibility in seasonal use and improved clover control.
Clopyralid	Lontrel	Active on very difficult to control broadleaves. Requires caution under stressful conditions. Grass clippings should not be composted as clopyralid imparts residual activity in the resulting compost. Also used as a directed spray in certain woody landscape ornamentals.
Dicamba[b]	Vanquish, Banvel	Excellent broadleaf herbicide; very soil-mobile, so avoid use around the base of ornamentals and trees. Best applied in combination with other herbicides.
Dicamba + mesotrione + triclopyr	Sublime	Selective postemergent control of many difficult to control broadleaf weeds and

		some grassy weed control without the bleaching of mesotrione applications alone; safe on several cool-season grasses, use only on dormant bermudagrass.
Flazasulfuron	Katana	Perennial ryegrass transition tool in overseeded bermudagrass turf with better performance in cold temperatures than other sulfonylureas; good broadleaf control, needs higher rates to control annual bluegrass.
Florasulam	Defendor	Noted for early season activity during cool temperatures when control by other products is questionable
Foramsulfuron	Revolver	Perennial ryegrass transition tool in overseeded bermudagrass turf needing warmer temperatures; in warm-season turf it controls young goosegrass, mature annual bluegrass, and provides dallisgrass suppression
Imazosulfuron	Celero	Excellent sedge control product.
Mecoprop (MCPP)b	Mecomec	Good for clover control; slower-acting than 2,4-D. Best used in mixtures with other herbicides.
Metsulfuron	Manor, Blade, MSM Pro	Labeled for use in Kentucky bluegrass or bermudagrass athletic fields; extensive broadleaf label as well as some grassy weed control. Selectively controls broadleaves, bahiagrass, and tall fescue and is commonly used in warm climates to transition overseeded bermudagrass.
Metsulfuron + rimsulfuron	Negate	Ryegrass transition tool for overseeded bermudagrass; excellent broadleaf weed control; often cheaper than other sulfonylurea herbicides
Mesotrione	Tenacity	Broad-spectrum annual and perennial grass and broadleaf weed control in Kentucky bluegrass, tall fescue, and perennial ryegrass; provides selective control of nimblewill and creeping bentgrass, and offers suppression of bermudagrass; can be applied at seeding of desirable grasses, so product has great versatility in renovation programs; weed response is “bleaching of leaves,” but tolerant grasses are either not affected or recover from discoloration quickly;

		bleaching can be moderated by mixing with triclopyr; generally requires two applications at three-week intervals for effective control of mature weeds.
Penoxsulam	Lockup	Broad-spectrum broadleaf control product with excellent residual activity;
Prodiamine + quinclorac	Cavalcade PQ	Selective POST and PRE activity on a wide variety of grassy and broadleaf weeds
Pyrimisulfan	Arkon, Vexis	Excellent sedge control and good activity on some broadleaf weeds; safety on a wide variety of grasses; Vexis provides sedge control with a granular formulation.
Quinclorac	Drive XLR8	Standard POST annual grass herbicide in both cool and warm-season grasses; almost no seeding restrictions in cool-season turf; no activity on goosegrass.
Quinclorac + sulfentrazone + 2,4-D, + dicamba	Q4 Plus	Broad-spectrum control of grass, broadleaf, and sedges with short reseeding window.
Sulfentrazone	Dismiss	Labeled on both warm- and cool-season sports turfgrasses and provides broad-spectrum and rapid (within seven days) sedge/kyllinga control. Also controls or suppresses several broadleaf species. Also used as a directed spray in woody landscape ornamentals.
Sulfentrazone + imazethapyr	Dismiss South	Labeled on warm-season grasses only; provides broad-spectrum annual grass, broadleaf, and sedge/kyllinga control. Improves sedge control over Dismiss to include purple nutsedge.
Sulfentrazone + prodiamine	Echelon	PRE and POST control of crabgrass, annual grass, and broadleaf weeds from the prodiamine (PRE) and sedge control (POST) from sulfentrazone; labeled for most sports turfgrasses.
Sulfosulfuron	Certainty	Labeled in most warm-season grasses (including seashore paspalum); wide spectrum of weed control activity depending on the situation, the grass, and the weed; in warm-season grasses, its primary uses are control of broadleaves, sedges, and kyllingas, as well as ryegrass transition in overseeded bermudagrass in warm

		climates. Among the best products on the market for hard-to-control sedges.
Thiencarbazone + foramsulfuron + halosulfuron	Tribute Total	Activity on broad spectrum of grasses, sedges, and broadleaf weeds in bermudagrass or zoysiagrass; activity on dallisgrass is noted.
Thiencarbazone + iodosulfuron + dicamba	Celsius	Broad-spectrum annual and perennial grass and broadleaf weed control in warm-season grasses.
Topramezone	Pylex	Superior POST goosegrass control product in cool-season turf and even in bermudagrass at very low use rates; used in combination with triclopyr for bermudagrass control in cool-season turf; also controls nimblewill and crabgrass and can be used at seeding cool-season grasses
Triclopyr	Turflon Ester	Labeled in Kentucky bluegrass, perennial ryegrass, and tall fescue; controls a broad spectrum of broadleaf weeds and reduces leaf bleaching of mesotrione when applied together. Although triclopyr, at low rates, can be used in bermudagrass for broadleaf control, Turflon Ester and other pure triclopyr products are important components of bermudagrass control programs in cool-season turfgrass and zoysiagrass.
Triclopyr + clopyralid	Confront	Labeled in most sports turfgrasses; very broad spectrum of broadleaf weed control with strengths in clovers and legumes; highly leachable so use with caution around shallow-rooted shrubs and trees; do not compost clippings.
Trifloxysulfuron	Monument	Labeled only for bermudagrass and zoysiagrass; has numerous broadleaf weeds on the label but is usually considered as a grass and/or sedge control product. Monument is one of the best products for hard-to-kill sedges and works relatively well for transitioning overseeded bermudagrass in cool weather.

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[b] There are other premixed combinations to consider than just those listed here.

Table 5. Common chemical names, trade names, and general use comments of postemergent herbicides for grass and grass-like weed control on sports fields.[a]

Common Chemical Name[b]	Trade Name	Comments
Amicarbazone	Xonerate PM	Primarily for annual bluegrass control in cool-season grasses in the spring; 2-week reseeding interval and sequential applications likely needed.
Atrazine	Aatrex	Primarily for winter broadleaf weed control in bermudagrass turf but also has activity on annual bluegrass.
Bentazon	Basagran	Controls yellow nutsedge, annual sedges, and many broadleaf weeds; poor activity on purple nutsedge and no activity on grasses; extensive label for use in ornamental beds.
Bispyribac sodium	Velocity	Good annual bluegrass control and has activity on roughstalk bluegrass in cool-season grasses.
Carfentrazone + 2,4D, + MCPP + dicamba	Speedzone	Primarily used for rapid burndown of broadleafs but also has activity on goosegrass with repeat applications.
Carfentrazone + Quinclorac	Square One	Broad-spectrum broadleaf and grassy weed control with good safety for new seedings.
Dicamba + mesotrione + triclopyr	Sublime	Selective postemergent control of many difficult to control broadleaf weeds and some grassy weed control without the bleaching of mesotrione applications alone; safe on several cool-season grasses, use only on dormant bermudagrass.
Ethofumesate	Prograss	Annual bluegrass control in fall or early spring in cool-season turfgrasses; sequential applications needed
Fenoxaprop	Acclaim Extra	Annual grass control in cool-season turfgrasses; offers suppression of bermudagrass.
Flazasulfuron	Katana	Perennial ryegrass transition tool in overseeded bermudagrass turf with better performance in cold temperatures than other sulfonylureas; needs higher rates to control annual bluegrass.
Fluazifop	Fusilade II	Annual and perennial grassy weed control in tall fescue and zoysiagrass; noted for activity on bermudagrass.
Foramsulfuron	Revolver	Warm-season grasses only; goosegrass control. Broad-spectrum activity on cool-season grasses, particularly as a spring ryegrass transition tool on overseeded bermudagrass.
Halosulfuron methyl	Sedgehammer	Broad-spectrum sedge control, labeled in most grasses.
Imazaquin	Image	Sedge control, particularly purple nutsedge; wild onion/garlic control; spring ryegrass transition tool on overseeded bermudagrass.
Mesotrione	Tenacity	Broad-spectrum annual grass weed control in cool-season grasses with noted activity on nimblewill and creeping bentgrass; offers suppression of bermudagrass, especially

		when mixed with triclopyr; repeat applications on 3-week intervals typically required for optimal weed control.
Metsulfuron	Manor, Blade, MSM Pro	Labeled for use in Kentucky bluegrass or bermudagrass athletic fields; offers some grassy weed control, particularly as a spring ryegrass transition tool in overseeded bermudagrass; extensive broadleaf label.
Prodiamine + quinclorac	Cavalcade PQ	Selective POST and PRE activity on a wide variety of grassy and broadleaf weeds
Pronamide	Kerb T/O	Early POST and PRE control of many winter annual and perennial grasses and annual broadleafs in bermudagrass; spring ryegrass transition on overseeded bermudagrass.
Pyrimisulfan	Arkon, Vexis	Excellent sedge control and good activity on some broadleaf weeds; safety on a wide variety of grasses; Vexis provides sedge control with a granular formulation.
Quinclorac	Drive XLR8	POST crabgrass control with excellent safety during seed or sprig establishments; no activity on goosegrass; controls torpedograss and a broad spectrum of legumes.
Quinclorac + sulfentrazone + 2,4-D, + dicamba	Q4 Plus	Broad-spectrum control of grass, broadleaf, and sedges with short reseeding window.
Rimsulfuron	Rimsulfuron	Cool-season grass control in warm-season grasses, in particular for spring ryegrass transition on overseeded bermudagrass.
Sulfentrazone	Dismiss	Labeled on both warm and cool-season sports turf grasses; broad-spectrum sedge and kyllinga control; broad-spectrum broadleaf control.
Sulfentrazone + prodiamine	Echelon	PRE and POST control of crabgrass, annual grass, and broadleaf weeds from the prodiamine (PRE) and sedge control (POST) from sulfentrazone; labeled for most sports turfgrasses.
Sulfentrazone + quinclorac	Solitare	Sedge and grassy weed control in both warm and cool-season grasses.
Sulfosulfuron	Certainty	Labeled in most warm-season grasses (including seashore paspalum; wide spectrum of weed control activity depending on the situation, the grass, and the weed; in warm-season grasses, its primary uses are control of broadleaves, sedges, and kyllingas, as well as ryegrass transition in overseeded bermudagrass.
Thiencarbazone + foramsulfuron + halosulfuron	Tribute Total	Activity on broad spectrum of grasses, sedges, and broadleaf weeds in bermudagrass or zoysiagrass; activity on dallisgrass is noted.
Thiencarbazone + iodosulfuron + dicamba	Celsius	Broad-spectrum annual and perennial grass and broadleaf weed control in warm-season grasses.
Topramezone	Pylex	Superior POST goosegrass control product in cool-season turf and even in bermudagrass at very low use rates; used

		in combination with triclopyr for bermudagrass control in cool-season turf; also controls nimblewill and crabgrass and can be used at seeding cool-season grasses
Trifloxysulfuron	Monument	Warm-season grasses only; broad-spectrum sedge control, broad range of activity on cool-season grasses, including spring ryegrass transition on overseeded bermudagrass.

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[b] There are other premixed combinations to consider than just those listed here.

Table 6. Common chemical names, trade names, and general use comments of nonselective herbicides for weed control and/or renovation uses.[a]

Common Chemical Name	Trade Name	Comments
Dazomet	Basamid G	Restricted-use pesticide. Soil fumigant used for renovation purposes. Controls most weed seeds, nematodes, and soil diseases. Incorporate granules into the soil, roll soil surface to impede fumigant escape, thoroughly wet the soil or seal with plastic. Consult label for soil temperature information regarding application and replanting timing.
Diquat	Reward	Contact material that provides rapid burndown. Do not mow or till for seven days after application. Not labeled for use in all states.
Glufosinate methyl	Finale	Contact material that provides rapid burn-down within two to four days. No residual activity in the soil.
Glyphosate	Roundup PRO and many others available	Systemic activity results in translocation throughout the plant; very limited soil residual allows for seeding soon after application; relatively safe to handle; usually requires 7–10 days to see a visible response.
Pelargonic acid + other fatty acids	Scythe	Naturally occurring fatty acids; no soil residual; rapid degradation; contact herbicide that acts by disrupting cell membranes and gives a rapid burn-down; combinations with glyphosate have been very effective.

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Summary

Pesticides are a tool to supplement sound fertility and cultural management programs in sports field management; they cannot overcome limitations in turfgrass performance caused by unhealthy plants, soils, and/or excessive field use. However, when utilized appropriately as part of a management program, they can be a very important tool in enhancing field safety and playability.

Remember that the application of any pesticide is to be accompanied by a thorough review of the label. This protects you, others, the environment, and ensures that your application will deliver the intended response. Remember: ***the label is the law!***

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