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TABLE OF CONTENTS

		Page
CHEMICALS IN A COORDINATED MANAGEMENT PROGRAM	C. G. Wilson	1
APPLICATION PRACTICES AS A KEY TO SUCCESSFUL USE OF CHEMICALS.	Howard L. Morton	7
AQUATIC WEED CONTROL	John E. Gallagher	13
MECHANICAL WEED CONTROL	Tom Mascaro	16
CHINCH BUG	C. O. Hanson	18
RECORD KEEPING AND COST OF GOLF COURSE OPERATIONS. . . .	Grover C. Keeton	21
MANAGEMENT SKILLS AND RECORDS FOR PROGRESS IN TURF. . . .	W. G. Scheibe	24
THE ROLE OF LIME IN TURFGRASS MANAGEMENT.	W. O. Trogdon	28
HERBICIDES IN TURFGRASS MANAGEMENT.	Wayne G. McCully	30

CHEMICALS IN A COORDINATED MANAGEMENT PROGRAM

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The title might better have been "How Not to Apply Chemicals". The answer - Improperly! - is also quite obvious. Yet it needs to be repeated constantly, because you who are supervisors tend to assume your help knows more than it actually does. Frankly, I would hate to be in your shoes. You are faced with a constant turnover in help. You pay low labor wages so often you are faced with low mentality workers.

We have long since passed the point where an adequate arithmetic or accounting system consisted of "One, Two - Plenty". Today, you must be familiar with both liquid and dry weights, parts per million, meters as well as feet and inches, and grams as well as pounds. This is the strongest reason of all why superintendents should supervise rather than mow.

Chemicals are becoming ever higher analysis, thus ever higher in power to do damage. Thus, what once would have been a small mistake can now be a chemical disaster.

<u>How Not To Apply Chemicals</u>?

Well, a good place to start would be by applying the wrong material. Entirely different chemicals packaged by the same manufacturer can at a fast glance appear to be the same. This is caused by the manufacturer's desire to maintain a brand image. We can't blame them for this because it costs manufacturers thousands of dollars to keep their names before the public.

We could use hundreds of examples. One well-known manufacturer, who incidentally makes excellent herbicides, packages many different forms of 2,4-D. Although each is different all come in a familiar red can and the first work of the trade name is always the same whether it is a potent brush killer or a mild amine to kill dandelions.

We are great believers in the efficacy of sodium arsenite to use as an all purpose herbicide. Yet it wasn't until last year that we realized one company manufactures both a four and six pound material and package both in similar containers. The standard rate to apply sodium arsenite is 1 pound per acre. I think you can see what might happen if your help picked up the six pound material when you were set to apply the four pound solution.

We know of one instance where a superintendent ordered chlordane as a 50% wettable powder. The distributors warehouse man filled the order with a 5% powder instead. The mistake caused considerable loss of turf from grubs as you might well expect.

<u>How Not To Apply Chemicals</u>?

An excellent way is to apply the wrong amount. Spreaders are extremely useful tools. However, the setting suggested by the manufacturer or the calibration made by you is merely a guide as to the approximate amount the spreader will apply. It is not exact, yet recently we visited an experiment station where a spreader was relied on to compare tow fertilizer materials. These were supposedly applied at the same time and same frequency to furnish the same amount of actual nitrogen. Actually one plot got 22 1/2 pounds and the other only 8 pounds of nitrogen. This could and did make a big difference is turf response.

Spot check your spreaders periodically. Know the exact size of each turf area. Compare the square footage with the number of empty sacks to see if your spreader and your help are performing the way they should.

How Not To Apply Chemicals?

Let's use the wrong concentration for the job! A few years ago I visited a course in central Illinois that was applying Aldrin in the form of 25% granules at 12 pounds per acre. The rate was right, and as a spray I feel sure it would have given excellent grub control. As a granular application it was doomed to failure because coverage had to be poor. There was insufficient bulk to contact all grub infested areas.

There are many occasions when a low analysis bulky material is the best buy even though it costs more per unit of chemical desired. The companies who manufacture high analysis fertilizer are faced with increasing complaints from those who "run out" before they finish the job. In figuring costs one should also remember that low analysis materials like fertilizers often have important minor or trace elements found lacking their highly purified cousins. Milk, as many of you know, is only a 3% product, yet rather than concentrate to make it more potent doctors often advise to dilute it even further.

How Not To Apply Chemicals?

I like to use the right material but apply it on the wrong pest! In the early days bichloride of mercury not only did a fine job on diseases, it helped to control earthworms as well. Morrah meal applied to control insects left a beautiful fringe benefit in the form of natural organic nitrogen which of course stimulated the grass. We also know that high nitrogen levels help in solving most weed problems. This is especially true of clover.

I suppose it is because of these general associations that some are prone to think one chemical will do everything. Unfortunately, this isn't the case and you must identify the problem before selecting the cure. Sod webworm injury looks much like dollarspot disease at one stage of development, and we know a lot of fungicide was sold in St. Louis and Indianapolis this year to control webworm, and of course it failed. One should remember that for the most part insecticides do not have fungicidal properties, and herbicides would be a poor choice to stop an attack of disease.

How Not To Apply Chemicals?

A real good way to end up hunting another job is to think that fungicide, as an example, will be a panacea for all turf ills. We hate to see disease blamed for every grass malfunction that comes down the pike. Many physiological or nutrient imbalances are treated with fungicides when actually the disease is a secondary symptom and not the primary cause of poor turf. A good example of this is Curvularia. Couch at Penn State has tried repeatedly to infect healthy turf with this disease and has always failed. This disease is at best a very weak parasite. In nature it is one of your best friends because as a saprophyte it breaks down thatch. Note also that the fungicides which are sold to specifically control Curvularia invariably contain iron. This makes one wonder if iron isn't often the real need, and since a penny's worth of iron will treat 1,000 square feet it is worthy of trial.

We are also certain that your choice, the total amount, and the timing of fertilizer applications can have a great deal of bearing on success or failure of chemicals to do the job they were intended to do. We have known for years that high nitrogen tends to discourage dollarspot. Recently, Rutgers University has shown that the source of nitrogen is just as important in this regard.

Obviously, fertilizer is no more a substitue for fungicide than the other way around. But, to get the utmost mileage out of any chemical you must have good drainage, careful watering practices, sharp mowers, proper soil reaction, and protection from other pests as well as the correct plant food applied at the proper time. Then and only then can you expect chemicals to do their job.

How Not To Apply Chemicals?

As for me, I like to dump everything in the tank at the same time in order to get the job done. This gives me plenty of free time to worry about why my turf looks so lousey! Please, please, please don't apply fungicides mixed up with a lot of other gook just to save on labor and money. If you want to save money forget about being a superintendent and become a banker. Mixing everything in one pot has more sex appeal to some superintendents than a roomful of naked girls. One course this summer put a little spreader sticker in with some PMA and insecticide to hold the mixture on the leaves. We never could tell whether or not this worked because something in the combination killed the grass. O. J. Noer makes the statement that you mix ammonium sulphate and hydrated lime together only once in a lifetime for the same reason - the ammonia fumes kill the grass.

On the other hand, we know that mixing two materials together may enhance the value of both. Like ham and eggs, a mixture of thiram with calomel-corrosive has done a better job than either material by itself. Thurston at Penn State found this out and attributed the fact to the tendency of disease outbreaks to overlap. Thiram worked okay on brownpatch but wasn't much good on dollarspot. Conversely, the mercury worked will on both diseases but discolored and retarded growth of the grass in hot weather when used by itself. Incidentally, Mid-Atlantic superintendents started the practice of using the mixture before Thurston started his investigations.

Before you get carried away with a potential of mixtures, keep in mind the wide range of things that might happen between this bad and good extreme. One chemical could directly knock out the effectiveness of another, yet you would be none the wiser because the kayoed chemical wasn't needed the day you treated. Further, you were lucky enough to put a few things together that didn't burn, and since it didn't harm anything you mark it down as being good.

Mixing insecticides and fungicides together doesn't make much sense to me. If you don't water the mixture in after application, the insecticide volitalizes and goes off into the wild blue yonder, where it can't possibly hurt your bugs. If you do water the mixture in, the fungicides lose their effectiveness.

Some say: "Well, it may be wasteful, but my turf looks okay and you can't argue with success." This is indeed true, and I must admit the carrier I have on one insurance policy protecting the entire family from beri beri has been most successful. We haven't caught it yet, but come to think of it, neither has anyone alse in this country since the eighteenth century.

Others ask: "Why don't the fungicide manufacturers make up compatability charts to guide us on what might and what can't be mixed together." Obviously, I can't answer for them, but would point out a few factors that could deter such a move. In formulating one mixture, years of detailed work are involved. One major supplier recently held back offering you a chemical that should control spring dead spot in Bermuda. They withdrew from the market at the last minute, not because the material wouldn't work, but because it was unstable in the package. Storing can be quite important. It seems PMA cannot be used if it has undergone freezing and thawing. In most sections of the country it can be mixed with iron sulphate with impunity. In one isolated instance where this was tried, the entire mix settled to the bottom of the tank like so much glue.

I use these examples to show there would be no starting or stopping point to such a chart. Even so, some manufacturers (I call them fly-by-night) will put anything in a bottle including several different fungicides, many insecticides, chlorophyl, stickers, spreaders, wetter water and fertilizer too. You, of course, are the guinea pig.

In mixtures such as these important questions are left unanswered. Is the urea a bargain import so loaded with biuret that of its own accord it can injure tender grass? How about the insecticides? Are they wettable powders or emulsions wherein the oil used to keep the insecticide in solution can directly injure sensitive turf.

Mr. Halacy in the new Harper & Row book, "Computers - The Machines We Think With" mentions that in the time it takes to read one sentence an electronic computer is performing 3 million mathematical computations, and that before you can read a page of print the same machine will translate several pages into a foreign language. He also goes on to state that even this remarkable speed is nothing to the game of chess where today's fastest computer could not possibly work out all the moves in a human lifetime.

I would liken compatability to chess, and if true, even the computer would fail to devise a chart. By the time it did, we would have changed the chemicals to make the chart worthless.

How Not To Apply Chemicals?

Buy the cheapest product becuase all are exactly the same! Beware of bargain chemicals. Ruskin said many years ago: "There is always someone who will build something more poorly and sell it cheaper and the person who buys on price alone is that man's lawful prey." Nothing, believe me, nothing is the same as only cheaper, unless it is the very same product marked down to bargain prices. It could be a better or it could be a worse product, but it can't be the same product. Milk from cows in the same herd fed the same food will differ, and of course, anyone who has ever had a drink of Wisconsin milk will think he is drinking skim milk in any other state in the union. In our economy you just don't buy Cadillacs at Chevrolet prices, or hire a $20,000 a year superintendent for $2,000. If everything was exactly the same only cheaper, all superintendents would be making $2,000 per year.

How Not To Apply Chemicals?

Forget the manufacturer's instructions on the label. Use it at a lower rate and less frequently than he says! Many superintendents fail their clubs and some even lose their jobs on this ploy. In an effort to save money they reduce the rate. Remember if the club's reason for existence was to save money, it would close down and invest its money in stocks and bonds. This is a trite statement, yet all of us know about good old John who cuts his budget to help pay for the new grill room. The course then suffers, so play falls off. The minute play slacks so does the grill room income, necessitating another budget cut. This means the new fairway mowers can't be purchased so the grass gets too tall. Then John is fired for doing such a lousy job. A new man is hired and the club goes through a costly renovation job.

Obviously, a golf course, park, school, etc, is no place to waste money. Protecting the turf is not wasteful. It is what you are paid for, and we are bound to see more protection in the years ahead. Fairway spraying with fungicides, as well as insecticides and herbicides will become more commonplace, and it makes sense. Happy golfers mean full membership and good income in all phases of the club operation. I believe the clubs who fail to budget necessary monies will fall by the wayside much the way marginal motels are collapsing today in favor of the posh newcomers with a million dollar investment. Obviously, you pay more for a room in this new type of hostelry, but just as obviously you get more for your money.

The analogy turfwise relates to a high budget course in Chicago. This club quite possibly has the highest salaried superintendent in the business. His club also took in $44,000 over previous years in guest fees this year because they had such excellent turf. So spend what is needed to take care of the grass. Anything else is false economy.

We have attempted to review some of the pitfalls involved in applying chemicals, and have used reverse psychology for effect. In summation, we will repeat the pitfalls in the right context.

1. Apply the right chemical for the job. Few materials are all-purpose.

2. Apply the right amount making certain your equipment is properly adjusted to do this.

3. Use the proper concentration. Remember that coverage is all important.

4. Make sure you have properly diagnosed the problem before selecting the chemical.

5. Remember that chemicals won't solve all turf problems. They should only be thought of as tools.

6. Don't apply every chemical at one time. In the long run this will cost more money, will be less effective and may even kill the grass.

7. The cheapest chemical is seldom the best. A Chevy is not a bargain Cadillac - only a cheaper and more poorly built car.

8. Follow the manufacturer's recommendations in applying chemicals. The directions on each container are there for a purpose.

APPLICATION PRACTICES AS A KEY TO SUCCESSFUL USE OF CHEMICALS

Howard L. Morton[1/]

The successful use of herbicidal chemicals is dependent upon four major factors. These factors are: proper chemical, proper distribution of the chemical, proper condition of the plant at the time of application, and proper environment at the time of application. When all of these factors are properly fitted together the chemical application will give the desired result. I would like to outline a model which best describes optimum conditions for the use of chemical herbicides. Such a model can be likened to a football play. Theoretically each football play should result in a touchdown if each man carries out his assignment. In practice this is seldom the case. Likewise, in the use of chemical herbicides, each application does not result in complete success. However, there are enough instances when complete success is obtained to make us realize that perfect conditions sometimes do exist and in time we will be able to perfect our description of the perfect model. In the mean time we will have to be content with partial successes, which often are sufficient to meet the needs of the situation.

PROPER CHEMICAL

Dr. McCully has discussed various chemicals used in turfgrass management and you will hear more about specific chemicals to be applied for specific problems tomorrow. I would like to discuss some of the physical and chemical properties of pesticide chemicals which are important to their successful application.

Many of the chemical pesticides are insoluble in the common carriers used in spraying operations. To make them soluble or at least compatible with water or oil carriers, the formulator changes the structure of the compound. The most common method used is the formation of a salt to make it water-soluble. Examples of this are the amine salts of 2,4-D and 2,4,5-T and the sodium salts of dalapon and pentachlorophenol. These compounds form true solutions with water and will not separate from the carrier, thus, agitation is not necessary once the chemical and the carrier are mixed. Salts will not form true solutions with oil. The label on the container of a chemical will indicate the type of carrier to be used, and the directions on the label should be followed when mixing these compounds.

Many of the chemical pesticides are soluble in fuel oils or kerosene. Others have been formulated to make them readily soluble in oils. DNPB and pentacholorphenol are examples of pesticides which are soluble in oil, and the esters of 2,4-D and 2,4,5-T are examples of compounds which are formulated to make them readily soluble in oil. These compounds will form true solutions with oil but not with water. Frequently oil-soluble chemicals are formulated in such a way that they can be applied as oil-in-water emulsions.

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An emulsion is formed when one liquid is dispersed in another and each liquid retains its own identity. The oil-in-water emulsion is the most common type encountered in pesticide applications; however, water-in-oil emulsions are also used. They are generally viscous mixtures which are difficult to apply, and they have been used primarily in brush control.

Emulsions vary in their stability. Most commercial pesticides which are designed for application as emulsions have emulsifying agents added which increase the stability of the emulsion. Emulsions will separate into the two liquids with time, and for this reason agitation is necessary for the successful application of an emulsion. The ability of a chemical to form an emulsion with water will be specified on the label of the container, and directions concerning the mixing of oil-soluble chemicals, whether as solutions in oil or as emulsions in water, should be stringently followed.

Another form in which chemicals are commonly marketed is as very fine particles which can be suspended in the carrier. These are marketed as wettable powder. Commercial formulations of wettable powders also contain dispersing agents and other surfactants which aid in the stability of the suspension. Most suspensions of wettable powders require agitation to prevent the solid particles from settling to the bottom of the container. Diuron, monuron, atrazine and simazine are examples of herbicides which are sold as wettable powders. It is important that instructions on the label be followed when mixing wettable powders.

Some chemicals are applied as solids rather than as solutions, emulsions or suspensions. A few can be applied without a diluent but most require a carrier. Sand, sawdust, clay, vermiculite, activated charcoal and other inert materials are used. The chemical is mixed with or adsorbed on the solid material for dispersal. Granules can be made of these mixtures in a variety of sizes and with a variety of physical properties. Granules can be made from clays so that they disintegrate on contact with water; however, other granules are made from materials such as perlite and charcoal which do not change their physical structure upon contact with water. In work with CIPC and various granular materials, Danielson (3) found that carriers which disintegrated upon contact with water had greater vapor- and contact-activities than did carriers which did not change their physical structure upon contact with water. He further found that granules with low adsorptive capacity had high contact- and vapor-activities, but as the adsorptive capacity of the carrier increased the vapor- contact-activities decreased. From this information it is evident that granules can be used to alter the phytotoxicity of volatile herbicides and in certain instances increase their selectivity. Granules have several distinct advantages.

1. They do not require costly distribution equipment.
2. The larger granules are not deposited on leaves and shoots of plants, thus, contact injury to susceptible plants can be prevented.
3. Granules decrease the hazard due to herbicidal drift.

Granules also have several disadvantages.

1. They are not easily transported due to their bulkiness.
2. They are often moved by wind after desposition on the ground.
3. Their uniform application is difficult.

Today we frequently have a choice as to how we are to apply our chemical, thanks to the ingenuity of our formulators. The method we adopt will ultimately depend upon the type of problem to be solved, the relative costs of the methods and the equipment available.

PROPER DISTRIBUTION OF THE CHEMICAL

The chemical must be applied in the right place and in the right quantity to be effective. For foliar applications the directions usually given indicate that the spray should "wet all weed growth thoroughly" or the chemical should be "sprayed to runoff" or "spray-to-wet". Uniform application and complete coverage of the plant parts are important in spray applications. Behran's (2) found that as long as there were at least 72 droplets applied per square inch to mesquite leaves an optimum response would be obtained. Most spray nozzles will meet this requirement, for spray equipment available today produces a wide spectrum of droplet sizes and gives a fairly uniform spacing of these droplets. Ennis and Dorschner (5) have shown that pubescence (or hairiness) of leaves is important in the retention of spray droplets. Pubescent leaves retained more spray than did glabrous leaves and both pubescent and glabrous leaves retained more of a 0.5% Carbowax spray than they did of a water spray. At the same time, the coverage of the leaves was better when a surfactant was added to the spray than when a water spray was used. Jansen (6) has concluded that in addition to reducing surface tension and increasing the spreading of sprays, surfactants also enhance biological activity of herbicides in as yet unexplained ways.

However, before we conclude that surfactants are a way of solving all our spray application problems, let us look at some other effects they may have upon the spray application. Although maximum spray retention has been shown to occur at low surfactant concentrations, Day and Jordan (4) have shown that retention of spray decreased by about 1/4 as the concentration was raised from 0.01 to 0.16%. Thus the spray-to-wet basis for application of chemicals is not always an efficient method of getting the chemical on the plant. In fact it appears that as much as 95% of the chemical is actually deposited on the ground. In some instances this may not be undesirable. Our own recent experience with woody plants has shown that spray-to-wet was giving effective kills; however, when the chemical was applied to the soil without touching the shoots an equally effective kill was obtained with less chemical. The chemical ran off the leaves treating the soil and was absorbed by the roots.

The proper placement of chemicals in the soils needs further investigation. For pre-emergence weed control most of the chemical is deposited on or near the surface of the soil, where it is most effective in killing germinating seeds and young seedlings. For perennial plants proper placement is not so easily described. Certain herbicidal chemicals, such as the phenoxy acids, show a marked toxicity to young roots and absorption of these compounds is almost entirely by older portions of the root system, if absorption takes place at all. On the other hand, the substituted ureas and triazine compounds apparently have a very low toxicity to roots and are readily absorbed by young roots. This explains in part why certain of the deep rooted perennial species are unaffected by these compounds when applied to heavy soils. The chemical is not applied at the point at which it will be absorbed by the young, growing roots.

PROPER CONDITION OF THE PLANT

In describing the most favorable time to apply an herbicide to a plant, we use a description of the morphology of the plant. We resort to such expressions as "appearance of first leaf", "fully expanded leaves", "early flowering", etc. What we are trying to do is define the physiological condition of the plant when it will be most susceptible to our herbicide by using morphological terms rather than physiological ones. We still do not know enough about the development of most plants to be able to do this with complete accuracy. However, we do know that under most conditions rapidly growing plants are more susceptible to herbicides than are slow growing plants. This is especially true of annual plants. In young annual plants absorption is usually more rapid than in older plants due to the absence of thick wax deposits and cuticular barriers on the leaves. Likewise, slower growing leaves are generally covered with a thicker layer of surface wax projections than are rapidly growing leaves.

With perennial plants the ideal conditions for optimum response to an herbicide are not as easily defined as for annual plants. Individual perennial plants do not always develop at the same rate and at the same time. Certain branches of the same plant may be more rapidly developing than other branches. This is especially true of evergreen species. The effect of plant maturity upon direction of translocation is still unresolved. McIntyre (8) found that applications of 2,4-D to bracken, Pteridum aquilinum, moved more readily into the rhizomes when applied to relatively immature fronds than from older ones. However, Linscott and McCarty (7) have found that 2,4-D applied to young ironweed, Vernonia bladwini, tended to concentrate in young leaves, axillary buds, petioles and stems, but mature plants concentrated it in rhizomes and roots. There are obvious differences between bracken and ironweed, so much of the controversy about translocation stems from differences in plants. Further work is needed to fully understand why translocation of herbicides in certain plant species differs with the degree of their maturity.

To overcome deficiencies in our knowledge of plant responses to herbicides, we must have a fairly wide margin of safety in our recommended application rates. Sometimes this is costly and wasteful, but the recommendations are the best available. If you attempt to modify an application rate to meet your specific situation, do so only within the range of rates given in the recommendations.

PROPER ENVIRONMENTAL CONDITIONS

The proper environmental conditions necessary for optimum response from herbicidal applications are frequently essential for success. The four environmental factors I would like to discuss very briefly are intimately associated with the condition of the plant. Soil moisture influences susceptibility of plants to herbicides for adequate soil moisture is necessary for rapid growth of plants. Soil moisture stress has been shown by Basler et al. (1) and Pallas and Williams (10) to have little or no effect on foliar absorption but to definitely inhibit translocation. Thus soil moisture may be much more important on perennial species than on some of the young annual species. Soil moisture is also necessary for the activation of certain chemicals.

The temperature range for action of herbicides is generally within the range from 55 to 90 degrees F., with optimum temperature range between 70 and 85 degrees. The activity of certain contact herbicides and oils increases with increasing temperature. Work with controlled environments indicates that with increasing temperature between the range of 70 to 100 degrees F., the phytotoxicity of 2,4,5-T to mesquite increases(9). However, optimum translocation of 2,4,5-T was obtained at 85 degrees, for at 70 degrees translocation was primarily to the roots and at 100 degrees there was translocation for only a short distance upward.

Moisture is essential for the absorption of certain of the metallic salts used as herbicides. At low relative humidity levels the salts form crystals upon the surface of the plants and are unavailable for absorption. In general higher humidity levels favor an increase in the response to herbicidal applications.

Air movement is an important factor in application for very obvious reasons. First, excessive winds will cause improper placement of the chemicals during application and even displacement of the chemical after application. Second, winds cause drift of the spray material onto susceptible crops. If you conduct spraying operations in one of the 130 counties in Texas which are covered by the herbicide law, you should be familiar with Herbicide Regulation No. 1-A. This regulation clearly spells out the distance from the point of application to susceptible crops at various wind velocities. Information on this regulation can be obtained from the Commissioner of Agriculture, Mr. John C. White in Austin, one of his area representatives, or from County Agricultural Agents.

It is sometimes possible to modify the application practice to take advantage of optimum environmental conditions. Adequate soil moisture is one which is frequently overlooked and one which can sometimes be controlled. While no control can as yet be excercised over the weather, it will be helpful to take advantage of optimum terperature and humidity conditions in chemical application practices.

While each of these factors, proper chemical, proper distribution, proper condition of the plant, and the proper environmental conditions have been presented separately they are obviously interrelated. In developing application practices we must be cognizant of the interactions of these factors. When each represents an optimum condition, an optimum response will be obtained from the chemical. When one or more of these factors is unfavorable, a less than optimum response will be obtained and in some cases no response.

The task of defining the optimum conditions for herbicidal applications is not completed. Those of us in research are still trying to define more clearly and concisely the conditions under which chemicals should be applied. What we know and what we find out are being incorporated into application recommendations to assure the applicator of continued success.

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AQUATIC WEED CONTROL

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Recent Advances in Aquatic Weed Control

The increased demand for recreational facilities has stimulated considerable research in the field of aquatic weed control. During the last five years, this public pressure has been responsible for greatly expanded research programs supported by state and federal agencies. As these programs become co-ordinated and begin to function more efficiently, we can expect to find concrete benefits in the way of specific recommendations for controlling weeds in lakes and ponds.

For the purpose of this discussion, it would be well to mention briefly some of the differences between aquatic and terrestrial weed control.

1. We are dealing with water, a different growing media. As a result, the plants differ in structure, having less complex translocation systems. We talk in rates of ppm (parts per million) rather than lb/A (pounds per acre) because many of the herbicides are used as total concentration treatments - the whole body of water must be treated. Granular formulations of some herbicides are available and they are used on the surface area basis where normal pound per acre recommendations apply.

2. We must consider other uses for the particular body of water (unless completely land locked within the confines of your property) what potential dangers a herbicide treatment can cause to your neighbor's cattle, fish or crops downstream.

3. The primary and alternate use for the body of water. Fishing, boating, swimming etc., all are factors to be considered before choosing a herbicide.

4. Check with your State Conservation Department to see if a permit is required.

5. Finally, some new weed control terminology must be learned and some new weed species identified. Just as in terrestrial situations, weeds vary in their response.

Aquatic weeds are classed as submergent, emergent, emergent floating, free floating, or marginal. This is a general classification and some weeds fit several classes. One additional grouping is the algae; one-celled plankton algae, filamentous algae, or the higher plant-like algae such as Chara.

Aquatic weed control has advanced to the stage of having answers to some problems, but there are more limitations than with terrestrial weed problems. We must be more exact in timing of applications and more accurate in rate of application. We must realize that plants growing in a water environment may be more difficult to wet with sprays.

Also, we must be aware of the factor called "contact time". By contact time we mean the period of time required for the chemical to be in contact with the plant. This is very short in moving streams and can be quite long in still ponds. Contact time can be quite critical if fish tolerance is important. For the present, it would be best to call in the state extension specialist and enlist his help in solving your aquatic weed problem.

Weed Control Chemicals

This somewhat abbreviated listing of available aquatic herbicides can be used as a starting point to help solve your particular problem aquatic weeds.

Algae

Plankton and filamentous - (no satisfactory control for higher algae.)

a) Copper sulfate — 1 ppm
   Apply when water temperature is above 60° F
   (2.7 lb. per acre ft. of water = 1 ppm)
b) Endothal (aquathol) — 1-5 ppm

Submergent Plants

There is a wide variety of submergent species and no one chemical will control all. An effective aquatic control program may use two or more chemicals over a period of three years.

a) Silvex (2,4,5-TP)
   Liquid or granular. The most commonly available formulation is Kurosal. This is most effective when applied early in the growing season at rates of 25 pounds granular or one gallon liquid per acre foot.

b) 2,4-D
   This is the least expensive material for the specific weeds it can control. For submerged species such as milfoil (Myriophyllum), coontail (Ceratophyllum), or waterstar grass (Heteranthera sp.) use rates of 20-40 lb. active ingredient as directed.

c) Endothal
   Liquid or granular. This contact acting herbicide is effective on a large range of submerged species and has a high degree of fish tolerance.

Free-Floating Plants

Duckweed

a) Diquat — 0.5 ppm
b) 2,4-D ester — 1/2 lb. in 5 gal. kerosene/A

Emergent Floating

Lillies, water hyacinth, etc.

a) 2,4-D granular — 20-40 lb/A

b) Silvex granular	20-40 lb/A
c) Amitrol-T (for water hyacinth)	1/2 - 1 1/2 lb/A
d) 2,4-D spray	6-8 lb/A

Upright Emergent

Cattails - phragmites - rush

a) Amitrol or Amitrol-T	5-10 lb/A
b) Dalapon	20 lb/A

To Summarize

The field of aquatic weed control is developing rapidly. Until it becomes more familiar to you, check with your college extension weed specialist before undertaking any weed control program.

MECHANICAL WEED CONTROL

Tom Mascaro
West Point Products Corporation
West Point, Pennsylvania

Much has been said and written about weeds in turfgrass areas. Much has been done about it. Still the weeds keep coming. Tremendous strides have been made in the chemical field of weed control. Many of these chemicals do a good job of selectivity for specific weeds. No control has yet been found for many weeds. Unquestionably, in the years to come, Selective Control for many of these weed pests will be developed.

Chemical weed control in many cases produces unsatisfactory results. This is because of the many variables involved in its use. These variables include the purity of the chemical, human error in its mixture with a carrier, human error in its application, season of the year, temperature, weather and soil moisture. Any one or a combination of these variables can cause expensive failure of a weed control program. Therefore, many turf men rely on mechanical weed control with chemical control to supplement the program.

Before we go into a discussion of Mechanical Weed Control, we should review some of the basic principles involving weeds in turfgrass areas.

The term "Weed" really means any plant that is out of place. In other words, a corn plant growing in the middle of a green would be considered a "weed". The farmer in turn would consider any grass growing in his corn field a "weed".

Weeds in turf, or anywhere for that matter, are an indication that something is basically wrong. Certain basic conditions exist that allows the weed to grow. Until these basic conditions are corrected, elimination of the weed is no solution, since the void left by the weed will be filled by another weed. Therefore, we must look for the basic reason as to why the weed is there.

In turfgrass areas, we find that two major basic reasons for weeds are Compaction and Thatch. Other reasons are lack of fertility, imporper pH, too little or too much water, improper height of cut, or the wrong grass for the area use.

Before starting a weed control program, analysis should be made of these basic causes that allow weeds to invade a turfgrass area. When these basic reasons have been brought under control, only then can we be reasonably sure of a successful weed control program.

Now, let's consider how a weed takes over a turfgrass area. It does it by actually killing the grass. This is accomplished by stealing the sunlight. In other words, weeds kill grass by shading. Suppose we were to establish a turfgrass area to a desirable stand of grass, and then turn it over to nature. First, the grass plants would compete with each other for sunlight. The hardier plants would shade out the weaker ones and they would become king. Low growing weeds, such as plantain, dandelion and crabgrass, would gradually invade the turf and by the simple process of shading would eventually kill off the turfgrasses. These low growing weeds would then be invaded by the tall weeds. These, in turn, would kill off the low growing weeds by stealing all the sunlight.

These thoughts are the basis of mechanical weed control. Mechanical Weed control simply means the gradual removal of the shading effects of the weed so that turfgrasses will get their full share of sunlight. This process can be accomplished in a number of ways. Severely raking or dragging followed by mowing will do much to raise the weeds so that the leaves can be cut off. However, this involves a number of operations and many weeds survive because the horizontal reel of conventional mowers cannot cut them off.

The proper and most efficient way of mechanically controlling weeds is with Vertical Mowers. These precision tools, designed to vertically mow, removes the leaves from broad leaf weeds, crabgrass, clover, etc. Although the weed plant is not completely removed, sufficient leaf surfaces are vertically cut off so that the weed plant is weakened and confined to a relatively small area. Well managed turfgrasses can then finish off the weed plant by shading it out.

Control of the weed should be gradual, since our objective is not to disrupt the use, playability or appearance of the turf.

A program of Verti-cutting should be balanced. In other words, weed leaves should be removed only as rapidly as the desirable turfgrasses can grow into the voids. Depending on the weed, spacing of the blades of Vertical Mowing machines is varied to efficiently remove weed leaves without removing the grass blades. This means that the Turfgrass Superintendent can change the blade spacing to suit any condition, whether it be a green, fairway, lawn or athletic field. Generally speaking, only two or three verti-cuttings are needed to control broad leaf weeds and crabgrass. Crabgrass should be verti-cut immediately after it begins to send out its runners on turfgrass areas other than golf greens. This operation should be followed in about two weeks as a general rule, verti-cutting at right angles from the first verti-cutting. According to Superintendents reporting on mechanical weed control these two verticuttings are usually sufficient to keep crabgrass from seeding or spreading.

It has been noted that chemicals when used in conjunction with mechanical weed control are more effective and the overall cost is considerably reduced.

The most significant effect however is from the standpoint of the person who plays on the turf. A sensible mechanical - chemical weed control program insures a gradual transition from weed infestation to good turfgrasses without altering the appearance of the turf.

It is simply a matter of controlling light and shade.

CHINCH BUG

Dr. C. O. Hanson
California Chemical Company
Ortho Division

Instead of rehashing turf insect control in general Dr. Holt and I thought that you would like to learn something about a relatively new pest that caused extensive damage for the first time in Texas last summer, the chinch bug Blissus insularis. What I have to say and the slides that I will show you are based on work that has been done in Florida instead of Texas. You can rest assured however, that most of what has been learned about chinch bugs in Florida will also apply here.

Probably most of you have read your program and expect to hear talks concerning bermudagrass in this section. Mine is an exception. Chinch bugs limit their destructive activities almost exclusively to St. Augustinegrass. There have been reports of chinch bugs feeding on other grasses, but we can safely say that St. Augustinegrass is their most favorite dish.

Chinch bugs have what entomologists call piercing and sucking mouth parts. They insert their mouth parts into the succulent grass tissue at or just below the soil surfaces, sucking out plant juices and injecting toxins into the plant tissue. The injured grass first turns yellow and then brown. If the chinch bugs are not controlled immediately the brown areas enlarge rapidly. As the grass dies a yellowish zone usually remains at the margin of the dead spots. It is in this area and beyond it into the green grass that you can locate large numbers of actively feeding chinch bugs.

In order to distinguish chinch bug damage from a number of other turf disorders it is necessary to locate and positively identify the bugs. This can be done in various ways but there is only one way that is worth mentioning. Take a coffee or similar can and remove both ends. Drive the can into the suspect area and fill it with water. If chinch bugs are present they will float to the surface of the water where they can easily be identified. The best place to insert the can is at the margin of the dying area. Do not expect to find chinch bugs in an area where the grass is completely dead. Keep water in the can for at least 5 minutes. I have here some slides which will illustrate the type of equipment that we use in some of our research work in Florida.

Chinch bugs are not difficult to identify. I know of no other insect found in St. Augustinegrass that is easily confused with chinch bugs once you are familiar with what a chinch bug looks like. Adult chinch bugs are about 1/5 of an inch long and are black with white wings. Notice the small black spot on the outer margin of each wing. You can usually find two types of adults in a lawn, one with short wings which extend to about the middle of the abdomen, the other with long wings which almost reach the tip of the abdomen. The legs are a reddish brown color.

The adults lay their extremely small eggs between the grass sheaths and the runners. A newly hatched almost invisible chinch bug, about 1/20 of an inch in length, is a pale yellow color. As it matures it first turns bright red then brown and finally black. The nymphs are easily identified by the presence of a white stripe across the abdomen. Black nymphs look just like an adult chinch bug without wings.

During hot summer weather it takes a chinch bug about 45 days to complete its life cycle or to go from egg to adult. Each adult is capable of laying 200 or more eggs. Populations can reach astronomical figures almost over night. I have noted many instances where home owners have left what they assume to be a healthy lawn for two weeks vacation during the summer and returned to find most of the lawn destroyed by chinch bugs. Dr. Kerr of the University of Florida has counted as many as 700 chinch bugs per sq. ft. That would mean that an average size lawn would contain between 3 and 4 million chinch bugs. It doesn't take long for a population that big to destroy a lawn.

In Florida severe chinch bug damage is usually associated with prolonged hot dry weather in the spring and fall. We believe that these conditions are ideal for chinch bug breeding and also result in weak lawns that are more easily killed by chinch bugs. I suspect that the severe chinch bug outbreak that you experienced in Texas this summer was triggered by hot dry weather.

Periods of heavy rainfall such as we experience during mid-summer in Florida tend to reduce chinch bug populations. This is probably due to the adverse effect that rainfall has on breeding habits and the masking of lawn damage by rapidly growing grass. Unfortunately watering does not seem to be a substitute for chemical control. During periods of hot dry weather in particular heavy watering will not keep chinch bugs from entering a lawn and eventually killing the grass. There is actually no known substitute for chemical control except to plant a different type of grass.

Now that you know how to locate chinch bugs and can identify one when you see it you probably would like to know what to do to keep them out of a lawn, or control them after they have become established. Before I discuss the chemicals that are recommended for chinch bug control I would like to stress some points that most be adhered to if you expect to control chinch bugs. Keep in mind that the best chemical improperly applied probably will not live up to its reputation. (1) Be sure that an area to be treated has been thoroughly watered (1 1/2 - 2 hours) or that a heavy rain has fallen not more than 24 hours before spraying. The turf must be wet for proper distribution of the chemical. (2) Use at least 20 gallons of water per 1000 sq. ft. if power equipment is being used, and 30 gallons per 1000 sq. ft. if applied with a hose applicator. (3) Direct the spray down into the turf for maximum penetration. The chinch bugs are not at the surface. (4) Cover the area being sprayed in two directions. This reduces the chance of missing part of the lawn. (5) Do not spot spray. Chinch bugs may be present in sections of a lawn that look perfectly healthy. Always spray the entire lawn. (6) If chinch bugs are a problem in your neighborhood and you have not yet been bothered by them consider a preventative spray program. Once part of your lawn has died no matter how small it is, it will never be the same unless you replant it. A preventative spray program will keep your lawn intact.

The following chemical are now recommended for chinch bug control in Florida and in many of the Gulf States:

	Lbs. active per acre
Ethion	7 1/4 - 10
Trithion	7 1/4 - 10
Diazinon	4 - 8
VC 13	17 - 35
ASP 51	7 1/4

All of these chemicals are safe enough for application by homeowners. You probably are wondering why DDT was not included. DDT has been excluded from the list of recommended chemicals because chinch bugs are no longer controlled by DDT in Florida. This of course does not mean that DDT will not do an adequate job on controlling chinch bugs in Texas. Since there has been some indication of resistance outside of Florida however, it would seem wise to limit the materials used for chinch bug control to one of those that I have mentioned. I have not included Parathion in the list of recommended chemicals because of the extreme toxicity of this chemical to humans. Parathion is recommended and is used by commercial applicators in Florida but many of us within the state feel that it should be excluded from the list of recommended chemicals becuase of its danger. One application of all of these chemicals will provide at least 6 - 8 weeks chinch bug control. In Florida excellent seasonal control has been obtained with 2 - 4 applications at 2 - 3 month intervals.

I would like to close by answering questions that always are asked about chinch bug control. "If my neighbor sprays for chinch bugs, will all of the bugs in his lawn run over into my lawn". If your neighbor has had his lawn sprayed properly any of the bugs that are able to stagger over to your lawn after they have left his lawn will probably die before they can damage your lawn. If your lawn has been sprayed and your neighbors lawn has not been sprayed and is running wild with chinch bugs, you will probably have to spray more often to keep your lawn from becoming reinfested but his chinch bugs will not enter your lawn. The dead area shown in this slide was an untreated plot in one of our tests. Notice how the bugs were confined to the untreated area. Six weeks after treatment we were unable to locate chinch bugs in the treated plots and the grass in the untreated area was completely dead.

As I stated earlier in my talk even though the information that I have given you has evolved primarily from test work done in Florida, we feel that it can be used to help you solve your chinch bug problem here in Texas.

RECORD KEEPING AND COST OF GOLF COURSE OPERATIONS

Grover C. Keeton, Superintendent
Special Activities, City of Dallas
Park and Recreation Department, Dallas, Texas

Today, record keeping of golf operations on the course in not only desirable by golf course superintendents but is essential. I believe its importance has reached such magnitude that it is a responsibility that we, as golf course operators, should not stop and do twice a month or even once a week but a task to be done daily. Daily record keeping on proper forms which are adaptable for our own conditions and if necessary can be done in the maintenance shed will be of real value, both dollar-wise to golf operations and to the golf course superintendents as a profession. As we think of the necessity of written records, let's not be overcome by such experssions as "I don't like detail work", "record keeping is for my chairman", "this is something they should do in the office", or "I do not want to become a pencil-pusher". During these days where golf course operations include chemicals, many pieces of equipment designed for special purposes and high cost of labor, we must adapt our attitude to include record keeping as a part of our daily operations.

I always think of costs in record keeping involving three major items. They are as follows:

1) labor
2) material
3) equipment

Emphases being placed on the above three responsibilities should result in the following three advantages:

1) Location of maintenance dollar. This, of course, is a very important item and its future use is very valuable in budget preparation and comparative studies.

2) An effective uniform system will result and the golf course superintendent will be in a position to make a complete presentation to his Chairman or Board.

3) Professional gain will automatically result.

LABOR

You will notice that I have mentioned as the No. 1 item in cost and record keeping involves labor. All records that I have seen indicate that about 70 to 80 percent of total expenditures for an 18-hole golf course is for labor. This means that we cannot give too much attention and time to this costly item. Record keeping will result in the golf superintendent giving special study toward his labor, particularly to such factors as a planned interview prior to employment, attention to job assignments, safety and many other conditions which will improve our productivity over costs of labor. It is conceivable that one labor-man can be costing an 18-hole golf course at least $5,000.00 yearly extra if records are not kept and readily available to the golf course superintendent.

After gaining the experience of participating with the U.S.G.A.

Green Section in a recent pilot study on record keeping for golf course operations, the City of Dallas operations have advanced greatly from the adoption and use of a monthly labor distribution report form. For example, we discovered we were devoting approximately 775 hours each year on an 18-hole course changing cups; 200 hours top dressing greens, and one 18-hole course devoted 1000 hours for brush control and a second 18-hole course devoted 196 hours. Regardless whether records are for comparative purposes of one 18-hole course with another the same year or with a previous year, such information is not only valuable but stimulating to your own personnel as well as your chairman or the committee. Furthermore, it pointed out that we were spending about 35% of total labor on greens alone. This, of course, substantiates the fact that the larger the green, the higher the expenditure on the golf course. Employment training, assignment and movement of labor on an 18-hole course is of vital importance. This is probably the reason today many golf courses are using scooters for movement of labor to various jobs on the 150-acre tract.

EQUIPMENT

There are many ways golf course management can keep cost of records on equipment. For example, gasoline equipment records, mileage, and other equipment may show hours of usage. The important matter, as in labor, is that records should be kept by the golf course superintendent himself or his assistants as he is interested in the use, care and the purchasing of equipment. All of this tends to provide basic information for preparation of budget and expenditures for the coming year and future years.

MATERIALS

The theme for the 1962 Texas Turfgrass Association Conference is centered around record keeping and chemicals. All golf courses today are using chemicals in some form. When properly purchased, stored and applied, chemicals have been a valuable contribution to golf course maintenance. I have not come across many golf course superintendents who are chemical engineers, therefore we must rely on what people tell us or reading the label or from actual experience. The best way to overcome our lack of knowledge in this field are through the guidance of other individuals and posting of records so we might advance by experience. I think we all agree we cannot work with chemicals from memory alone. The point I want to emphasize is that if we have never kept records in golf course operation before, certainly chemicals point out the need and have brought us closer to this important responsibility.

In addition to chemicals, there are many other materials used in daily operations where records would be a source of valuable information. For example, I can think of my own experience where record-keeping showed we were making too many "emergency purchases" whereby some kind of advance planning and research of previous years records would have saved money by making purchases in larger quantities. I think it is well for any golf course superintendent to analyze his own operation and compare emergency purchases with standard purchases. Again, such a study cannot be made from memory.

In conclusion, I want to emphasize if we as golf course superintendents want to advance with the times, we must develop a favorable attitude toward record keeping, you can call it "paper work" if you want to but that is exactly what it is. Furthermore, our responsibility on the golf course and overall operation has reached the relation to where maintenance is from curb to curb or property line to property line and not just the green, tee and the fairway. As we meet here at the Texas Turfgrass Conference each year, our knowledge is expanded to include other fields such as chemicals, tree maintenance, shrubbery, parking lots, public relations, etc. Lets now add record keeping. One final thought and that is - written records, past, present and future will result in golf course operations being based on facts instead of opinions.

MANAGEMENT SKILLS AND RECORDS FOR PROGRESS IN TURF

W. G. Scheibe
Superintendent of Parks, Dallas, Texas

In preparation for this subject "Management Skills and Record Keeping" the speaker suddenly realizes several things. First of all, he is talking to a group who for the most part are in the same vocation he is. Our problems are identical. Our skills are equal. Our ability to manage is not much different than that of others. We all keep records of a sort - some on paper, some in our minds. However, we are constantly on the alert for new ideas, methods and approaches to doing our jobs.

How many of you have had the following happen at one time or another? Realize you need a new piece of equipment, study the brochures and observe demonstrations, but when discussing with management the equipment is turned down. How many have seen the need for additional employees due to the work load, but refused this additional manpower? Have any of you lost good conscientious employees because you couldn't pay their true worth? Since all of us are equipment minded, are we still having frequent breakdowns? Do you ever have the feeling you are not accomplishing as much as you should? Are you and your employees receiving fewer compliments from both management and the public?

If you will take just a moment to re-read the preceding paragraph, you will note that many other items could be added to this list. Regardless of how many we add, our management is slipping if we continue to have any one of these happen. Adequate records is the answer. We can't be skilled managers without some form of record keeping.

In approaching this subject, then, I will review our record keeping in the Dallas Park Department, why we keep these records and what their actual worth is to us.

Charts and graphs are good visual ways of reviewing and analyzing records. Here is a graph and chart on labor distribution in "building maintenance". The reason we keep these records are many; for example, it is very difficult to know how many employees we should ask for when a new facility is constructed. How frequent is the building to be painted? Are the lighting facilities so arranged whereby they are easily maintained? Will the electrician, carpenter, and plumber be spending on this building 500 or 1,000 hours per year? Are 1,000 hours adequate? Are 500 hours adequate? Regardless, will the employees be able to handle the job, or will it be necessary to hire more? Charts and graphs assembled from records will point this out.

It so happened this chart enabled us to find the following: (1) that maintenance (tradesmen) of a recreation building in Dallas is an approximate percentage of its total value per year. Another interesting facet discovered was that when a maintenance call to a building was received, 25% of the cost of doing the work was preparing to do the job. Now record keeping and training employees can greatly reduce this 25%. If this is not done it is out of proportion with maintenance techniques. This chart also points out that as a rule 10% of labor for the year is usually not available. This is due to sickness, injury, vacation, holidays, etc. These are hidden hours of charges each of us are never fully aware of.

Although we are all here today to discuss turf maintenance rather than building maintenance, this preceding discussion has pointed out the reason we keep records on buildings, and to point out records are excellent guides for budget purposes.

How can records be kept in turf maintenance? Here is a chart and graph showing a year's study of mowing operations. You will note there are three (3) applications to this study - (1) hours spent on rotary mowing, (2) hours spent on reel mowing, and (3) hours spent on hand work. To obtain this information the methods are simple but practical and places most of the bookkeeping on the employee. First of all, this time card is used. Each employee notes on the time card what he did each day, when he did it, how many hours, and notes by code number what equipment was involved. The information, then, is assembled daily by the clerk or supervisor. At the year's end the total hours on rotary, reel mowers and hand work are compiled.

Now let us briefly observe the graph on rotary mowing. First of all rotary mowing hours are 50% of total turf maintenance hours. Is this economical? Rotary mowing is dangerous to the operator. Our analysis of accidents points this out. Therefore, what are we doing about this? Rotary mowers do an excellent job stemming Dallisgrass after the initial mowing by reel units. Is this practical? Walking rotaries need to be transported by trucks from park to park. In a rapidly expanding park program is it good business to buy a truck for every three or four walking rotary mowers? However, we do know rotary mowers have a minimum breakdown (heavy duty units) and do an efficient job where applicable. In brief the graph on rotary hours tells this:

1) Dallisgrass can be controlled by chemicals.
2) Increase in rotary hours could very well skyrocket injuries.
3) Continued park expansion will create need for transportation of mowing units and employees.

The reel mowing hours as brought out on the graph appear to be out of balance to other turf treatment. There are several advantages to reel mowing though.

1) Several riding units are available.
2) Some units serve as transportation.
3) Maintenance on units is not out of line.
4) Reel units are not hazardous to employees.

If the individual park area is studied reel type mowing could very well reduce hand work. Reason: 1) Small riding unit cuts grass close to trees. 2) The unit will overhang curbs. 3) If plant beds are designed correctly and the planting set back from grass edge reel units will do all the work except edging. Therefore, it seems practical to increase reel mowing operations.

This chart also points out the degree of hand work in turfgrass areas. Hand mowing can consist of mowing around trees with small units, around shrub beds, buildings, fencing, and miscellaneous edging including curbs and walks. From past records hand work can be a high percentage of the total cost of lawn maintenance. The reason for this is that large mowing units leave so many of the previously mentioned items uncut, therefore, small tools do this work. It appears, then, that the area of concern is finishing the job. To alleviate this condition in parks, cemeteries, etc. it might tie back to initial design. A helpful hint would be to study the area where the hand work is predominate, then, slowly rearrange for mowing conditions. This could be done by making perimeter sidewalks adjacent to the curbs. This eliminates edging alone by 66%. Small "hard-to-get-to" areas could be surfaced or planted in ground cover whichever fits the condition. Miscellaneous fencing around ball diamonds and other recreational facilities might be treated with chemicals or hard-surfaced. Controlling grass around trees with chemicals should be looked into.

It is desirable that equipment be in tiptop shape at all times. Each of us realize that when the spring rainy season begins areas are sometime too wet to mow. The entire mowing schedule is usually set back two weeks when this happens. It is important that areas seen by the public are mowed first and the out-of-the-way areas later. If equipment is in top shape and properly crewed, this wet weather condition should not be the problem it sometimes is. In Dallas we have a route which the mower operators travel from park to park. By following this route closely we are able to mow every park approximately every five days. During the rainy season we backtrack so that those areas seen more frequently are properly maintained first.

These slides point out maintenance hints that have helped our maintenance program. One is the treatment of median strips with hard surface patterns on the ends of the medians and around fixed objects. It is known from several years of study and record keeping that the surfacing has reduced mowing cost 66%. Something else which is helpful is surfacing underneath new fence installations, such as, at swimming pools, ball diamonds, and property lines. The concrete aprons of swimming pools are extended beyond the fences so that large mowing units mow all the grass rather than leaving strips for small units. This is now done on ball diamond fencing, tennis courts, and play pads. In some instances parking lots are so curbbed that there is an apron out from the back of the curb to permit large mower operation. This is in special cases only, where the grade permits.

I don't intend to touch on fertilizer techniques today because it is an entirely different subject. However, where color displays such as annuals and perennials are used the texture and color of the turf is the secret of any color display. Therefore, turfgrass should be fertilized according to accepted standards. Here again another technique, aerifying, should be used, especially during the spring months. I think all of us will agree that we don't aerify enough. Usually when aerifying time is at hand we are too busy mowing.

In our city where travel crews go out to do the mowing the lead foreman is responsible for turning in the day's report. This report has several columns under different headings. The foreman checks each item while mowing the park area. He notes the condition of turf, hazards, low growing tree limbs, and other horticultural items which normally prevail on a park. These reports are turned in daily and the supervisor finds them beneficial in checking out the park areas. Other foremen reports are here on the desk and each of you may pick them up at the end of the meeting.

In a group such as this, I am of the opinion there should be a short discussion period. Before we do this, however, I would like to again mention that all of us are in the same vocation. We are managers of sort and we do keep records. On the other hand, each of us has a turnover of employees; we don't receive equipment asked for and the complement of men we feel we should have. For overcoming this situation it is suggested that each problem be analysed, determining if some form of record keeping might be the solution. Management skills will certainly increase once record keeping is established.

THE ROLE OF LIME IN TURFGRASS MANAGEMENT

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Calcium has been recognized as an essential nutrient element since 1856. The exact function of calcium in plant growth is somewhat obscure but it is believed to be of help in the translocation of carbohydrates in the plant. It promotes early root formation and growth, is essential to healthy cell walls, reduces toxic effects of single-salt solutions and neutralizes organic acids. The symptoms of calcium-starved plants are: growing point (terminal bud) dies under severe deficiency; the margins of affected leaves (usually the younger ones) have a scalloped or curled appearance; and there is a tendency for the plant to shed its blossoms and buds prematurely.

The role of lime in turfgrass management is more complex than simply supplying calcium as a nutrient element. In addition, lime is used for correcting the undesirable effects of soil acidity on plant growth, maintaining and improving the availability of applied and native soil nutrients, enhancing desirable types of microbiological activity, and reducing toxic effects of manganese and aluminum. Further, builders lime or slaked lime is often used to control algae growth on wet or poorly drained turfgrass areas. It has been said that "Lime is like a foreman in a factory in seeing that many factors operate to give top output".

The rates of reaction of liming materials with soils depend largely on the nature and degree of fineness of the materials and the completeness with which they are mixed. An instrument called a pH meter is used to make the test for acidity. The pH scale tells how acid or alkaline a soil is in much the same way that numbers on a thermometer show heat or cold, except that the pH scale is logarithmic - that is a pH of 6.0 is ten times more acid pH 7.0 or a pH of 5.0 is 100 times more acid than a pH of 7.0. A pH of 7.0 is neutral. Values downward from pH 7.0 show increasing acidity. Values upward from pH 7.0 show increasing alkalinity.

The amount and kind of clay together with the organic matter in the soil influence the amount of lime needed at a given pH. The greater the amount of clay and the greater the surface area of the clay, the greater will be the amount of lime needed to change the pH value any given amount. Because the reaction of lime with soils involves neutralization, with little if any soluble anions as end products, the movement of calcium and magnesium away from the point of reaction is relatively slow.

The use of lime is not simply a matter of putting it on the soil in the proper quantity. This impression has come about mainly because in the earlier use of lime it was mixed with the soil through normal tillage. The problem with permanent crops such as untilled turf and forage crops is quite complex. In the case of turfgrass any nitrogen which penetrates to the subsoil in the form of ammonia is potentially acid-forming. It moves into the subsoil only in combination with an acid ion, and subsequent utilization of the ammonia in excess of use of the acid ion, or conversion of the ammonia ion to nitrate will leave a residue of strong acidity. Deliberate liming to provide surface soil pH values above the neutral range is not a recommended practice. Deep placement of lime has been demonstrated as being valuable, and lime applications for turfgrass should normally be made immediately following aerification in order that the lime may be placed deeper in the soil than would otherwise be possible.

Soil reaction greatly affects the availability of the various mineral nutrient elements. The availability of nitrogen, potassium, phosphorus, calcium, magnesium, manganese, copper, iron, zinc, and others varies with the soil pH.

The phosphates are the most insoluble of the soil nutrients. At a pH between 5.0 and 6.0 the phosphates are fixed primarily as iron and aluminum phosphates and become less available. The best pH range for phosphate availability is between about 6.2 and 6.8. As the pH increases from 7.5 to 8.5, phosphates are precipitated by calcium. Above a pH of 8.5 there is an increase in phosphate solubility but under such conditions the turfgrass growth would be restricted due to effects of high alkalinity and poor soil structure from high amounts of sodium salts.

Like potassium, calcium and magnesium are absorbed by plants as the ion. This may take place either from the soil solution or by the process of contact exchange. The absorption of these elements by plants is dependent upon the amount present, the degree of saturation, the nature of the other exchangeable ions, and the type of clay. The most obvious way to correct a deficiency of calcium and/or magnesium is by the application of calcitic or dolomitic lime. However, in the event that calcium is required without the increase in pH that would result from the use of lime, gypsum is a satisfactory source. If magnesium is needed without an increase in pH then Epsom salts can be used. Gypsum and Epsom salts are sulfate compounds of calcium and magnesium and would not greatly influence the pH except to slightly shift it toward a more neutral pH.

A soil test is the only reliable method for determining whether a soil is acid or not although the following indications may attract attentions to a possible lime deficiency: 1. Failure of grass to respond to fertilizer. 2. Seeming lack of response to watering. 3. Lack of color or vigor when growing conditions seem favorable.

HERBICIDES IN TURFGRASS MANAGEMENT

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Since the Middle Ages there has been a certain air of mystery, even fear, associated with things chemical. This feeling has been carried forward with respect to the use of chemicals as herbicides, especially those which induce abnormal plant growth responses. A better understanding of herbicides and of their effects on both turf and weed plants will permit them to be used effectively in turfgrass management.

Turf may be extensive, as parks or roadside rights-of-way, or it may require intensive management, as golf greens. Whether the management is extensive or intensive, problems are encountered with herbaceous, grassy, brushy and aquatic weeds. The concepts and techniques of vegetation management using herbicides have developed rapidly since the release of 2,4-D soon after World War II. Chemical weed control was practiced prior to that time, but on a limited scale. Many other herbicides have been released since the development of 2,4-D, and chemical weed control has become quite specialized.

Herbicides should be considered as tools for dealing with many of the weed problems in turf. The various herbicides are specialized in their effects on plants, as are the various items of mechanical equipment used in the maintenance of turf. If herbicides are to be used to best advantage, it is important that the benefits as well as the limitations of each chemical be recognized. If they are used properly, herbicides can do an effective job of weed control with a considerable saving in labor costs.

In the development of herbicides, the tendency has been toward highly specific chemicals. In other words, many of the herbicides have a rather narrow range of plant species against which they are effective. One should not expect a miracle chemical which will arbitrarily control the plants he wishes to remove and not affect the plants which he wishes to retain.

The safest and most efficient use of these chemicals requires a knowledge of the herbicide being used, of the plant being treated, and of the techniques of application. An herbicide is a phytotoxic chemical used to kill or to control the growth of plants. A plant is a weed only so long as it is objectionable. It follows then that the nuisance character of the weed may be overcome without completely eliminating it from the area being treated, particularly in those turf areas which are not managed so intensively. The proper functioning of an herbicide may be either enhanced or curtailed by the application.

Chemicals used for weed control can be arbitrarily classified by the way in which they affect treated plants. This classification is not absolute, and a particular chemical may be entered under different categories depending upon the rate of application. Some of the most common chemicals and the category in which they are most commonly used are shown in Figure 1. The action of a particular chemical may be contact, translocated or systemic, or the chemical may be used as a soil sterilant. Contact chemicals kill only the parts of the plant to which they are applied. There is little or no movement within the plant, and none is required. Systemic chemicals move within the plant from the point of entry to the site of toxic action. They may enter the plant through the leaves, the stems, the roots, or a combination of these. The soil sterilants are a group of chemicals which prevent growth of plants within the treated area by either contact or systemic action.

Action	Individual herbicide	Combined herbicide
1. Contact	Sulfuric acid	
	Dinitrophenol → Fortified oil	
	Petroleum oils → Fortified oil	Fortified oil
	Pentachlorophenol → Fortified oil	
2. Translocated or systemic	2,4-D → "Brush killer"	"Brush killer"
	2,4,5-T → "Brush killer"	
	Silvex → Garlon*	Garlon*
	Dalapon → Garlon*	
	TCA → Monuron TCA, etc.	
3. Soil sterilants	Substituted ureas, → Monuron TCA, etc.	Monuron TCA, etc.
	monuron, fenuron, etc. → Ureabor*	
	Borate → Ureabor*; → Chlorate-borate mixtures	Ureabor*
	Chlorate → Chlorate-borate mixtures	Chlorate-borate mixtures, both liquid and granular.

Figure 1. A partial listing of herbicides which may have utility in management of turf. The materials may be used separately or are available commercially in the combinations shown. The listing is illustrative only and by no means exhaustive.

* Commercial names; no endorsement implied.

Contact herbicides usually are used to control annual and other plants having exposed growing points. Some selectivity is possible by using the lighter distillates, provided the desirable plants contain some natural oils. These herbicides are largely non-selective and can be used in maintaining pavement seams and for some edging.

Herbicides which are systemic in action can be used to control a number of weedy plants in turf. Materials are available which offer a wide range of selectivity. These materials are very demanding as to proper time of application, but properly used they give spectacular results. Systemic materials require the treated plants to be actively growing to facilitate the movement of the herbicide from the point of application to the point of action. The movement of herbicides within plants seems to be with plant food materials. The proper time of application for controlling perennial weeds usually coincides with the period during which food reserves are lowest in the roots. For annuals, this period of least food reserves is during the early seedling stage. In perennials, food reserves are lowest after the flush of early growth and is related in many plants with the early period of flowering.

Soil sterilants are used to keep soil bare of all plants, as in walkways and under pavements. These herbicides vary in the period of sterility induced. The length of the sterile period is determined by the herbicide used, the amount of precipitation, the type of soil treated and inactivation of the chemical by light or other agents. Generally, the less soluble materials persist for a longer time. Sterilants are leached from deep sandy soils sooner than from shallower or heavier soils. Materials subject to photoinactivation should be covered or incorporated into the soil. Soil sterilants often enter a plant through the roots, so they should be used a safe distance from susceptible trees and other plants with spreading root systems.

Various herbicides exhibit both selectivity and specificity. Selectivity means that an herbicide will kill or control certain plants while leaving other plants apparently unaffected. Both 2,4-D and dalapon are selective chemicals. For example, 2,4-D generally is considered to selectively control herbaceous weeds, while dalapon is more effective against grasses. While herbaceous weeds are controlled with 2,4-D, most brushy plants are more sensitive to 2,4,5-T. Within each of these broad categories, the chemicals are more specific for certain plants than for others. Tomatoes are extremely sensitive to 2,4-D, yet many weeds such as the nightshades apparently are not greatly affected by this material.

Frequently, combinations of chemicals are marketed to extend the range of plants which may be controlled. Where possible, it usually is better to use a manufacturer's combination of herbicides. However, with experience, various herbicides may be combined to combat specific weed problems. The herbicide combination may be either physical or chemical. Likewise, they may combine a systemic and a soil sterilant, as well as two systemic materials. The physical combination of dalapon and silvex yields the material known as Garlon, which is effective against both grassy and herbaceous weeds. Monuron and TCA are combined chemically to produce monuronTCA which combines the immediate action of the TCA with the long residual effect of monuron. Following application the chemical reaction for combination is reversed, and the component herbicides are released for their respective plant control actions.

Proper application involves the rate, volume of spray and timing of treatment. The recommended rate of herbicide should be used, as more or less material usually gives unsatisfactory results. A sufficient volume of spray should be applied to obtain proper coverage and distribution of the spray material. The use of a small amount of oil or other wetting or penetrating agent may increase the degree of control achieved. Applications should be timed to coincide with the most susceptible stage of plant growth. Spraying should be avoided during periods when wind velocities are greater than 8 to 10 miles per hour. Not only is the danger of spray drift to susceptible plants greater if wind velocities are high, but less material is deposited on the plants being sprayed. Some thought should be given to the designation and training of spraying crews.

These are some of the general considerations for the use of herbicides in a turf management program. Specific recommendations for a particular problem should be sought from research personnel, extension specialists, or from representatives of reputable companies. An understanding of the materials available, together with any restrictions, will enable the turf manager to select the treatment which will best fit his specifications. Finally, it should be remembered that herbicides are only another tool to be used in gaining more efficient management of turf. They should be considered as additions to and not substitutes for the usual practices of mowing and fertilizing which are customarily followed.