

# Long Term Effects of Herbicides

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In 1940 only 14 herbicides were registered in the United States. By 1963, 110 herbicides were registered and about 7,000 more were on file with the United States Department of Agriculture.

We have come a long way in this short period but we have only scratched the surface. There are many theories about why herbicides kill or injure plants. Observations of treated plants and plant parts provide some information. However, finding the "why" of herbicidal action is very difficult.

With post-emergence selective control of weeds, both physiological and morphological differences between the weed and turf crop are used. Physiological differences are differences in internal mechanisms of growth while morphology refers to outward differences in structure. Both systemic and contact chemicals are used for post-emergence spraying. Systemic chemicals make use of physiological differences for selectivity whereas contact chemicals make use of morphological differences. Systemic herbicides are most conveniently characterized as being readily translocated in living tissue as contrasted with contact herbicides which do not readily translocate in living tissue.

Even with systemic herbicides, whose selectivity is based on physiological differences between the weed and turf crop, selectivity is a matter of degree. We can cite numerous examples where the degree of tolerance to the turf crop in question has suffered. If 2,4-D is the herbicide in

question, the amount of chemical necessary for damage is only two or three times that employed for weed control. Results of systemic herbicides are affected most by growing conditions of the plant, stage of plant development and weed variety.

Herbicides when properly used alter, inhibit or terminate the growth of weedy plants. Some herbicides kill all plants or at least the plant parts with which they come in contact. In general, however, the selective herbicides are of greatest interest. A study of the phenomena of absorption of herbicides by leaves and roots and their translocation within the plant helps in understanding their action.

A herbicide applied to leaves may penetrate the cuticle and stomata, move to the food or water conducting tissue and then to other parts of the plant. The pattern of translocation within the plant is influenced by the kind and stage and growth of the plant. Sometimes the herbicide is absorbed and inactivated by cells in the leaf, and sometimes it may remain on the leaf surface and never enter the plant. The herbicide 2,4-D appears to be absorbed and held more in the cell walls of grass than broad-leaved-type plants, a factor probably important in its selectivity.

## Turf Injury

Turf injury from 2,4-D, 2,4,5-T and silvex herbicides has been demonstrated on occasions. In a study nearing completion, silvex was injurious to both top and root growth of Colonial and creeping bentgrass. Injury to top growth occurred in most of the treatments, appearing as dis-

coloration and thinning. Root growth was reduced in total growth and extensiveness by most treatment rates. Other effects from silvex treatments were lower drought tolerance, decreased food reserves in roots, and tissue abnormalities of the roots.

Since silvex and related compounds are very effective herbicides, it is still logical to use these chemicals and assume the risk of injury on many turf areas. If this is done, careful consideration should be given to factors that will reduce the chance of serious injury. For instance, silvex, 2,4-D, 2,4,5-T, and other phenoxy compounds might be used only on those portions of the turf area where there is a significant quantity of weeds.

In some instances the location of a growing point of a plant influences the toxicity of a given herbicide. For example, the embryonic leaves and terminal meristem of many forage and turf grasses and cereals are well protected during certain growth stages, whereas in other plants they are brought into intimate contact with herbicides applied to the foliage.

Differences in shape, size, distribution and density of the roots of crop plants and weeds also partly determine the amount of soil applied

herbicide that actually comes in contact with the plant. Thus, plants with different types of root systems growing in close association may respond quite differently to soil applied herbicides.

Leaves with waxy, hairy or variously sculptured leaf surfaces differentially retain and absorb herbicides.

Stomate size and distribution and nature of the cuticle probably determine the quantity of material that penetrates leaves. Cell membranes may act also as permeability barriers and further decrease the amount of chemical absorbed by individual cells.

Movement of soil applied herbicides into the plant and to other parts of the plant is with water and nutrients. Factors which favor growth also favor rapid absorption of herbicides. Most of the water conducting tissue of the plant is nonliving. Some absorption and translocation of phytotoxic chemicals may occur even after other root tissues have been killed by a herbicide.

Membranes of different plant species appear to be penetrated more rapidly by some compounds than others. The reasons are not understood. The differential permeabilities

### **TURF BOOK AVAILABLE**

The book "Turf Management," a popular educational printing of all matters pertaining to turf, is available at \$10.95 per copy from the USGA, 40 East 38th Street, New York, N. Y. 10016; the USGA Green Section Regional Offices; the McGraw-Hill Book Co., 330 West 42nd Street, New York, N. Y. 10036, or at local bookstores.

"Turf Management" is a complete and authoritative book written by Professor H. Burton Musser and sponsored by the USGA. The author is Professor Emeritus of Agronomy at Pennsylvania State University.

of membranes are considered important in determining whether a given compound will affect the plant.

Surfactants, solvents, and various other additives and formulation agents influence the external molecular environment of herbicidal sprays. Some of these substances increase toxicity of a herbicide several fold. In other instances, toxicity is unaffected. Under some conditions, toxicity on one herbicide may be increased by a given surfactant whereas the activity of another herbicide may be reduced by the same surfactant. The particular combination of formulation ingredients to use with a specific herbicide is critical.

What are other relationships we must consider when using a herbicide, not only for weed control alone, but in respect to the turf crop which is competing with the weed environment? What is the soil relationship to the herbicide? It is generally accepted that organic matter content has a direct influence on herbicide action. Soils high in organic matter retain 2,4-D in greater phyto-toxic quantities than those with less organic matter. Results of soil type and quality studies show that phyto-toxicity of herbicides may be strongly modified by soil conditions.

#### **Effect of Temperature**

The importance of the effects of temperature upon the effectiveness of herbicides has been recognized almost from the beginning of the use of chemicals for weed control. Numerous studies have shown beyond question that temperature must be given prime consideration, both in evaluating herbicidal materials, and in making recommendations for their practical use.

The moisture factor also is important in determining the effective-

ness of post-emergence treatments. Moisture relationships must receive major consideration in an evaluation of herbicidal effects.

We must not lose sight of the fact that herbicides in general will aid our turf management practices. New improved herbicides have shown great promise. However, a great deal of reservation is still warranted when dealing with new or old materials. We have a long way to go in interpreting the effectiveness of each herbicide against every different management program that is practiced.

Is there a set rule of thumb for any particular practice . . . ? I think not. A general rule or two may work for most everyone, but often the rule that works for you turns out half-way for your assistant and doesn't work down the road at all.

However, one rule we can emphasize is that *you* have to know what you are applying, when it is going to be applied, and who is going to do the job for you. In general, the membership wants you to stay within the time allotted to do a particular job with a fixed number of men, and yet maintain good conditions.

With the limited turf growing weather we have had the past few seasons, more undesirable weed problems than ever are facing us. The time element of maintaining the course has brought the outside contractor to do your job. He has the proper equipment and the ability to produce. But he has to show results and will, many times at your cost; this cost can be very dear to many, it could mean a job and it has.

Last April was pretty wet, in many areas you couldn't get on the course to keep the turf cut let alone put into effect any herbicide program. To get the herbicide program done,

you contracted a custom spray outfit to do the job for you, which was all right, but in many instances it was already too late to begin a herbicide program. May was a dry month, you couldn't keep much moisture in the ground, yet the weeds flourished and they were an eyesore. By the time you got to work one morning the custom spray operator had already done the job and was gone. How much herbicide material had he applied? How much water did he use per acre with the herbicide material? Only one man knows.

I have talked to many superintendents who have had custom work of this sort done for them; the superintendent hadn't the equipment or the time to have the weed eradication done by his own crew so he did the next best thing. When you're talking turf you always ask, "What herbicide did you use?" And the reply nine times out of ten is, "I don't know! Take a look on the can over there."

We have mentioned the requirements which are necessary for proper use of herbicides. We have discussed

the systemic and contact methods of spray application and how they effect the plant organisms. We know that effects to turf from the constant use of herbicides can destroy countless acres.

Have we overlooked something with our present herbicide management program? I feel that we have! We must ask ourselves these questions, "Has there been enough research on this herbicide to justify my using it? Should I use a herbicide this year to control my weed problem, or is there another cultural practice I might use? Does my weed problem warrant a herbicide? Have I tried my own research with this herbicide to see what it might do for my turf management program?"

We will continue to use herbicides and will understand them better as the years go along. But let's keep this mental note:

"Have I strengthened my turf population from the use of herbicides or has there been a decrease in permanent turf population from, LONG TERM EFFECTS OF HERBICIDES?"

## The Troubles We've Seen

By **MARVIN H. FERGUSON**, Mid-Continent Director, USGA Green Section

Sunday morning, between the hours of 7 and 9:30, is the favorite time for calling a Green Section agronomist to discuss golf course troubles.

It is true that this is the time when he's most likely to be home. But it may not be the time when you'll find the agronomist in a humor to be greatly sympathetic to your problems, particularly when the club has encountered troubles through deliberate actions that could have been avoided.

Clubs could save themselves many troublesome and expensive situations if they asked questions *before* they

took actions. It is a distressing fact that relatively few golf course problems we encounter are caused by uncontrollable factors. Rather, they are brought about by poor management, poor construction, or a misunderstanding of plant growth principles.

These points probably can be illustrated most vividly by reciting some of the trouble calls that have come to one Green Section office during the past year. To save possible embarrassment to the club, the accounts are fictionalized to some degree, but all are based on actual cases. If a club member should recognize his own