TABLE OF CONTENTS

ABOUT THE COVER

Portrait artist J.L. Samerdyke presents Steve Abler for the cover of this issue of The Grass Roots. Steve is the new director of the TDL, a Wisconsin native and recent graduate student of Dr. Houston B. Couch. Get to know Steve a little by reading Personality Profile.

To remind us, on this Memorial Day, why so many American servicemen have given their lives to their country:

"In Flander Fields the poppies blow
Between the crosses, row on row,
That marks our place, and in the sky
The larks, still bravely singing, fly
Scarce heard amid the guns below.
We are the Dead. Short days ago
We lived, felt dawn, saw sunset glow,
Loved and were loved, and now we lie
In Flanders fields.
Take up our quarrel with the foe:
To you from our failing hands we throw
The torch; be yours to hold it high.
If ye break faith with us who die
We shall not sleep, though poppies grow
In Flanders fields."

- John McCrae

THE GRASS ROOTS

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EDITOR AND PUBLISHER
Monroe S. Miller
Blackhawk Country Club
P.O. Box 5129
Madison, WI 53705
groots@globaldialog.com

EDITORIAL STAFF AND BUSINESS AFFAIRS
Dave Brandenburg
P.O. Box 314
Theresa, WI 53091

Opportunities Abound!

By David Brandenburg, *Golf Course Superintendent, Rolling Meadows Golf Course*

Thank you for the great turnout for our spring business meeting. I hope you all received the education and information you hoped to. It was nice to see a big crowd and I hope we can continue that at our summer meetings.

I have noticed some of our members never attend our golf meetings, and often wonder why. Yes, it is a partial day away from work and family but we all need time off. I can truly say I have learned something from the host course every event I have played. Either a new idea or method of accomplishing the things we do. I also take home something from my conversations with other superintendents.

The current format offers education and golf in April, September and October so you have extra incentive to come. May is the Super-Pro, June and July are golf meetings and August is the WTA Field Day.

If you have never been to a meeting because you do not play that much, you have nothing to worry about. Although we have competition, it is secondary to having fun. So do not worry about your handicap as we have all kinds of players in our group. If you are new or have not had a chance to meet many other members yet, we will match you up with a foursome.

The summer meetings are also a great way to pay respect to the superintendents and facilities that invite us, while seeing how another course operates.

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If you have not been to the Wisconsin Turfgrass Association Winter Expo lately give it a try next January and I know you will get value out of it. The Expo is always improving and I have heard from a variety of sources the Expo is going to be a "cannot miss" event for us and our staffs.

Dennis Robinson of Horst Distributing is chair of the Education Committee and he has expressed the committee has come up with some great ideas to make the show even better. Even though they have their own ideas do not be afraid to let the WTA know what you want to see and learn about. Your input is invited and always welcome.

The education will be expanded to offer sessions for mechanics and general staff to attract more participants. They have planned some 'big name' speakers along with our own popular University of Wisconsin-Madison professors. The Expo will be January 6th and 7th so pencil it in on your calendar and plan to take your staff down for a terrific show.

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I want to thank Kendall Marquardt for his service to the WGCSA Board of Directors. Kendall left the board this spring to concentrate on work and family and we appreciate his help during his time.

At the same time, we welcome Jeff Millies to the board. Jeff is the superintendent at Edgewood Golf Club in Big Bend.

By the time you're reading this, we will hopefully be well into a prosperous season, with good grass-growing and golfing weather. Remember to take time to get away from work to spend time with family and those important to you. Spending time away from work was one of my goals for last year and although I have room for improvement, I am getting better at leaving.

It is easier said than done as I take pride in my work ethic and there is always work we can be doing to improve our courses. No matter how hard we work, our jobs will never be done and a part of you wants to try. In the end, overworking will cause trouble in your life and make you less valuable to your employer. So get out and smell those roses!

How Herbicides Work: Part I - Chemical Classification

By Dr. John Stier, *Department of Horticulture, University of Wisconsin-Madison*

INTRODUCTION

Weeds are the top pest problem in home lawns and are the second most important pest problem on golf turf in Wisconsin (WASS and UWEX, 2001). Though good cultural management can effectively reduce most weed populations, the traffic, disease, and insect injuries on golf turf provide opportunities for weed encroachment in even the most highly managed golf turf. Herbicides are the last line of defense against weeds, but aren't consistently effective. This article is the first of a series on understanding herbicide activity for better control: the current article focuses on the chemical classifications of herbicide and describes the basis for selective weed control and herbicide resistance. Future articles in the series will discuss factors that influence herbicide efficacy, fate, and environmental impact.

WHAT'S IN A NAME?

Herbicides, like other pesticides, have three types of names. The **chemical** name is assembled by chemists based on the structure of the compound. The chemical name is developed following rules of nomenclature (naming) established by scientific organizations such as the International Union of Pure and Applied Chemistry (IUPAC, 2003). Certain chemical structures, ranging from chains of atoms to cyclic structures, have been assigned permanent names. Nomenclature rules define the position of specific groups of molecules or atoms on a large molecule by assigning them a numbered position. Since chemical names are long and complex, companies that produce chemicals for pesticide use must propose a **common name** for the chemical to the Environmental Protection Agency (EPA) as part of the registration process. To entice buyers, and because a given active ingredient may be sold in different concentrations or formulations, a herbicide product will be given a **trade** name by the distributor (seller). In many cases the distributor is someone other than the manufacturer of the chemical.

An example of chemical, common, and trade names can be described using 2,4-D. The chemical name is 2,4-dichlorophenoxyacetic acid (Fig. 1). The central structure is a ring of six carbon atoms which is shown as a hexagon (the circle inside the hexagon indicates there are two bonds between each carbon atom). This is the most stable portion of 2,4-D. The ring structure has an oxygen atom (O) attached to it, making the central molecule a phenoxy group. The oxygen atom has an acetic acid (CH2-COOH) molecule attached to it, modifying the base name to a phenoxyacetic acid. (Incidentally, acetic acid is the chemical which gives vinegar its acidic flavor. At high enough concentrations, acetic acid itself can be an effective contact herbicide. See *The Grass Roots* 31(6):5-7, "Hard cider? Kill some weeds with it!) The carbon with the oxygen attached to it is assigned the number 1 position in the ring. Chlorine (Cl) atoms are attached to carbon atoms number 2 and 4. Thus, the **chemical** name 2,4-dichlorophenoxyacetic acid. The **common** name, of course, is 2,4-D. The chemical is used in many herbicide formulations under **trade** names such as Weedone LV-4, Trimec, etc. Trade names change routinely. Common names almost never change. Chemical names never change.

UNDERSTANDING HERBICIDE ACTIVITY

Herbicides can affect one or more plant parts or enzymes. The plant part or enzyme(s) affected is/are known as the **site of action**. The **mode of action** is the physiological basis for herbicide activity, e.g., a herbicide that affects photosynthesis has a mode of action known as a photosynthetic inhibitor, even though its site of action may be a particular enzyme necessary for photosynthesis. Both the site of action and mode of action help determine the effectiveness, length of time, and other variables associated with herbicide application and the impact of cultural management practices. For example, rainfall or removal of leaf

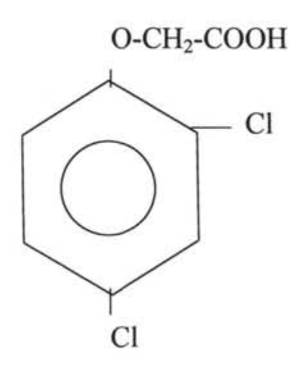

Figure 1. Chemical structure of 2,4-dichlorophenoxyacetic acid (2,4-D).

tissue immediately after application of a slow-acting herbicide may remove a critical amount of the herbicide before it can act to kill the growing point of the weed.

The mode of action is important because many herbicides have similar modes of action yet may be in different chemical classes. The EPA, under the Food Quality Protection Act, is currently reviewing all pesticides and grouping pesticides within a similar chemical class when deciding to allow (re)registration of individual chemicals. Routine use of herbicides that have similar sites of action, especially if they target the same enzyme, can lead to herbicide resistant weeds or enhanced microbial degradation.

Herbicides are placed in a specific chemical class based on their chemical structure. Understanding resistance mechanisms is difficult, though, because herbicides within a chemical class may act differently. For example, bensulide and glyphosate are both organophosphates. Bensulide inhibits cell division (meristem inhibitor) and is used as a pre-emergent herbicide for control of annual weeds while glyphosate inhibits an enzyme needed for amino acid production and is used as a post-emergent. Specific characteristics of each chemical class are outlined in Table 1.

TYPES OF HERBICIDAL ACTIVITY

Herbicides may have one or more modes of action (Callahan, 1994; Penner, 1994). The most common types are described below. In some cases, the mode of action is restricted to a specific site of the plant.

Auxin agonists. Most of the herbicides used for broadleaf weed control in turfgrass are auxin agonists, including those in the phenoxy and pyridine chemical classes. Auxin agonists mimic and/or enhance production of naturally-occuring plant hormones. The chemicals cause uncontrolled growth, resulting in twisting and curling of weed stems and leaves. Weed death is slow because the plant basically grows itself to death. Auxin agonists are the mainstay of the home lawn weed control industry but are also important for golf courses. While some phenoxys like 2,4-D can be phytotoxic to creeping bentgrass, chemicals in the pyridine class have less toxicity and in some cases have been developed as formulations specifically for broadleaf weed control in bentgrass fairways (e.g., Lontrel).

Photosynthetic inhibitors. Some of the most potent and rapidly-acting herbicides disrupt photosynthesis. Without the energy produced by photosynthesis, plants will eventually die. Benzothiadiazoles inhibit the Photosystem II (PS II) portion of

Table 1. Herbicides commonly used in cool season turf management.

Class	Primary Mode (site) of action	Weeds controlled	Timing	Examples: Common name	Examples: Trade name
Arsenicals	Photosynthesis inhibitor	Annual grasses	Post-emergent	Monosodium methanearsonate (MSMA)	MSMA
Aryloxyphenoxy propionates	Fatty acid synthesis (ACCase inhibitor)	1) Grasses 2) Annual grasses	Post-emergent	1) Fluazifop-butyl 2) Fenoxaprop	1) Fusilade 2) Acclaim
Benzamides	Mitosis inhibitor (roots)	Annual bluegrass	Pre- and post-emergent	Pronamide	Kerb
Benzoic acids	Auxin agonist, DNA inhibitor, ethylene production	Broadleaves	Post-emergent	Dicamba*	Multiple trade names and combinations
Benzofuran	Lipid synthesis (cuticle inhibition)	Annual bluegrass	Post-emergent	Ethofumesate	Prograss
Benzothia-diazoles	Photosynthetic inhibitor (PS II)	Yellow nutsedge, broadleaves	Post-emergent	Bentazon	Basagran
Bypyridiliums	Photosynthetic inhibitor (PS I)	Non-selective	Post-emergent	Diquat	
Dinitroanilines	Mitotic inhibitor	Annual grasses & broadleaves	Pre-emergent	Benefin* Oryzalin* Trifluralin* Prodiamine Pendimethalin	*Multiple trade names and combinations Barricade Pre-M
Organophos-phates	1)Amino acid inhibitor (EPSP synthetase), 2) mitotic inhibitor	1) Non-selective or 2) Annual grasses & broadleaves	1) Post-emergent or 2) pre-emergent	1) Glyphosate 2) Bensulide	1) Roundup 2) Betasan
Oxadiazole	Chlorophyll inhibition	Annual grasses	Pre-emergent	Oxadiazon	Ronstar
Phenoxys	Auxin agonists	Broadleaves	Post-emergent	2,4-D* 2,4-DP* MCPA* MCPP*	Multiple trade names and combinations
Pyridines	Unknown, likely auxin agonist	Broadleaves	Post-emergent	Triclopyr* Clopyralid*	Confront Lontrel
Substituted ureas	Mitotic inhibitor (roots)	Annual grasses	Pre-emergent	Siduron	Tupersan
Sulfonyl ureas	Mitotic inhibitor	1) Tall fescue, perennial ryegrass 2) Yellow nutsedge	Post-emergent	1) Chlorsulfuron 2) Halosulfuron	1) Cavalier 2) Manage
Miscellaneous compounds					
	Auxin agonist and enhanced ethylene production?	Annual grasses and broadleaves	Pre- and post-emergent	Quinclorac	Drive
	Fumigant	Non-selective	Pre-plant	Dazomet	Basamid
	Mitotic inhibitor	Annual grasses	Pre- and partial post-emergent	Dithiopyr	Dimension

Adapted from Penner, 1994.

*Usually sold in mixtures with other active ingredients.

Note: Many of the pre-emergent compounds inhibit germination of multiple species, including broadleaf weeds, though their primary use in cool-season turf is for annual grasses.

photosynthesis by binding to the D1 protein and reducing electron transport. Bypyridiliums act on another stage of photosynthesis, PS I, and kill weeds quickly because their activity generates highly energized "free radicals" which literally bounce around a cell and destroy membranes, rapidly and completely eliminating all types of metabolic activity. Many photosynthetic inhibitors turn sensitive plants white.

Amino acid inhibitors. Amino acids are the building blocks of proteins (many of which are enzymes) which are the vehicle for production of all other plant compounds, cell structures, and organs. Glyphosate, for example, interrupts the production of phenylalanine, tyrosine, and tryptophan by blocking the activity of the EPSP synthase enzyme. Glyphosate-resistance has been developed in some transgenic plants, including creeping bentgrass, by inserting a different form of the EPSP enzyme (from bacteria) which is not affected by glyphosate.

Fatty acid inhibitors. Chemicals in this class inhibit the activity of a specific enzyme known as ACCase. Chemicals that inhibit only one specific enzyme in a target organism often allow the development of pesticide resistance when the chemical is not properly rotated with chemical of different activity. Although some agronomic weeds have developed resistance to ACCase inhibitors, this has not been common in turf in part because herbicides are used less frequently or are rotated; in addition, those labeled for turf may also have secondary modes of action such as membrane disruption, auxin inhibition, or meristematic inhibition.

Lipid synthesis inhibitors. Herbicides such as ethofumesate (Prograss) destroy weeds by preventing production of lipids which have various functions in the plant, including the development of the waxy cuticle on leaf surfaces. Plants without a proper cuticle are more likely to dry out and die, or be attacked by pathogenic fungi, than plants with a fully formed cuticle.

Mitotic inhibitors. Mitosis is the process of cell division followed by formation of new cells, a form of asexual reproduction. Mitosis is absolutely necessary for plant growth. Many pre-emergent herbicides stop mitosis in the meristem (region of active mitosis) of new roots during seedling germination, effectively stopping root growth. Without roots, the germinating seedlings die without usually ever emerging from the soil. Many mitotic inhibitors are actually contact herbicides. Sulfonyl ureas can also prevent cell division but these herbicides are applied post-emergent and

are usually selective for certain grasses and broadleaves.

Ethylene production. Some herbicides enhance ethylene production in addition to having other modes of action. Ethylene is a plant-produced hormone and a certain amount is necessary for normal growth and development. Herbicides that enhance ethylene production, though, cause uncontrolled effects from it such as rapid cell death and reduced plant growth. Quinclorac (Drive) is a recently labeled compound for turf which has both ethylene-stimulatory and auxin-mimicry properties (Hawes, 1999). It is especially effective for post-emergent control of crabgrass.

CONCLUSION

There are additional types of herbicide activities and many of those described above may be much more complex than indicated. However, the above descriptions should serve as a guide to understanding herbicide activity. While herbicide resistance has been reported for many agronomic weeds, herbicide resistance in turf is currently of minimal importance. Part of the reason may be underreporting of non-control; lack of resistance may also be due to lower herbicide use (less consistent) and/or rotation of chemicals. Though herbicide resistance could in the future become more important in turf management, much more problematic is the loss of conventional herbicides due to the Food Quality Protection Act.

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He's Ready To Fight Those Turfgrass Pathogens

By Lori Ward Bocher

And in this corner, fighting for golf course superintendents and other turf professionals with turfgrass pathogen challenges, is Steve Abler. Weighing in with a brand new Master of Science degree from Virginia Tech, where his advisor was the renowned Dr. Houston Couch, Steve is the new director of the Turf Diagnostic Laboratory at the O.J. Noer Research Facility.

"I really look forward to working with the golf course superintendents and turfgrass professionals in Wisconsin," says Steve, who began his new duties on May 1. "While working in Dr. Couch's lab at Virginia Tech, we received turfgrass samples from throughout the U.S. Analyzing a sample is like working on a puzzle. I enjoy the challenge of trying to figure out what's causing the problem.

"We realize that when you send a sample to the lab, it's not an easy case and you could be getting pretty desperate," he continues. "We really have to be sensitive to that. Jobs could be on the line. I've heard of superintendents being fired because of something that's not their fault."

Steve has plans for making the TDL as responsive to the needs of its users as he possibly can. But before we get into that, let's get to know Steve a little better. Five years ago he didn't even know there was such a thing as a turfgrass pathologist. Now he's donned his boxing gloves and is ready to help knock out those nasty pathogens. How did he end up in the ring?

Native of Fond du Lac...

Steve is a native of Fond du Lac where is father was a mason and his mother is a secretary. He graduated from L.P. Goodrich High School in 1994 and then attended the UW-Oshkosh where he majored in biology. Why biology? "Mostly because of the classes I took in high school in the conservation area," he answers. "Those classes really interested me. I've always liked the outdoors and thought this might be a