UNDERSTANDING TURF CARE

This booklet has been written as an educational introduction to the techniques of successful turf management. It is divided into three sections:

I. HOW PLANTS GROW

All plants require light, air, water, nutrients, and a healthy, productive soil to grow properly. Usually, a plant starts from a seed, and will continue to develop into a mature plant if all of the "growing conditions" are favorable. We can look at the seed as an embryo, or tiny immature plant, that lives in a dormant state. In this dormant state, it is surrounded by a large amount of stored food, and resides safely inside the hard shell of the seed. This embryo is a living plant, but it will remain dormant until it finds itself in conditions that are favorable for growth. When the conditions become ideal, the seed will germinate. The growing embryo draws upon its stored food supply until it breaks through the soil, develops green chlorophyll, and begins to manufacture food by photosynthesis. It is important for the grounds manager to remember that seeds can remain dormant for years, until proper conditions for growth exist.

A. THE STRUCTURE AND FUNCTIONS OF PLANT PARTS

Once a seed germinates, it is considered a plant. There are four basic parts to a plant: ROOTS, STEMS, LEAVES, and FLOWERS.

1. **ROOTS perform the following functions:**
    a. **ANCHOR the plant, and support the aboveground parts.**
    b. **ABSORB water, minerals, nutrients, and air from soil.**
    c. **TRANSPORT these substances to the upper plant parts.**
    d. **STORE finished foods that are produced by the leaves.**

    Roots may have various structures:
    a. **TAP ROOTS, the large, deep growing main root.**
    b. **SUPPORT ROOTS, branch off taproot to anchor the plant.**
    c. **HAIR ROOTS, tiny roots diffused in many directions that do the actual work of absorbing nutrients and water.**

2. **STEMS perform the following functions:**
    a. **SUPPORT and hold the leaves and reproductive parts.**
    b. **TRANSPORT water and nutrients to and from the roots, leaves, and reproductive parts.**
    c. **STORE food that has been produced by the leaves.**

    Stems also have various structures:
    a. **BARK, an outside protective coating on woody plants.**
    b. **LENTICELS, the small openings that allow oxygen (O_2) and carbon dioxide (CO_2) to pass in and out.**
    c. **VASCULAR TUBES, which are the "veins" or "pipelines" that transport vital fluids up from the roots to the leaves (called the xylem) or down from the leaves to the roots (called the phloem).**

3. **LEAVES do the following jobs:**
    d. **PHOTOSYNTHESIS, a complex chemical reaction that uses the energy of sunlight to create food (sugars and starches) out of water, carbon dioxide, and simple nutrients.**
    e. **ABSORB carbon dioxide from the air, and release oxygen back into the air (oxygen is a waste product of photosynthesis).**

Leaf structures can vary in small – but important – details:

a. **STOMATA are tiny openings that allow the in-out movement of important gasses and moisture vapor.**
b. **CUTIN is a waxy protective coating that helps to protect against scalding, moisture loss, insect damage, and disease.**
c. **CHLOROPHYLL is a complex chemical substance that is made and used by leaves. It is responsible for the green color of the leaves, and is the main catalyst for the chemical reaction that we call photosynthesis.**
d. **VEINS are the tubes that transport the various fluids.**
e. **HAIRS are surface growths on the leaf that help hold moisture and protect the plant (this feature is not found on all plants).**

4. **FLOWERS are the plant parts necessary for sexual reproduction and seed formation.**

B. MONOCOTS AND DICOTS

A grass plant has all of these features, but its structures are slightly different from most larger plants. The roots of a grass plant are fibrous and branching – there is no identifiable main taproot. The stem is very short – in fact, the stem of a grass plant is almost non-existent and is called the *crown* of the plant. Grass leaves are long and slender, and all the veins run parallel to each other along the length of the leaf.

It is important to note the arrangement of the veins in the leaves of the grass. This gives us an unmistakable clue that all grass plants belong to the same group. Botanists divide all flowering plants into two main groups: MONOCOTS and DICOTS

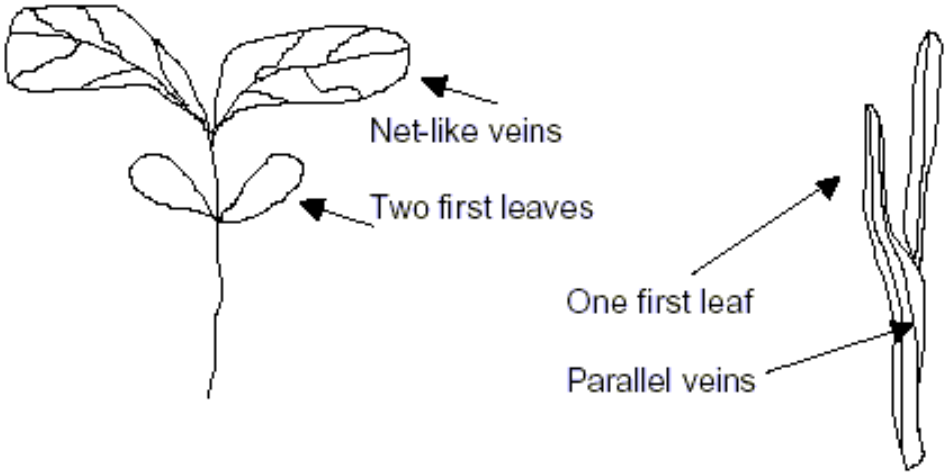
MONOCOTS are distinguishable because the veins of the leaves run parallel to the center of the leaves. Also, the first leaf looks the same as the leaves that follow. They comprise one-quarter of all flowering plant species. They include some of the largest and most familiar groups of plants, including lilies, orchids, agaves, palms, and grasses.

Economically, monocots are perhaps the most important organisms on earth. Our four most important foods – corn, rice, wheat, and barley – all come from monocots. Bamboo and palms are a primary source of building materials and fibers in many tropical countries. Sugar cane, pineapples, dates, bananas, and many of our familiar tropical fruits also come from monocots

DICOTS have veins in their leaves that criss-crossed and intersecting. Also, the two "first" leaves look different from all that follow. Nearly all our deciduous trees and common flowering bushes and vines are dicots,

There are several other major differences between monocots and dicots, but they are not important to our discussion.

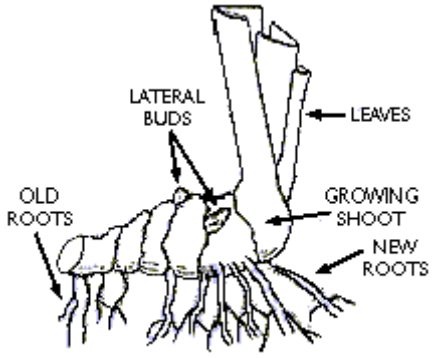
Dicot **Monocot**



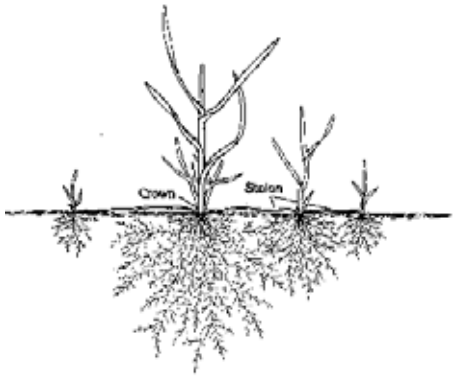
C. VEGETATIVE REPRODUCTION IN GRASS PLANTS

Grass plants may reproduce in one of two ways: via seeds or VEGETATIVELY. Vegetative reproduction is the most common on established turf. Vegetative reproduction means that a new plant is started from the parent plant without the use of flowers or seeds. It is essentially a *spreading* process that can occur in two different ways:

1. RHIZOME spreading, where the rhizome is an underground root that grows laterally and sends up another plant if the soil is in good physical and chemical condition. This type of spreading is characteristic of blue grasses and certain fescues.



2. STOLON spreading, where the stolon is a creeping stem. As the plant matures, the stolon forms as a "creeper" that grows laterally along the surface of the soil. It then sends down "rootlets" which anchor into the ground and begin the new grass plant. This spreading is characteristic of bent grass (often used on golf coarse greens).



VEGETATIVE REPRODUCTION via rhizomes or stolons depends on proper soil conditions for success. Soil is most important to the success of vegetative reproduction – the soil must be in good physical and chemical condition to promote this "non-sexual" reproduction.

II. ENCOURAGING GROWTH OF DESIRABLE PLANTS

A. THE FIVE ESSENTIAL ELEMENTS OF TURF CARE

As hinted above, the PHOTOSYNTHESIS process is the life-giving ability of the plant to take some simple gases, water, and nutrients and build them into the complex food it requires. All of the structures of the plant are designed to facilitate efficient photosynthesis, and thus help the plant grow to reproduce.

In order for any plant to grow, we can clearly identify the FIVE ESSENTIAL ELEMENTS it must have:

LIGHT – used for energy to power the photosynthesis reaction.

AIR – to provide carbon dioxide used in photosynthesis.

WATER – used in photosynthesis and as a carrier for nutrients.

NUTRIENTS – Chemicals that are used in food production.

SOIL – supports the physical plant and provides nutrients.

These five essential elements provide a key to the proper growth of any plant – including the crop we are most interested here: *TURF GRASS.* Through the careful and balanced management of L-A-W-N-S (Light, Air, Water, Nutrients, and Soil), a healthy crop of turf grass can be attained and sustained.

To many, this may seem to be an over simplification. However, it has been shown time and time again that 99% of all turf problems can be resolved by paying attention to these factors. To grow a successful crop of turf grass, careful analysis of our management (or mismanagement!) of these five areas is necessary. Before you act, stop … think … then re-act to what must be done by following the recommendations spelled out by L-A-W-N-S!

With frequent and measured mowing, approximately 2 inches in height, along with a wary eye on accumulations of thatch and mat, your efforts will result in a beautiful, healthy green, show-case LAWN – now there's a beautiful four letter word!

B. THE IMPORTANCE OF SOIL

Of the five factors expressed in L-A-W-N-S, one single condition stands out as being the most important for us to actively manage: SOIL. Most seed will germinate in soil of poor quality, but it will never grow into a mature, productive plant.

Remembering that the seed is the embryo from which we anticipate an abundant crop, the soil is the "womb" from which we expect that birth. From the turf manager's point of view, the soil is truly the plant's "Mother earth".

1. WHAT IS SOIL?

The topsoil of our earth was formed from the action of nature over long periods of time. The natural physical forces of our environment work on rocks (the "raw material" of soil) to weather them down into soil particles. Nature's freezing and thawing, the erosion from wind, rain, hail, snow, rivers, streams and glaciers are responsible for the creation of soil. These forces break down mountains into boulders; rocks into stones; stones into pebbles; and finally, into soil particles of sand, silt and clay. These particles form the INORGANIC part of soil.

A healthy, productive soil must also have substantial amounts of ORGANIC matter. Over the course of time, countless plants and animals live and die over, under, on, and within the soil. Their decomposed remains provide this vital organic matter. This organic material is gradually combined with the soil particles to form a SOIL AGGREGATE. Simply stated, one can think of organic matter as a binding agent and stabilizer. It holds soil particles together, and also provides a "cushion" effect to keep the soil aggregates from packing together too tightly.

Organic matter is extremely important because it serves as a sponge to absorb moisture, air, and nutrients. It also supports bacteria and other microorganisms that work constantly to improve the soil texture. A soil that has high organic content is always more productive than one that is low in organic matter.

2. SOIL POROSITY

The spacing of soil aggregates, relative to each other, is extremely important. These spaces give the soil POROSITY, and allow air, water, and nutrients to penetrate and flow freely within the soil structure (the "cushion" effect mentioned above).

A COMPACTED soil is one with little or no porosity. The soil aggregates are crushed tightly together. This severely limits the flow of L-A-W-N that plants require. Compacted soil is much less productive because it hinders the development of deep, healthy root systems, and cannot supply an adequate flow of the necessary nutrients and water.

Yes, to produce a healthy crop of grass plants, the soil must supply the proper balance of L-A-W-N-S. If any of these essential elements is out of balance with the needs of the plant, the seed may still germinate, but sustained healthy growth will not be achieved.

C. PHYSICAL PROBLEMS OF SOIL

Almost all new construction sites have a better-than-average chance of soil problems. Construction activity and heavy equipment traffic will compact the soil to the point where seeds cannot germinate, nor can nutrients and water penetrate. Consequently, we have problems with run-off, puddling, and erosion. The plants we try to grow have shallow roots, stunted growth, and are susceptible to disease, insect attack, scalding, and dehydration. They just won't grow very well in this soil. Experienced turf managers are aware of this problem, and spend extra time preparing the soil after the construction is finished, so as to avoid more serious problems later on.

COMPACTED SOILS (especially soils with a high clay content) are the scourge of the conscientious turf manager, and may be the most pressing turf problem he faces. Along with compaction, caused by heavy vehicle and pedestrian traffic, clay soils present unique problems to be dealt with.

Clay soils can also be compacted by over-watering. This is because the soil aggregates *shrink* when they are dry, and *expand* when they are wet. The unwary turf manager may actually create more turf problems - as well as waste water – by excessively frequent and heavy irrigation. How can he solve the compaction problem to promote the most vigorous growth and save water at the same time?

Here are some techniques used to improve compaction problems, some work well while others have been shown to be a waste of time and money.

1. VERTI-CUTTING: Making vertical slices on the soil with a small disc; this has proved beneficial in breaking up thatch and mat. However, it has not shown itself to be helpful in improving porosity.
2. TOP DRESSING: Working sand, organic loam, and other porous materials into the soil, allowing the aggregates "room to breath."
3. SPIKING: A procedure of running a roller studded with appendages like large nails; this process is not recommended because it simply doesn't work very well.
4. AERIFICATION: Another roller device with hollow prongs that punch holes and pull out soil "cores." This removes the compacted soil aggregates allowing L-A-W-N to penetrate. Without any doubt, this is the fastest way to remedy compaction, but aerification of large areas is time consuming and expensive.
5. CHEMICAL CONDITIONING: An effective method for reducing or eliminating compaction, with longer lasting results, if the correct process is used. Chemical methods of soil conditioning do not work as quickly as mechanical aerification, but they do offer other advantages.

"FAIRY RINGS": Fairy rings are visible marks left by the effects of a fungus disease. These rings appear as large circles in healthy turf, radiating out from a center point where there is decaying organic material in the ground (such as an old stump). The circles may spread until they are 40 feet or more in diameter. Grasses within these circles are weak, browned, and lack vigor due to decreased chlorophyll. This is due to soil compaction caused

by the underground part of the fungus growth (called mycelium). The fungus does not attack the grass directly, but it does harm it by making the soil water-repellent. This disease is best treated with a fungicide mixed with #395 Surfactant organic soil conditioner, to help the fungicide penetrate into the soil. This treatment restores turf quicker by making it possible for the grass to absorb water. The soil no longer repels moisture electrostatically.

D. CHEMICAL CONDITIONING OF SOIL

The simplest, least costly procedure to reduce compaction is the use of chemical soil conditioner. The turf manager must be wary because some so-called "soil conditioners" are nothing more than wetting agents and detergents. These can be harmful, as the detergent can actually wash out the binding agents that hold soil particles together. This may cause soil *layering*, where larger soil particles migrate towards the surface and smaller particles sink lower. Certainly not a good situation! We see, then, that it is important to choose a chemical soil conditioner that will give the desired results without harming the soil.

Once a decision has been made to use a chemical conditioning method, we strongly urge the use of an organic soil conditioner. This type of product will function like common wetting agents, but without the disadvantages mentioned above. A high quality organic conditioner will offer these outstanding features:

1. Promote faster and deeper penetration of water into the root zone.
2. Increase the horizontal movement of water within the soil layers, through electrostatic actions.
3. Make nutrients more readily available for uptake by the roots, because they are carried deeper into the soil.
4. Reduce the amount of water lost to evaporation by retaining more moisture down at root level.
5. Decrease puddling problems by allowing the soil to accept larger amounts of water at a time.
6. Limit the erosion of topsoil by increasing water penetration on slopes and areas of bare, unprotected soil.
7. Increase penetration of air into soil through the opened pores. This improves the environment for soil life forms, such as beneficial bacteria and earthworms, and greatly accelerates the decomposition of thatch and mat converting them into valuable nutrients.

By using #395 Surfactant, the smart turf manager has taken a major step to improve the soil quality. The porosity of the soil will be effectively increased, allowing a better flow of Air, Water, and Nutrients to the plants. They can grow larger, deeper, and stronger root systems in this improved soil environment, and will absorb more life-giving nutrients. Transported up to the leaves (where photosynthesis takes place), more food will be produced with the abundant flow of vital elements. The result:

A HEALTHIER, LUSH GREEN, DISEASE RESISTANT CROP OF TURF GRASS!

E. FERTILIZERS AND MICRONUTRIENTS

Fertilizers supply nutrients for use by the plants. Their function is to improve the quality of plant growth. Fertilizers are used when the naturally occurring nutrients are insufficient to maintain the vigorous growth that is desired in our crop of turf. Plants need three of these elements in large amounts:

1. **NITROGEN – Expressed with the chemical symbol "N."**
2. **PHOSPHORUS – Expressed with the symbol "P."**
3. **POTASSIUM – (Sometimes called Potash) expressed as "K."**

These three chemical elements are classified by the U.S.D.A. as *PRIMARY* nutrients. When you look at a fertilizer label, it must state a guaranteed analysis of three primary nutrients. This N-P-K statement tells you how much nutrition you have per pound of fertilizer. For instance, a 100-pound bag of 16-4-8 fertilizer contains:

16% N, supplying 16 pounds of N per 100-pound bag,
4% P, supplying 4 pounds per 100-pound bag, and
8% K, supplying 8 pounds per 100-pound bag.

Fertilizers containing these primary nutrients are available in a wide variety of analysis and forms, both liquid and dry. Dry fertilizers require water to make the nutrients available to the plants, while liquid fertilizers are nutrient solutions that provide the nutrients in a form that is immediately available to the plants.

Other nutrients are required only in very small (trace) amounts. They are called micronutrients and include:

1. **IRON: Key element for chlorophyll production.**
2. **COPPER: Essential element for plant reproduction.**
3. **BORON: Necessary for flower pollination.**
4. **MANGANESE: Absorbs carbon dioxide in photosynthesis.**
5. **ZINC: Used in making of hormones and accelerates early growth.**
6. **MOLYBDENUM: Reducing agent used in photosynthesis process.**
7. **SULFUR: Also required for production of chlorophyll.**

Soil that has the proper pH will usually provide sufficient amounts of most micronutrients. On turf areas, iron deficiency is the most commonly occurring problem. Iron deficiency appears as chlorosis, a lighter than normal green coloration of the grass plants. This deficiency can be remedied by application of #133 Chelated Iron. The recommended application rates for this product vary from 1 to 2 gallons per 10,000 square feet, depending on the severity of the problem. Annual application of all of the above micronutrients is very expensive, and is not usually necessary. This could be a waste of money. A thorough soil analysis will be able to pinpoint any deficiencies, and direct the turf manager to correct specific problems.

We can summarize this section by reviewing the following terminology:

1. **N-P-K: The primary nutrients that are the "meat, bread, and potatoes" of the plant's diet.**
2. **MICRONUTRIENTS: "Vitamins and minerals" needed by the plant in very small amounts for the best growth.**
3. **AVAILABLE: Nutrients in water-soluble form that are usable by the plant.**
4. **SOLUTION: The mixture of water and nutrients that is made available to plants as a liquid, not a solid.**

F. TYPES OF FERTILIZERS

N-P-K is N-P-K! One pound of 16-4-8 fertilizer contains 16% nitrogen (0.16 pounds of nitrogen) whether the fertilizer is in a liquid or dry form. The important question is: *Which form of N-P-K is best available to the plants?*

1. DRY FERTILIZERS

Water soluble granules: Require large amounts of water to dissolve and wash the nutrients into the soil before the plants can use them. However, irrigation is expensive, and excess watering can lead to compaction on heavy clay soils.

Urea granules: Bacteria in the soil must break down Urea before any nutrients are released and made available to the plants. If the proper soil moisture and bacteria are not present, the plant may have to wait for days or weeks until the nutrients become available.

Sewage products: Fertilizers made from dried sewage byproducts have a very low nutrient content, and very large amounts are required to provide adequate nutrition. They work, but can have objectionable odors, attract flies, do not penetrate into the soil, and have uncontrolled release of nutrients.

Dry Fertilizers are easy to apply with a spreader, but have several disadvantages:

a. **They "burn" the grass easily.**
b. **They draw moisture out of the soil.**
c. **Slow release of nutrients can cause shallow root systems.**
d. **"Streaking can occur due to inexact application.**

2. LIQUID FERTILIZERS: Truly the *WAVE OF THE FUTURE.*

a. **They provide nutrients in a form immediately available to the plant, and go to work immediately.**
b. **Penetrate deeper into the soil for better root system development.**
c. **Application with spray equipment is more exact, giving more uniform coverage with no streaking.**
d. **Can be applied to wet turf without the danger of "burning."**
e. **Do not require criss-cross applications.**

Once we decide on the type of fertilizer to use, we must consider the N-P-K composition. The *BALANCE* between N-P-K, as well as the amount of each, is a very important factor in determining exactly what fertilizer to use. We want to apply enough nutrients to make our crop of turf grass grow well, but avoid the waste, expense, and possible damage due to over-application of the fertilizer, or the wrong choice of fertilizer.

Let us look at each of the three primary nutrients:

NITROGEN (N): Along with iron, zinc, and sulfur, N is necessary for the production of chlorophyll in the leaves of the plant. Adequate nitrogen must be provided early in the growing season to assure proper springtime "green-up." Lesser amounts of nitrogen are required in later growth stages, but it is still an absolutely essential nutrient at those times.

PHOSPHORUS (P): Phosphorus is necessary for proper root development in all plants. High P fertilizers are often used as "starter" fertilizers after seeding to promote strong root development in the young plants. However, too much phosphorus can be detrimental to established turf. Excess P tends to slow their growth and vegetative spreading characteristics, and also encourages weed growth. On the other hand, high phosphorus fertilizers are ideal for flowering plants (remember that most weeds are flowering plants). Choose a formulation with a lower proportion of phosphorus for use on established turf grass.

POTASSIUM (K): This element is usually associated with the proper development of the stalk of the plant. It also helps the plants "harden off" in preparation for the dormant winter period. Thus, applications of high potassium fertilizers are more beneficial in the late (fall) season.

On most established turf grasses, a good fertilization program will require that two different grades of fertilizer be applied over the course of the growing season to provide sufficient amounts of N-P-K - and in the correct balance. For springtime and early season applications, apply a high nitrogen formula like #242 Liquid Fertilizer 20-2-3 or #245 Liquid Fertilizer 16-8-4.

Of course, other grades are suitable for early season use, to meet special nutrient requirements that can be determined by soil analysis. 5-20-10 or 15-10-5 may be necessary to correct nutrient deficiencies. Likewise, the 15-10-5 or 5-20-10 could be used in late season applications. Your local agricultural extension office can analyze your soil and point out any deficiencies or problems. Specific N-P-K-ratios can then be applied to correct specific nutrient deficiencies.

III. ELIMINATING UNWANTED PLANT GROWTH

The goal of every turf manager is to create the best possible crop of lush green grass. With proper attention to L-A-W-N-S, we can make conditions favorable for the best growth of grass plants. Unfortunately, weeds will also benefit from all the steps taken to encourage good growth of the grass plants. After all, weeds are plants too, just plants that we do NOT want growing in that area!

This next section will discuss the different types of herbicides (weed killers) that the turf manager can use to control the growth of undesirable plants in his turf.

Various methods can be used to control weeds, but chemical control is by far the most effective and economical. Chemical control methods require the least time and labor, and give the longest lasting results. Once the decision has been made to use chemical control methods, the turf manager must define his objectives; that is, he must identify just what exactly he wants the herbicides to do for him. Only then can he choose the correct product to achieve those desired results.

The flow chart on the page 19 will help the turf manager ask the right questions to discover and define his objectives. The answers to these questions will lead him to choose the correct herbicide product to do the job. The first question is quite simple:

***QUESTION:* What plant do we want to kill?**

***POSSIBLE ANSWER:* We want to kill ALL of the plants.**

In some areas, it may be desirable to kill *ALL* of the vegetation growing in that particular area, whether that vegetation is *weeds* or *grass*. This could be along fence lines, in parking lots and driveways, around electrical equipment, storage yards, next to buildings, etc. Here, we want to kill everything, and we make no distinction between desirable plants and undesirable plants. We want a NON-SELECTIVE herbicide that will kill everything.

***POSSIBLE ANSWER:* We want to kill only SOME of the plants.**

In other cases, we may want to kill only those plants that we call *weeds* and leave the desirable plants that we call *grass* growing undisturbed. In other words, we want to be selective about the plants we kill. In this case, we must use a *SELECTIVE* herbicide to do the job. A selective herbicide is a chemical that will kill some types of plants without harming other types.

We have now made an important distinction between *SELECTIVE* weed control and *NON-SELECTIVE* weed control. Now we can go on to the next question that will help to define our objectives in more detail and eventually lead us to pick the correct product for the job.

A. SELECTIVE WEED CONTROL FOR BROADLEAF WEEDS

Let us take a closer look at the second possible answer to question 1. We want to kill SOME of the plants. For example, this answer will apply to a fairway that is infested with weeds; we want to kill the weeds without harming the desirable turf grass.

Weeds are not only ugly; they can (and will) smother the growth of desirable turf grass plants. To prevent this, we want to SELECTIVELY kill the weeds without injury to the desirable grass. The objective is to eliminate the weeds and have them replaced with desirable grass. This immediately improves the appearance of the area, and makes it harder for the weeds to return. Two plants cannot be in the same spot at the same time; you either have healthy weeds or healthy grass! To choose the correct product for this job, we must ask:

QUESTION: **What kinds of weeds do we want to kill?**

POSSIBLE ANSWER: **We want to selectively kill broadleaf weeds like dandelions, thistle, and clover.**

In answering this question, we have established that the target weeds are broadleaf weeds or *DICOTS*, as defined earlier. Let's face it; identifying specific weeds can be very tough. Many common weeds look very much alike. Even when you can recognize the weed, you may not know what it is called. Weeds have different common names in different parts of the country – sometimes the same name you use for a different weed in your area. For help identifying specific types of weeds, call on the expertise of the local Agricultural Extension office in your area. They will be able to give you much information about the weeds that are common to your area. With a little bit of practice, you should be able to identify most of them.

However, even if we don't know the exact name of the weeds, we can easily identify the broadleaf weeds as dicots just by looking at the leaves. We have determined that we need a SELECTIVE herbicide that is designed to work on broadleaf weeds – dicots – without harming the grass plants (monocots). There are several different chemicals that will do the job:

a. **2,4-D: Herbicides containing this chemical are very effective in killing many species of broadleaf weeds. However, you will need a strong solution to control some of the tough weeds like chickweed, knotweed, clover, ground ivy, and woody plants like sumac.**
b. **MCPP: A mild but very effective product. More effective than 2,4-D on the tough clovers, plantains, and ivy. It will generally control about 23 species of weeds.**
c. **2,4-DP: Closely related to 2,4-D, but more effective on tough perennial weeds and woody brush.**

These chemicals are *DICOT* killers; they selectively kill only those plants that meet the definition of dicots. They will not kill monocots. Also, all of the above chemicals are systemic herbicides. They are absorbed into the plants and kill them by disrupting important chemical processes within the plant to grow much faster than it normally should, and strains the life support system so much that death results.

#363 Triple Selective Herbicide *(Total Solutions Triple Threat)* and #8363 *Total Solutions Triple Threat Foaming Selective Herbicide* are products that combine 2,4-D, 2,4-DP, and MCPP. This mixture provides the best control of the widest variety of broadleaf weeds, and is highly recommended for most turf areas. #8363 Triple Threat Foaming Selective Herbicide is an aerosol that can be used to spray the weeds from a standing position, and the foam marks the plants that have already been sprayed.

While not really an herbicide, adding a surfactant to your herbicides help them penetrate the foliage and increase the efficacy of any water-based herbicide. #395 Surfactant can be mixed with any of these herbicides speeding their penetration into the soil and to the root systems of the plants.

B. NON-SELECTIVE WEED CONTROL WITH CONTACT HERBICIDES

Let us go back and ask the very first question again:

***QUESTION:* What plants do we want to kill?**

***POSSIBLE ANSWER:* We want to kill ALL of the plants.**

If we decide that we want to kill ALL of the plants, down to bare ground, we will want to use a NON-SELECTIVE herbicide that kills everything. We do not need to determine what kinds of plants we want to kill – because we want to kill everything non-selectively. Now we need to determine whether we want any residual action:

***QUESTION:* Do we want to grow other plants in this soil?**

***POSSIBLE ANSWER:* We DO want to grow other plants in this soil, like flowers or ground cover, after the weeds are killed.**

For instance, we may want to kill all vegetation in an overgrown flowerbed, and then plant or seed new flowers the next week. Otherwise, we may want to kill weeds underneath a canopy of decorative shrubs.

In these areas, we do not want to harm the soil or do damage to future plantings or to existing plants immediately next to the area being treated. We must use an herbicide that kills the weeds and then disappears without affecting the soil. By choosing the right product, we can kill off weeds without any harmful effects on existing or future desirable plants. We want a CONTACT herbicide to do this job.

#145 Contact Herbicide #1 *(Total Solutions Eliminator)* and #134 Diquat 4.35% are concentrates that contains Diquat as the active ingredient. When it is absorbed into the plant, it disrupts the photosynthesis process to kill the plant.

#145 Contact Herbicide #1 *(Total Solutions Eliminator)* contains 1.85% active ingredient, Diquat, while #134 Diquat 4.35% is a super concentrate containing 4.35% Diquat. They both behave similarly when used as directed.

If they are sprayed onto the ground, they are absorbed by the soil and DE-ACTIVATED. It has no RESIDUAL ACTIVITY, and does not affect the soil in any way. New planting or seeding can be made in the treated areas within days after application of CONTACT herbicide. It can also be carefully sprayed or brushed on to kill weeds underneath shrubs or trees, as long as the herbicide is not sprayed onto the shrubs themselves.

These CONTACT herbicides are the answer to many gardeners' prayers: they can eliminate the time consuming, backbreaking task of weeding ornamental beds. They do not kill the roots of the plant, and kill only what they are sprayed on. Even if some is accidentally sprayed on a shrub, this herbicide only kills the leaves, not the roots. Most woody plants can recover from some damage due to contact herbicides.

C. NON-SELECTIVE WEED CONTROL WITH RESIDUAL HERBICIDES

There is another possible answer to this question:

***QUESTION:* Do we want to grow other plants in this soil?**

***POSSIBLE ANSWER:* NO – we want to kill ALL the vegetation and leave bare ground for an extended period of time, with no re-growth of any vegetation for a long time.**

For example, a parking lot area should remain free of all plant growth for as long as possible. Here we want a RESIDUAL herbicide that provides long lasting action to prevent the re-growth of any plants. We want to kill everything and *sterilize* the soil, so that nothing else will grow for a long time.

Various chemicals have been used over the years to do this job. Salt was probably the first chemical used as a residual herbicide, but the amount of salt required to do the job was prohibitive. Later, arsenic compounds were introduced, but they had disastrous effect on man, wildlife, and the environment. Thank goodness, the use of highly toxic products like arsenic has been outlawed.

Today, there are many safe and effective products that will give long lasting residual control of all vegetation. Products that contain the active ingredient Bromacil are widely used, because they provide excellent control and resist movement through the soil (leaching).

The products #314 VOC-Non-Selective Herbicide #1 (Total Solutions Vacate), -#315 Non-Selective Herbicide #1,), #320 Non-Selective Herbicide #2 (Total Solutions Barren) and #8320 Non-Selective Herbicide Aerosol (Total Solutions Barren Aerosol) are ready-to-use herbicides that contain Bromacil. These products also contain 2,4-D for rapid knockdown of weeds, and are mixed in low-volatile oil base carriers for the maximum residual activity and resistance to leaching.

Injury to Citrus caused by Bromacil

Bromacil is also the active ingredient in #317 Brom 7.5 Herbicide Concentrate and #318 Non-Selective Weed Killer Concentrate, (*Total Solutions Banish).* These are water-dilutable, very economical concentrate for killing ALL vegetation. Finally, #316 Granular Weed Control *(Total Solutions Weed Easy)* contains 4.0% Bromacil for long lasting vegetation control in convenient granules.

Prometon is another popular and respected residual ingredient. #322 Non-Selective Herbicide #3 *(Total Solutions Turf King)* is an emulsified concentrate

Injury to foliage caused by Prometon

(designed to be diluted with water) that contains 3.73% of this active ingredient. Adding #395 Surfactant increases the effectiveness of both of these products. Dilutable concentrates such as these provide the user with options and alternatives to the ready-to-use products.

D. AQUATIC HERBICIDES

Many turf managers must keep ponds or small lakes looking good as well. This may require that steps be taken to control growth of algae or waterweeds. Of course, we want to eradicate these pests without harming people, fish, or other wildlife.

#134 Diquat 4.35% and #145 Conkill *(Total Solutions Eliminator)* will kill almost all aquatic weeds and algae without any harmful side effects. Like the contact herbicides, it becomes DE-ACTIVATED upon contact with the soil on the bottom. Results will be visible within a few days after application.**

There are certain precautions that should be taken when using this aquatic herbicide. Although this product is non-toxic to fish, certain steps should be taken to ensure that the fish population is not harmed by the treatment. While the chemical itself is not harmful to the fish, the decomposing dead vegetation can use up all the dissolved oxygen in the water. This lack of dissolved oxygen may cause the fish to suffocate. To prevent any possibility of fish kill, treat no more than 1/3 of the pond at a time.

When using any grounds maintenance product, always read and follow the label instructions and safety precautions. The wise turf manager knows that he will get the BEST RESULTS by using these and all chemicals in a SAFE MANNER.

****Aquatic use directions are not allowed in the states of Michigan, New Hampshire and New York. For these states please order product #146 Contact Herbicide #1 (Total Solutions Eliminator NW), which has terrestrial uses only (this is the same formula as the #145).**

GROUNDS MAINTENANCE SURVEY

Customer: _____ Date: _____

Address: _____

Supervisor: _____ Phone: _____

EQUIPMENT

Large capacity sprayer on trailer or turf scooter?	Yes_____	No_____
Calibrated to deliver:	_____ gallons per acre	
Small backpack or hand held sprayer?	Yes_____	No_____
Large capacity spreader for dry materials?	Yes_____	No_____
Small push-type dry spreader?	Yes_____	No_____
Water for mixing solutions?	Hard (1)_____	Soft_____

MANICURED TURF AREAS

Area that is maintained: _____ sq. ft. or acres (43,500 sq. ft. per acre)

Frequency of mowing: _____ Mowing height_____ inches

Irrigation: Automatic_____ Manual_____

Soil type: SAND CLAY ORGANIC LOAM LIGHT MINERAL HEAVY MINERAL

Compaction?	Yes (2)_____	No_____
Signs of iron chlorosis?	Yes (3)_____	No_____
Type and amount of fertilizer used	Spring (4)_____	
over the last growing season:	Fall (5)_____	
% shaded at noon, in midsummer:	_____ percent	
Areas requiring reseeding or over seeding:	Yes (6)_____	No_____
Average number of broadleaf weeds per square yard:	(7)_____average	

(Count 3 patches of 3 ft. on opposite edges and center)

Heavy infestation of clover or plantain:	Yes (8)_____	No_____
Heavy Infestation of crabgrass, chickweed, nutsedge:	Yes (9)_____	No_____
Signs of fungal disease (snow mold, copper, spot, etc.):	Yes (10)_____	No_____

ORNAMENTAL PLANTINGS

Flowers / Shrubbery area: _____ Weeds?	Yes (11)_____	No_____
Number of trees: _____ Weeds?	Yes (11)_____	No_____
Timbers, plastic, stone or metal edging around beds?	Yes (11)_____	No_____