Dandelion and clover, two well known weeds that spoil turf.

Weeds and Their Control

by **A. ROBERT MAZUR**, Agronomist, USGA Green Section

A weed is classically defined as a plant that is growing where it is not wanted, or a plant that is out of place. Weeds are plants that have more undesirable than desirable characteristics. At times even some of our fine turf species can be considered weeds; bentgrass in a Merion bluegrass tee is a weed. In turf, uniformity is the key to high quality. Any plant that causes a variation in leaf color, texture, or growth habits of the turf stand is classed as a weed.

History of Weed Control

Agriculture has advanced more in the past 100 years than in the previous 100 centuries. More striking is the fact that man's ability selectively to control weeds has been developed to the greatest degree only in the last 30 years. Presently we are in the era where specific chemicals are used for the control of specific weeds. The major historical achievements that have led to our present knowledge are approximated as follows:

1850-1900 **Julius Sachs** and **Charles Darwin** observed the significant fact that plants produce certain growth-regulating substances. These growth-regulating substances are translocated from the site of production to a site of activity and could be compared with the nervous system in animals.

1900 **Bonnett, Schultz** and **Bolley** working independently observed that copper salts would selectively kill broadleaf weeds in cereals.

1941 **Pokorny** reported the synthesis techniques for 2, 4-D.

1944 **Marth** and **Mitchell** showed that 2, 4-D selectively removed dandelions, plantain and other broadleaf weeds from bluegrass turf.

1945 **Templeman** established the principle of preemergence soil treatment for selective weed control.

Weed Classification

A plant's method of reproduction, the length of time it grows and the time of year that it grows are instrumental in determining control measures. The three principal groups of weeds are annual, biennial, and perennial.

Annual weeds complete their life cycle from seed in less than one year. Due to the prolific production of seed and their fast growth, annual weeds are very persistent. The summer annuals such as crabgrass, goosegrass and knotweed that germinate in the spring, make most of their growth during the summer, and they usually mature and die in the fall. The winter annuals such as wild garlic and henbit usually germinate in the fall or winter and mature and seed in the spring or early summer before dying. Another weed we can consider with this class is "our old friend" **Poa annua.**

Biennial weeds such as bull thistle and cinquefoil generally live for more than one year but less than two years.

Perennial weeds such as dandelion, plantain, mouse-ear chickweed and quackgrass live more than two years and may live almost indefinitely. Most perennial weeds reproduce by seed but many are able to spread vegetatively.

Weed Control

In turf management we have principally two methods of weed control available to us; mechanical and chemical control.

Mowing is an effective means of mechanically controlling tall-growing weeds in turfgrass. Repeated mowing not only prevents seed production of some species but it may also starve underground parts by drastically reducing the weed's photosynthetic surface. This type of control is only effective on tall-growing weeds when an area is mowed repeatedly. Vertical mowing is effective on the lower growing weeds only when properly timed to set back seed production and plant growth.

Weed-killing chemicals are referred to as herbicides. The use of chemicals for the selective control of weeds has developed rapidly since the work of Marth and Mitchell with 2, 4-D. The type of herbicide application is usually classified with reference to weed-seed germination or turf establishment. Preemergence treatments are applied prior to weed-seed germination. This is the most effective means of controlling some of our grassy weeds such as crabgrass and goosegrass. Post-emergence treatments are applied after the weeds have become established. This is the manner in which most broadleaf weeds are eliminated from mature turf. Seedbed sterilization is a nonselective treatment made prior to the seeding of the turfgrasses.

Herbicides fall into three classes: soil sterilants, contact herbicides and growth regulators.

Soil sterilants are chemicals that prevent the growth of green plants when present in soil. The length of time any chemical remains active in the soil depends on (1) the nature of the chemical, (2) the activity of soil microorganisms, (3) adsorption on soil colloids, (4) leaching, (5) volatility and (6) photodecomposition.

In order for a herbicide to give effective seedbed sterilization, it must not only remain active in the soil long enough to kill both the viable weed seeds and existing plant parts, but also the herbicide must dissipate prior to the seeding of the turfgrasses. If the herbicide has killed both the viable weed seeds and existing plant parts the soil will remain weed free for a long period of time after the chemical has disappeared.

A preemergence herbicide treatment depends on the ability of the herbicide to remain in the top 1/2 inch of the soil for a sufficient period of time and at a high enough concentration to control weed seedlings. This takes into consideration that most of the annual weed seeds germinate near the surface of the soil.

Contact herbicides are directly toxic to living cells and kill the plant parts covered by the chemical. There is little or no translocation of this type of herbicide through living cells. Contact herbicides such as sodium arsenite have been used effectively on golf courses in the past for the control of annual weeds such as knotweed. However, they do little more than "burn off" or chemically mow perennial weeds.

Growth regulators are organic compounds other than nutrients, which in small amounts promote, inhibit, or otherwise modify the physiological processes of plants. Growth regulators or hormone-type herbicides are generally applied as postemergence treatments. They can be absorbed by either the roots or above-ground parts of the weed and are translocated throughout its system. Essentially hormone-type herbicides upset the plant's growth and metabolic processes. The fact that certain chemicals will selectively kill certain plants without harming others make them a very effective tool in weed control. Rate of application is often the key to usefulness. The old axiom, "If a little is good,

more is even better," does not apply. Where small amounts give selective weed control, increased rates can often injure the turfgrasses.

Herbicide Selectivity

A selective herbicide is one that is more toxic to one plant than to another. When this herbicide is applied to a mixture of plants, some may be killed and others may be affected only slightly or not at all. Selectivity is based upon factors such as morphology, absorption, translocation, and physiology.

The morphological or structural differences such as protected meristematic regions, differences in leaf surface or orientation, and the presence of a waxy cuticle or hairs permit the selective application of herbicides. On broadleaf plants the new growth is located in the terminal portion of the stems which is exposed to the herbicide spray. The growing point of grasses, on the other hand, is usually protected by a leaf sheath. Grasses may also present far less leaf surface than broadleaf weeds and are generally oriented so that chemical sprays will quickly flow off the leaf surfaces.

To be effective herbicides must enter the plant. Absorption can take place either through the leaves or the roots. Depending upon the nature of the chemical it may be absorbed quickly or little if at all. The leaves of most plants are covered by a non-polar wax-like cuticle which prohoibits the penetration of polar materials such as water. While the roots on the other hand readily pick up and translocate polar materials like water. In order to get penetration of leaf tissues we must use an organic or non-polar herbicide such as the organic acids and esters. Any material that will bring the polar or water-soluble herbicides into more intimate contact with the leaf tissue will aid absorption. It is for this reason that wetting agents and spreader stickers added to polar herbicides increase their herbicidal toxicity. However, this can reduce the selectivity of the herbicides if it is dependent upon the difference in foliar absorption for its effects. Non-polar herbicides applied to the soil are generally converted to polar substances which can be absorbed through the roots of the weeds.

Translocation

Translocation or movement of herbicides in the plant takes place in the phloem with food materials, in the xylem with water or in the intercellular spaces.

The movement of herbicides in the phloem is generally from the leaves toward the roots. The phloem consists of living cells that translocate food materials from the leaves to the other plant parts. Extremely toxic chemicals such as contact herbicides quickly kill the cells and are therefore not translocated. Because the hormone-type herbicides are translocated along with food materials, we can expect the best results with these materials when the weeds are actively growing.

Translocation through the xylem is generally from the roots upward. Movement of herbicides is believed to be in conjunction with the upward movement of water in the plant. The xylem tissue is principally non-living. Therefore, all types of herbicides, even the toxic or poisonous chemicals, can be absorbed from the soil and quickly translocated to all parts of the plant. Actually, some of the toxic chemicals such as the arsenicals may even move downward through the xylem tissue under special conditions.

Translocation through the intercellular space is primarily by non-polar substances with low interfacial surface tensions. An example would be the absorption of kerosene or fuel oil through the cuticle, bark and stomates. Once these materials are inside the plant they can move in any direction. Water-soluble materials move little if at all through the intercellular spaces.

Physiological Differences

There are a great many factors that account for selective herbicidal toxicity. Differences in cell metabolism, enzyme systems, cell permeability, chemical constituents and polarity could be involved. Many of these factors interact and often the exact mechanism of action is not definite. The entire metabolic process of a plant can be thrown out of balance by either blocking or stimulating a certain biochemical process.

Photosynthesis and respiration are the two basic physiological processes that are taking place in plants. Photosynthesis is essentially a building process while respiration is a breakdown process. The substituted ureas, such as siduron, and the triazines, such as simazine, interfere with a basic reaction in photosynthesis known as the Hill Reaction. The Hill Reaction is essentially the splitting of water into hydrogen and oxygen, which is the primary step in the synthesis of plant foods. Therefore when the herbicide disrupts this reaction, the plant dies from starvation.

Weed Prevention

The most important requirement in the prevention of weeds is good turf management. This includes selection of the proper grass specie, fertility rate and regime, soil type and

reaction, cutting height and frequency of mowing, good moisture level and drainage along with the control of damaging insects and disease. Chemical control of weeds is not the long-term answer if the preceding factors are not recognized and practiced. Chemical weed control is no substitute for good turf management.

Weeds generally become a problem in turf when the grass loses its vigor and density. Many of the weeds thrive under conditions that are unfavorable for turfgrasses. Knotweed, for example, will flourish on dry and compacted areas that receive constant traffic. Therefore, we must start with a program to improve conditions so as to promote a stronger and more vigorous turfgrass stand.

Kentucky bluegrass and fescue fairway turf should be mowed at a height of 1-1/4 to 1-1/2 inches, watered deeply and infrequently, and receive the major portion of its fertility in the early fall. Closer cut, more water and early spring fertility will leave a weak, open, and diseased turf that is subject to invasion by weeds that will tolerate this management regime, i.e., **Poa annua,** crabgrass and knotweed.

Delaying fertilizer applications in the spring until the soil has warmed up and the bentgrasses are actively growing helps to hold down the early spring flush of growth by the annual bluegrass. The use of our more slowly available forms of nitrogen during the summer months, the peak period for weed-seed germination, gives a slow, steady feed to our permanent grasses and avoids the quick stimulation that encourages weed seedling development.

Water management is important in checking weed-seed germination and development. A mature turf will tolerate dry soil at the surface for a longer period than the germinating and developing weed seedlings. Withholding water until the permanent grasses show signs of stress is an effective means of minimizing weed-seedling development.

Grasses differ in their ability to resist weed invasion. We should select grasses according to the management they will receive. In the areas we intend to water and mow at 1/2 inch, or less, the situation dictates the use of bentgrasses or bermudagrasses. In areas that we will mow infrequently at 1-1/2 inches or higher without supplemental irrigation, the bluegrasses and fescues are more appropriate.

Contamination of weed-free areas should also be avoided. Topdressing materials should be sterilized to prevent the introduction of weed seed. The use of certified seed for turf establishment and overseeding will minimize the introduction of undesired species. Clean seed is particularly important as many of our weedy grasses cannot be selectively removed with herbicides from the desired turf species. Cleaning equipment will reduce the amounts of weed seed and vegetative parts that are carried from one area to another. Preventing adjacent weedy areas from going to seed by mowing or chemical treatment will also reduce this source of infestation.

Use of Chemical Herbicides

The application rates of herbicides as expressed in pounds per acre are usually very critical. When herbicides are applied at less than the optimum rates they seldom give effective control unless a second application is made. Applications at rates in excess of those prescribed on the label can result in the nonselective killing of all vegetation, including the turfgrasses. By reading the labels and thoroughly familiarizing yourself with all materials prior to use, you can greatly reduce the chances of injury to man and turf. Equipment should be properly calibrated at selected pressures and speed to insure uniform application at desired rates. Sufficient water should be used to facilitate even distribution of the material over the predetermined area. Applications are most favorably made in the late afternoon or early morning when air movement and traffic are at a minimum. Dew in the early morning often provides an excellent reference line for application of these materials.

Climate affects the results of a herbicide application indirectly through the growth rate of the weeds and turf. There should be adequate soil moisture and favorable temperatures so that the weeds and turf are actively growing. On the other hand, herbicide applications should be avoided during the heat of summer when herbicides tend to lose their selectivity and can injure the desired turf species.

In instances where a minimum number of weeds are present, it may be more advisable to remove them by hand rather than embark on a complete spray program.

Summary

It is important to evaluate your weed problems and eliminate the conditions that have brought them about. You can eliminate weeds through mechanical and chemical treatments but only good turf management practices will replace weeds with desirable turf coverage and keep the weed from reappearing. Let me reiterate by saying chemical weed control is not a substitute for good turf management.