Dave Fearis

UNIVERSITY OF ILLINOIS
DIVISION OF UNIVERSITY EXTENSION

9th

TURFGRASS CONFERENCE

PROCEEDINGS

College of Law
Auditorium

December 5 - 6, 1968

arranged and conducted by the

COLLEGE OF AGRICULTURE

with the cooperation of the

ILLINOIS TURFGRASS FOUNDATION

University of Illinois
Division of University Extension

Announces the

NINTH ILLINOIS TURFGRASS CONFERENCE
December 5 and 6, 1968
Auditorium, Law Building
Urbana, Illinois

Arranged and conducted by the College of Agriculture

With the cooperation of the Illinois Turfgrass Foundation

PROGRAM

Thursday, December 5

10:00 a.m. - 12:00 noon	Registration

Thursday, December 5 - First Session

Moderator - P. Vandercook, Orland Park, Illinois

1:15 - 1:20 p.m.	Welcome - J. B. Claar, Director Cooperative Extension Service University of Illinois
1:20 - 1:50 p.m.	A discussion of turfgrass diseases Mr. P. Britton University of Illinois
1:50 - 2:10 p.m.	Studies in turf weed control - 1968 J. D. Butler and H. J. Hopen University of Illinois
2:10 - 2:55 p.m.	The turfgrass industry in the south E. O. Burt University of Florida
2:55 - 3:10 p.m.	Break

Moderator - T. Thornton, Elgin, Illinois

3:10 - 3:30 p.m.	What causes turf insect problems? R. Randell University of Illinois
3:30 - 4:15 p.m.	Reducing the labor expenditure on a golf course Lee Record & James Holmes
4:15 - 4:45 p.m.	Question and answer session M. P. Britton, H. J. Hopen J. D. Butler, E. O. Burt, R. Randell, and J. L. Holmes

5:30 p.m. Social Hour

6:30 p.m. Banquet - Illinois Turf Foundation Banquet and Business Meeting - Ramada Inn, Champaign, Robert Johnson, President, Illinois Turfgrass Foundation presiding

Transportation will be provided from the Law Auditorium to the Ramada Inn.

Friday, December 6 - Second Session

Moderator - J. Brandt, Danville, Illinois

8:30 - 8:50 a.m. Some golf green soil tests
J. B. Gartner and J. D. Butler
University of Illinois

8:50 - 9:20 a.m. Criteria for Landscaping
W. R. Nelson
University of Illinois

9:20 - 9:50 a.m. A fungicide inventory for the turf manager
M. C. Shurtleff
University of Illinois

9:50 - 10:05 a.m. Break

Moderator - Paul Craig, Springfield, Illinois

10:05 - 10:25 a.m. On weed control
J. A. Tweedy
Southern Illinois University

10:25 - 11:10 a.m. Sod production research in Michigan: factors affecting sod strength, rooting, and heating
J. B. Beard
Michigan State University

11:10 - 11:30 a.m. Question and answer session
J. D. Butler, W. R. Nelson, M. C. Shurtleff, J. A. Tweedy, and J. B. Beard

11:30 - 11:35 a.m. Wrap-up and adjourn

GENERAL INFORMATION

REGISTRATION

The registration fee for this conference is $12.00. A copy of the proceedings and admission to the banquet Thursday, December 5 are included in the registration fee. The registration fee does not include other meals or housing. To ensure a place for yourself in the conference, enroll in advance by completing the enclosed registration card and mailing it with your check, made payable to the UNIVERSITY OF ILLINOIS to:

Conference Supervisor
University of Illinois
116 Illini Hall
Champaign, Illinois 61820

All registrants are requested to check in at the Conference Desk in the corridor outside the Auditorium of the Law Building, Peabody Drive, between Fourth and Sixth Streets in Champaign, between 10:00 a.m. and 12:00 noon Thursday, December 5, 1968.

HOUSING INFORMATION

Blocks of rooms have been set aside at the Illini Union and the Ramada Inn. To ensure housing accommodations during the conference, please complete the enclosed reservation request and mail it directly to the accommodation of your first choice by November 15.

MEALS

The conference program includes a banquet session at the Ramada Inn in Champaign on Thursday evening, December 5. Admission tickets will be issued to registrants as they complete their registration at the Conference Desk.

PARKING

Vacant, on-street, metered parking spaces are difficult to discover. Transportation via shuttle bus will be provided between the Law Auditorium and the Ramada Inn. Illini Union guests should obtain a parking permit from the desk clerk. Parking is available on the N.E. and N.W. coin-gate controlled lots of the Assembly Hall, a few blocks from the Law Auditorium.

ADDITIONAL INFORMATION

Additional information about the conference may be obtained by writing to Conference Supervisor, 116 Illini Hall, Champaign, Illinois 61820.

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FACTORS INFLUENCING TURFGRASS DISEASE DEVELOPMENT

M. P. Britton

Temperature influences nearly every function of fungi. For each fungus there is a temperature above which it will not grow, the maximum temperature, and a temperature below which growth is prevented, the minimum temperature. A few fungi are capable of growth below 32 F., but most are restricted by temperatures between 32 and 40 F. The maximum temperature tolerated varies widely from about 75° to 122°F.

Most fungi reach an optimum growth rate quite near the maximum temperature and grow more and more slowly as the minimum temperature is approached. The ability of most fungi to cause disease in grasses is temperature related. Studies have shown that the minimum temperature for the growth of *Pythium aphanidermatum*, the cause of *Pythium* blight, is 50 F, the maximum slightly more than 95 F, and the optimum temperature for growth is near 90 F. In Florida it was shown that the fungus grew in the soil at 50 F, but did not infect the grass plants. At 67 F, grasses were infected and death of 50% of the plants occurred in 8 to 24 hours. As the temperature was increased, the time required for the fungus to kill 50% of the plants was reduced. Thus at 86 F, 4 to 8 hours were required and at 95 F only 2 to 4 hours. It is not known whether this is due solely to the effect of temperature on the growth rate and pathogenicity of the fungus. It is possible that high temperature might alter the metabolism of the host grasses so that they would be more susceptible to attack.

Strains of the same fungus species vary in their response to temperature. In California, low temperature and high temperature strains of *Rhizoctonia solani*, the cause of brown patch, have been found. The cardinal temperatures for the low temperature strain were a minimum below 40 F, optimum between 60 and 70 F, and a maximum near 90 F. This strain was pathogenic over a wide range of temperature, 40 to 80 F, but killed the plants slowly and the optimum temperature for disease development was 60 to 70 F. The high temperature strain had a minimum of 40 F, an optimum near 80 F, and a maximum above 90 F. Plants were infected over a range from 60 to 90 F, but the damage was greatest at 80 to 90 F.

Moisture in the form of films or droplets on plant surfaces is necessary for the germination of most fungus spores. In the absence of free moisture they become rapidly dehydrated, and the germinating spores are killed.

Fungi like Sclerotinia homeocarpa (dollar spot) and Rhizoctonia solani (brown patch) can easily be seen in the early morning on wet leaf surfaces and in the guttation droplets on leaf tips. With the onset of drying conditions, they rapidly wither and disappear. Free moisture is necessary for their continued growth over the leaf surfaces.

Normally the moisture in the live tissues of an invaded host plant is sufficient to support the growth of the fungus pathogen. When the host plant tissues are killed, they tend to dry out, and further growth and sporulation of fungi in these dead tissues will be curtailed as long as the tissues remain dry. In many cases, the mycelium will survive in dry dead plant tissue in a dormant condition, and sporulation of the fungus will occur if the tissue is moistened.

Perhaps a less obvious role of water is that of an agent of dissemination of the fungus pathogen. Spores are splashed from their place of formation to growing plants by raindrops and droplets from sprinklers. Runoff water from rainfall or irrigation will carry spores, sclerotia, and perhaps mycelial fragments from one location to another. The streaking of Pythium blight toward low areas on putting greens is an example of such spread.

Too much water in the soil for prolonged periods of time is detrimental to growth and survival of grass roots. Plants that are damaged in this fashion may be less able to survive attacks of leaf and crown diseases.

Too little water may also increase disease damage. During drought periods diseased turfgrass plants often die. This is illustrated in the case of stripe smut in Kentucky bluegrass.

It has been reported that significantly greater dollar spot development occurred on Kentucky bluegrass maintained with irrigation practices that allowed the plants to extract the soil mosture to 3/4 field capacity or below than when soil moisture was maintained near field capacity.

The humidity of the air exerts an influence on turfgrass disease occurrence. If the humidity remains high until late morning, the leaves stay out longer, thus prolonging conditions favorable for growth and penetration of fungus pathogens.

Wind is a factor of great importance in disease occurrence. Spores of many fungi are disseminated widely by wind, especially the spores of fungi that cause rusts, smuts and mildews. Air movement also facilitates evaporation of water from turf areas. In locations where air movement is impeded by surrounding trees, shrubs, or topography, there will be a rapid rise in air temperature above that experienced in an exposed area. In addition, the air in these pockets tends to be more humid. Turfgrasses in such locations may be damaged more frequently by high temperature diseases than turfgrasses in exposed areas.

The pH of the soil influences the incidence of turfgrass disease primarily because of the effect that pH has on the pathogen. The pH of the soil affects the growth and reproduction of some fungus pathogens directly.

It may also act indirectly by affecting certain biological and chemical processes in the soil. Another indirect effect of soil pH on disease occurrence is that of determining the availability of nutrient elements to plants.

The management practices necessary to the maintenance of turf have a decided effect on disease incidence and development. Most cultural practices exert an indirect effect on disease development by modifying certain factors of the micro-environment that in turn affect disease incidence. Others are directly involved with disease development or with the severity of damage caused by disease. These effects are abundantly illustrated by the basic turf management practice--mowing.

Within limits, as the height of cut is lowered greater numbers of smaller plants occur in an area. The individual plants are crowded closely together causing: 1) a greater degree of shading of the soil surface, and 2) a greater restriction of air movement in the plant zone than would be found in unmowed situations. These conditions would tend to extend the wet period necessary for disease initiation.

On putting greens, the individual plants are very small, and attack by a fungus pathogen may involve an entire leaf and sheath in a very short period of time. The same infection on an unmowed plant of the same species might result in only a leaf spot on a leaf blade.

The wounds caused by mowing constitute the primary avenue of entry for some of the most important turf pathogens. On putting greens, cut leaf tips are close together, and mycelial bridging from one leaf tip to another by fungi is an important means of spread from infected plants to adjacent healthy ones. At a higher cut there are fewer cut leaf tips in close proximity, and bridging from one to another is more limited.

The spores of some fungi are readily dislodged by the mower. Spores, mycelia, and infected leaf fragments adhere to mowing equipment and are then spread to healthy plants. This is more likely to happen if the grass is mowed when it is wet. Under dry conditions the dislodged spores are caught by air currents and are carried by wind to other plants.

Mowing can be beneficial. In the case of fungi that attack plants primarily through the cut leaf tips such as Rhizoctonia solani, Fusarium spp. and Curvularia spp., infections usually do not progress very rapidly toward the base of the leaf. Therefore, once the disease is controlled, the diseased portion of the leaf is pushed upward by basal growth of the leaf and is removed by mowing. Thus in two to three weeks, or less in light attacks, the damaged leaf tissue is removed and the affected areas are healed.

The application of fertilizer to turfgrass if properly done is beneficial in that it stimulates the desired level of growth needed for a particular use. The application of fertilizer elements to turfgrass will not change the inherent susceptibility or resistance of the grasses to diseases. However, the severity of the disease attack on a susceptible host may be greater under certain levels of fertility than others.

The application of fertilizer may increase disease severity by making growth conditions more favorable for the pathogen. Glutamine is an abundant constituent of turfgrass guttation fluids formed after fertilization with readily soluble nitrogen fertilizers. The glutamine in the guttation droplets is used by Helminthosporium sorokinianum to develop multiple infection structures, the result being increased leaf spot infection on creeping bentgrass. Other workers have suggested that other organic constituents of guttation fluids also may enhance disease development on close-cut turf by providing nutrients for the saprophytic growth of the pathogens on the host surface.

Recovery from disease damage is dependent upon regrowth of the plants to replace the killed tissues. The beneficial effect of high nitrogen fertility in avoiding severe dollar spot damage is probably the result of rapid growth of the grass during periods of reduced activity of the pathogen.

Maintenance practices that prevent or limit the development of thick layers of thatch on the soil surface are largely beneficial to disease prevention. Some turf pathogens like R. salani and Fusarium spp. grow saprophytically in the thatch. Other pathogens, including Helminthosporium species, produce spores on the dead material in the thatch layer. Mechanical removal of the thatch layer is beneficial in eliminating much of the material that could be used by fungi.

The benefits derived from the addition of nonsterilized soil and composted topdressing materials are perhaps not as obvious, but they may be equally important in limiting disease occurrence. Such topdressings contain a wide range of beneficial bacteria and fungi that hasten thatch decomposition. Also, organisms that are antagonistic to pathogenic fungi are replenished. The physical action of burying some of the leaves with soil would mechanically prevent spores from being dispersed; and most spores do not survive for long in moist soil.

A REVIEW OF TURF WEED CONTROL - 1968

J. D. Butler and H. J. Hopen

Chemical weed control continues to progress as rapidly as any aspect of agriculture. The future possibilities in this field are unlimited. A few possibilities for the future include the development of varieties of grasses which are highly resistant to existing herbicides, thus allowing for the use of highly selective materials on such problems as quackgrass and nimblewill. Possibilities already exist for removal of certain bents with siduron and zoysias with atrazine. Also, de-activation, as with activated charcoal, will provide ways of reducing or eliminating residue problems. Of course, new chemicals will constantly be developed and added to the multitude that now exist, giving an even broader base for the development of more and better materials. With the great interest - and usual success - of chemical weed control, the possibilities and feasibility of the cultural aspects of weed prevention and control often go neglected, except for a limited amount of research, which often is successful but not applied. Remember that weeds are, more frequently than not, the result of poor turf, not the cause.

Cultural Control

Cultural aspects of weed control should be considered well in advance of seeding. In some areas where turf is to be grown, planning the use of herbicides two or three years in advance of planting may be wise (ex. corn and a triazine to eliminate quackgrass). Row cropping former pastures, and other areas where perennial grasses were grown, for a few years before seeding to turf may be the answer. However, time and investment frequently force seeding where the development of a weed problem is not only possible, but probable.

Quality seed on soils free of perennial grass weed problems can be made to provide, for a few years at least, a high quality turf if properly maintained. The fertility program for the production of a dense turf is extremely important. Fertilization can be over as well as under done, although over doing is extremely rare.

The watering program can influence the weed population - through disease, the loss of density, etc. Poa annua is associated with overwatering, and from our experience difficult to keep under control in a watering program considered best for Kentucky bluegrass. The height of mowing also influences the persistence of lawn weeds. Poa annua and crabgrass are frequent problems in low cut turf. A constant, and usually the first, recommendation for growing better turf is to ease up the mowing height. Then, of course, uncontrolled diseases, insects, compaction (wiregrass, knotweed), etc. will attribute to weed problems.

Longevity and Control

An examination of the longevity of a turf weed will usually give some valuable information on control. If the weed is an annual broadleaf or grass that is to be controlled postemergent, then it usually should be treated when the plant is young. Two or three treatments of young goosegrass with an organic arsenical will usually give good control while the same treatment on older, more mature plants would be expected at best to give only fair control. However, treatment too early will not be satisfactory since most of the postemergent materials, especially those used on cool season grasses, do not give satisfactory preemergence control. Treatment of annual weeds from mid-summer on, may not be desirable since the weeds may be providing desirable cover, are usually already seeding heavily, and will go out with the first freeze anyway.

Annual grasses, and certain broadleaves, that are to be controlled preemergence, should be treated early in the season. Control from fall applications, especially with the longer residue preemerge "crabgrass" materials, often prove satisfactory the following spring, but it would seem that satisfactory control during the entire summer might not be achieved. Certain of these materials may give satisfactory selective control when applied on very young annual grass.

Perennial broadleaves should be treated when they are actively growing.

Little can be said about selective control of perennial grasses today that could not, and has not, been said for the last several years. Spot treatment, usually on a repeat basis, with a non-selective, translocated material such as dalapon or amitrole may solve some of the problems. The contact materials, such as cacodylic acid and paraquat, used properly may also provide satisfactory weed control.

Mechanical weed control, often overlooked, should be considered as an alternative to chemicals, especially where there is no good selective control and the weeds cover only a small percentage of the total area. All things considered, mechanical control may often prove to be the least expensive and best method of eradication even on fairly large areas.

Soil and Climatic Conditions

An application of fertilizer a week or so before using a selective postemergence herbicide will stimulate the weeds, causing them to be more susceptible to the herbicide. Also, a healthy, vigorous turf will usually be less likely to be injured by an herbicide. It is also good for the soil to be moist before applying a postemergent material, for best control and least injury. In using preemergent arsenicals, the soil phosphorus levels and phosphorus fertilizer applications need to be taken into consideration.

For best results from herbicides, temperatures can be very important. The temperature at the time of application for 2,4-D type materials should be 70-85^{o} F, while the contact materials such as paraquat may do a better job, although perhaps less dramatic, on a cloudy day when the temperature is not too high. Also, for best results with postemergence herbicides, it is best to treat when fair weather is likely for the next 24-28 hours. However, there are exceptions - 2,4-D is translocated rapidly into the plant, and a rain a few hours after application may not lessen the amount of weed control. However, spraying when the dew is on may cause chemical runoff and reduction in effectiveness. Watering after application of preemergence materials is usually suggested for best results.

Although many of the herbicides are used as sprays or granulars, the manufacturer will often prefer one form over another. More often than not, the preemergence "crabgrass" control materials are applied as granulars, and the postemergence broadleaf herbicides are applied as sprays. Materials such as dicamba and atrazine are picked up by the plant roots and give a dual control action.

Herbicides are just what the name indicates. And if used improperly, can spell disaster.

Some general observations from plot work in 1967 and 1968 on weed control are:

1) A general benefit from herbicide mixtures.
2) Differences in varietal tolerance to a given herbicide.
3) The broad range of weeds controlled by dicamba.
4) Continued excellent control of several weeds with siduron at time of seeding.
5) Little if any problem from residual of 2,4-D type materials to new seedlings.
6) Excellent control of Poa annua seedlings with several preemergent materials.
7) Good to excellent weed control with an organic arsenical plus 2,4-D and MCPP.

TURF OPPORTUNITIES IN THE DEEP SOUTH

Dr. E. O. Burt
Orn. Hort. and Head

Plantation Field Laboratory
3205 S. W. 70th Ave.
Ft. Lauderdale, Florida 33314

Professional turf managers as well as do-it-yourself home owners in the deep south face problems second to none in the nation. Not only are they faced with year round mowing, watering and fertilizing, but also must control pests year round.

The long growing season and the stoloniferous habit of growth of warm-season turfgrasses results in a heavy thatch within a few months. A 6" thatch is not unusual. Vertical mowing or verti-thinning is becoming a common practice in the south.

The first problem the migrant northerner encounters is the fact that none of the better-quality southern turfgrasses are propagated by seed, thus they are more difficult to establish. In addition, they are more difficult to contain after they are established since all of them spread by stolons and/or rhizomes. On most turf areas, edging and sweeping or vacuuming usually are as time consuming as mowing.

The number and seriousness of the pests makes the Yankee yearn for the king of the turfgrasses - bluegrass.

Insects, fungi, nematodes and weeds are a greater problem in Florida turfgrass than in any other part of the U. S. Within a few days, insects, such as chinch bugs, can almost completely kill a St. Augustine lawn. Likewise, brown patch can almost eliminate a lawn in a few days. Nematodes, although slower acting, are equally as damaging.

Weeds rapidly become established when the turf becomes thin. Even with dense turf, certain weeds appear, persist, and are very difficult to control. Satisfactory control measures are difficult for several reasons. Many annual weeds persist for two or more years making it difficult to follow a preemergence control program. Control procedures are further complicated by differences in the tolerance of the warmseason turfgrasses to herbicides on St. Augustine, zoysia and centipede but not on bermuda or bahia. The organic arsenicals can be used on bermuda and zoysia but not on St. Augustine, centipede or bahia. St. Augustine is susceptible to injury from 2,4-D and other phenoxy herbicides.

The low water holding capacity of the sandy soils and the high evapotranspiration rate increases the importance of irrigation in turf maintenance. Although the annual rainfall for Florida is approximately 55 inches, the weekly distribution is poor for growing turf. Most lawns in South Florida have wells and an irrigation system.

The low base exchange capacity, high rate of leaching and high soil pH make it difficult to provide adequate amounts of both major and secondary elements without phytotoxic excesses. Deficiencies of iron, manganese, copper and other trace elements are not uncommon on turf and ornamentals. Some fertilizer ratios are given as four numerals; the last one being magnesium.

Thus, it is apparent that careful daily attention must be given to several different and important phases of turf management in order to maintain healthy turf.

In contrast to the more northern climates where grass mixtures or blends are compatible, the warmseason grasses are found only as pure stands, because of distinct differences in texture and maintenance requirements. Management programs differ widely among the five warmseason turfgrasses.

Following are some of the characteristics of and problems associated with each of the five turfgrasses found in Florida.

St. Augustinegrass is the predominent lawn grass in Florida. It has a wide range of adaptation to a variety of growing conditions. Although, it is coarse textured, it has reasonably good appearance under good management.

The main disadvantages to this grass is its susceptibility to chinch bugs.

Centipedegrass is the second most common lawn grass in the state. This grass does well under a low level of maintenance. Centipedegrass is susceptible to brown patch fungus and three or four insects, especially mole-crickets.

Zoysiagrass is slow growing but once established, makes a very dense turf. The primary problems with zoysiagrass are nematodes, brown patch and insects.

Bermudagrass is the finest Florida turfgrass in texture and quality. The improved bermudagrasses require high maintenance. These grasses will stand foot traffic and wear better than most turfgrasses. Golf greens consist of one of the fine textured bermudas, such as Tifgreen; tees and fairways consist of one of the improved bermudas, usually Ormond or Tifway. Bermudas will not tolerate shady locations. The primary problems are nematodes, sod webworms and fungi.

Bahiagrass is the only permanent warmseason turfgrass that is propagated from seed. This grass has lower maintenance requirements than any of the above. Bahiagrass does well on poor soils and will strive reasonably well under either dry or moist conditions. This grass forms a coarse open turf that looks good from a distance. Its worst disadvantage is the tall seed spikes that are produced prolifically during the summer.

Because of the complexity of the problems and the large amount of time required to maintain turf in South Florida, many lawns are maintained by commercial lawn services. Most of the lawn service companies specialize in either lawn spraying or lawn maintenance. Some specialize in thatch control.

The greater emphasis on turf and ornamentals is exemplified by the fact that this past July 1, a separate experiment station was established in South Florida where research will be conducted on ornamentals, including turf. There are 13 men working full time in the area of turf and ornamentals in research, teaching and extension in Florida.

WHAT CAUSES TURF INSECT PROBLEMS?

Roscoe Randell

Insects like many other pests can be the result of a combination of different factors such as temperature, moisture, vegetation, other insects and many others. In this presentation I want to select a few insects and a related pest and discuss the reasons for their possible presence and increase in abundance. The insect list will include a few insects which are only occasionally found in turf areas, others which are found in turf areas but do not feed on the grass and other insects which are common tree and schrub pests.

With each insect let us consider then the following questions about a potential outbreak.

--Where did the population come from?

--What factors favored high population?

--How often will this insect be a problem?

--How many in the population before treatment is necessary?

--What signs or symptoms can be used for early detection?

--What type of chemical control program is needed?

Let's look at each insect species in light of the previous questions.

White Grub - This insect along with its related species such as Japanese beetle larva and green June beetle larva typically have a three-year life cycle. Two years are spent as grubs in the soil. The adult, usually the June or May beetle, prefers to lay its eggs in grassy areas rather than in bare soil. Therefore, continual generations can be occurring in the same grass area. Detection of a grub problem is simply observing dead patches in the turf area with the grass roots destroyed. Chemical control is a preventative process which kills the very young grubs. Not growing grass is the best cultural method but this presents other problems!

Sod Webworm - This insect has two-to-three generations per year with the overwintering stage being partly-grown larvae. High numbers of larvae in the fall, absence of extreme cold temperatures and protective grass cover aid in winter survival. Population in a particular turf area run in cycles over a period of a few years. Spring generations are of little economic importance, but the late summer generation can often be destructive. Irregular brown patches with tunnels and webbing are the chief symptoms of the problem. High fertility levels and irrigation will allow a turf area to support more webworms but such an area is also the most attractive as an egg-laying site. Chemical control timing is important as it cannot simply be the addition of a soil insecticide in the spring of the year.

Varigated cutworm - This species and its relatives were very common this past summer in turf areas - also in vegetable crop areas, pastures and hay crops, etc. This insect overwinters as a pupa emerging as an adult moth in the spring. There are two-to-three generations a year with each one producing a higher population. Detection is usually the result of birds digging in the turf for the larvae as they do for webworm larvae. Treatment for cutworms follows a very close pattern to webworms in the case of chemical selections and timing.

Armyworm - This insect does not overwinter in the state. The first generation occurs in southern and central Illinois in late May and June in grasses and small grain crops. Moths emerging from this generation migrate northward to lay eggs in grassy areas for the second generation. Fungus diseases and parasites commonly kill most of the first generation. As a second generation pest in the northern part of the state, it occurs in late summer and may appear as large numbers of dark-colored worms moving across grass areas. Chemical control is timed with cutworm and sod-webworm infestations in late July and early August.

Leafhoppers - These wedge-shaped pale green insects do not commonly overwinter in the state but enter as adults as do the armyworm moths. Swarms of these insects usually migrate to grassy areas and rapidly build up in numbers with several generations during the growing season. These insects suck sap from the grass leaves but are primarily a nuisance insect. Population levels can vary from day to day due to rains, condition of grass growth in which they are feeding, etc. Chemical control usually is a pattern of repeat treatments as new populations migrate in to a turf area.

Ants and soil nesting wasps - This group of various species of ants and soil nesting wasps are called social insects since they provide food for their young and live as a colony in the soil. Being a colonizing insect, the population once established, remains in a definite location in the turf area. Detection is by observing ants or wasps moving about from a definite location. Chemical control is obtained by treating the nests or colonies. Soil insecticides applied for grub control will control ants and soil nesting wasps.

Periodical Cicada - This insect sometimes indirectly affects turf grass areas. It lives in the soil as a nymph or immature form for a period of either 13 or 17 years. It emerges as an adult cicada in early summer. The egg laying punctures on twigs of trees plus the nymph exit holes in the soil are the two forms of damage. Chemical control is strictly a matter of killing the adult prior to egg laying.

Cankerworms - There are two species but the most common is the spring cankerworm, often called the inch worm. It passes the winter as a pupa in the soil and adult moths emerge in February and March. The wingless adult females crawl from the soil up the trunk and onto the branches of trees. Eggs are laid on the loose bark on the limbs. Application of a sticky substance on the tree trunk will prevent movement of the adults up the trunk, otherwise chemical control is a foliar application of an insecticide.

Millipedes - These animals are not true insects and do not feed directly on grass. But many times they are found migrating across turf areas from a feeding site to an overwintering location. Their primary food is decaying vegetable matter. These many-legged animals can be controlled chemically with insecticides commonly used for webworms, cutworms or armyworms.

REDUCING LABOR EXPENDITURES

L. Record and J. Holmes

Present

Reducing labor expenditures, increasing labor productivity, and still maintaining playing conditions without player inconvience is expected of the modern golf course superintendent. Todays maintenance programs must be precise. Firm decisions must be made and expedited, results have to be constructive, and errors corrected immediately. Demands by the golfing membership hampers, prevents or delays necessary programs. Therefore, continuing long range programs are necessary to cope with existing problems before new ventures are attempted. Complete understanding of budgets, personnel, equipment and communications are key factors to reducing labor expenditure and increasing labor productivity. The responsibility, organization and facilitation of these programs is the business of the golf course superintendent.

Labor is the greatest expense in each golf course operation; polls report between 60% and 75%. The golf course superintendent, in order to effectively reduce this large expenditure, has to think as an owner and perform as the chief administrator regardless of the size of his operation. Productivity of manpower then, is the most important issue the golf course superintendent must face. To receive the most productivity from an employee, the workman must be aware of what is expected of him. He must know how to do the job in question. He must know the standards that are set for each particular job. He must have the ability to do the job. It is important that he carry out his duties because he wants to, and can take pride in accomplishment.

When an employee reports to work it is important to have the man complete the job the way you want it done. Perhaps this is the first time the man has worked on a golf course. Patterns as he first develops them, are relatively easy to alter. If he is permitted to develop bad working habits over a period of time, such habits are harder to break. Considerable effort, is necessary in order to train a competent employee.

The employee's job is production orientated, while the superintendent's job is "people orientated". The superintendent must create an environment in which his men can reach maximum production. The superintendent must provide all the equipment and facilities that are required to complete a job, and he must pay a respectable wage.

In that labor management and communication are the greatest challenges to a successful superintendent, this challenge must be conquered before other phases of turf maintenance and management programs fall into line. The superintendent must continue to educate himself, his employees and his membership.

How many men are required to maintain a normal eighteen hole golf course? Obviously this will vary from course to course, depending upon many factors such as size of the layout, demands of the membership and demands of the superintendent himself. However, regardless of the number of employees, if they do not have the desire to work, because of inadequate wages or lack of proper supervision there is no way possible to effectively reduce labor expenditures.

Ten to twelve occasionally fourteen to sixteen men are employed on most eighteen hole courses, during the summer months. The question which must be answered by each superintendent is, "can six or seven year around employees accomplish as much?" Most golf courses keep two to four employees on a permanent basis. Perhaps this is an inadequate number to retain as a nucleus. Part time employees, or those hired for summer work, can take away from sound management practices, largely because adequate and trained personnel are not available. The end result is an unhappy membership and many times a change in management.

Scientific discoveries and achievements during the past decades have aided in reducing labor expenditures on a golf course. The necessity for endless hours of hand labor has been circumvented. This "patient medicine" of turf management continues to revolutionize this great and challenging occupation.

Look what has been gained through years of mechanical and chemical advancement. The day of hand greens mowing is past history, the twentieth century has brought tri-plex green mowers, once they were walked behind, now they are ridden upon. Time required to mow greens has been cut by a factor of three. Application of chemicals, such as fungicides, insecticides, nematocides, etc. is no longer guess work. The obsolete wooden barrel and faulty pump need not be relied upon any longer. New pumps, new engines, new ways of applying chemicals have reduced the original two or three man task to a one man operation. Mobile equipment such as trucksters being used on greens to deliver fertilizer and pesticides is common practice. Many superintendents have "put every employee on wheels". Certainly, this reduces the total number of employees necessary to effectively operate a course and increase their productivity.

Drop fertilizer spreaders should be past history, and with them goes the three man operation. Perhaps, the cyclone fertilizer spreader has saved more man hours than any other innovation. Fertilizer misses, burns and uneven distribution of material no longer is an occupational hazard.

Topdressing greens is no longer a drawn-out and tedious operation. Hand shoveling and pushing topdressing machines on greens is outdated and grossly uneconomical. The new improved method is all power, with even distribution of material to boot. Weeds that once ruled the domain are no longer. But let remember the countless hours of hand labor it took to weed greens and bunkers.

Today, pre and post emergent materials are used without hesitation and with little injury to desirable growth. Hand labor for weeding which once soared the budgets is now eliminated.

Let us not forget the hours that are being saved with automatic watering. The night water man is no longer so important. Wilt, which could not be kept up with on hot dry days, can now be controlled within minutes.

Automation of irrigation is only one example of mechanical labor saving. The use of two-way radios and television is just coming into its own. Labor is reduced here through greatly improved communication.

Education of yourself and your employees will continue to reduce labor expenditures. Short courses for key personnel at local turf schools, automotive shops, or manufactures seminars orient and motivate labor productivity. These aids, are a definite and vital asset to the overall function of the superintendent.

Future

What can we look forward to in the future as a contribution in reducing labor expenditure. As we gaze into the crystal ball countless dreams are before us. Selective chemicals which biologically control growth as desired or systemic pesticides which need be applied only once or twice a year may be just around the corner.

We are already working with grasses which grow to a desired height. But, can't you see the new improved blues, bents, bermudas, and zoysias that resist disease, traffic, insects. How about the new plastic turf currently being tried, which needs Vacuuming only?

Perhaps the crystal ball will show that wheel vehicles are no longer seen after mowers which cut with a sonar principle have finished their work. There is no need to worry about clipping accumulation or dew as air cushion machines take care of these problems as well as offering swift and "rutless" transportation. Helicopters are made practical for fungicide, insecticide, herbicide and fertilizer applications if indeed our new improved plants require them.

These are only a few of the dream mechanisms being visualized. Are they unreal? No. Today's technology won't let them be unreal; the Saturn rocket and Appollo capsule were in the crystal ball only a few years ago.

Reducing labor expenditures and increasing labor productivity without player inconvenience is available to us today. However, after all is said and done, communications is the key to reducing labor expenditures and increasing labor productivity.

A SOIL TEST SURVEY OF GOLF GREENS

J. B. Gartner and J. D. Butler

Soil fertility levels, pH (which contributes to nutrient availability), and soluble salts should be considered in any turf management situation. The watering practices on greens, the growing media (perhaps 80% sand), the grass grown, the high quality desired, etc. contribute to fertility needs. Greens, due to management, and frequent low nutrient fixation from the high percentages of sand, should have a well-planned fertility program which will often include the addition of certain minor elements.

In both greenhouse grown crops and container grown nursery stock where a highly amended soil media is used (equal parts by volume of soil, sand and peat) it has been found essential to fertilize more frequently and add minor elements to the fertility program. With these crops, soil testing has proved to be a great aid in determining the nutrient needs of these plants.

Field crop yields have been widely correlated with certain soil tests. However, the correlation of soil tests to turf quality is limited, and work needs to be done in this area. Of importance here is the fact that turf quality is difficult to measure, and is influenced by several factors besides nutrition.

Soil tests, properly used, can be a great asset in both problem solving and prevention, and can also be used as a basis for making fertility applications. Nitrogen, a mobile element, is most important in turf production. However, it is not usually tested for in the soil, but is applied on a periodic basis in several different forms to supply the needs of the grass.

The following soil test survey is presented in part to: Indicate the general fertility levels on golf greens in the area, and serve as a rough guide on what to expect. Point out specific problems and possible causes.

In the fall of 1965 (early October) and the spring (mid April and early May) and summer (late July and early August) of 1966, Dr. M. J. Healy sampled 26 golf courses in Illinois and Missouri. Two greens were sampled on each course. Five samples 3/4" diameter were taken to a depth of 2 1/2" from the front 1/3 of each green. These samples were combined for the soil test providing 1 test per green at 3 different times.

Reported here are tests from 40 greens from 20 courses (Fig. 1) which have been established from 1 to 40 years or more. Typically the physical structure of the greens is quite variable. The courses in this survey would be considered to have from average to better-than-average maintenance (fertilizer, etc.) programs with better-than-average greens. The courses reported here had greens of bentgrass or bent and *Poa annua*.

The soil testing was done in the University of Illinois Soil Testing Laboratory under the direction of Dr. T. R. Peck. The Illinois testing procedures were used to determine the levels of phosphorus (P_1) and potassium. The Spurway Test was used in determining the levels of calcium and magnesium.

Levels of other elements extractable from the soil could have been determined, but for this survey this was not done, nor is it done in routine field analysis. Field crop tests in Illinois are only for pH, P, and K.

pH--The importance of soil pH for grass production has been widely discussed. The pH of the soil has a direct effect on nutrient availability and may result in deficiencies or toxicities. Most greens are under heavy fertility programs and the cost of fertilizer is unimportant compared to quality; however, on large acreage fairways, this is seldom the situation. Research at the University of Illinois has shown bentgrass and *Poa annua* to grow over quite a wide pH range. Musser (2)-after

Scarseth--reported the soil reaction for good growth of bentgrasses to be from about 5.4 - 7.6 and for Poa annua from 5.1 - 7.7, while Jackson (1)--after Morgan--reported the desired range for bent to be from 5.0 - 6.2. Using these figures as guides (see Fig. 2 and 3) little difficulty would be anticipated from pH, or if so, more on the high than the low side since more nutrients are available at a pH of 6.5 than any other pH. Should the pH be high, an acid-reacting fertilizer could be used to lower the soil acidity. In 1961 Weinard (3) found 26.2% of 290 samples, mostly from home lawns, to be 6.4 or below and 12.4% of the samples to be 7.5 or above. The pH ranges from the home lawns are generally distributed over a wider range than on greens.

The pH on the greens varied little regardless of when the soil was sampled (Fig. 3) and from green to green on the same course (Table 1).

P--An adequate amount of phosphorus available to the plant is especially important, particularly in the initial establishment of turf. At low soil P levels, observations at Dixon Springs have shown a great response of newly established Kentucky bluegrass to rather low P applications.

A problem that could be anticipated from the data presented here is the interference of arsenic on greens with the P test, and the need of controlling P if As is used. Even on greens, P may be fixed near the soil surface, causing the depth of sampling, etc. to be more critical in getting a "good" test. In work at the University of Illinois with container grown ornamentals, it was found that even when fertilizing with liquid phoshporus that it was fixed in the top 1 inch of soil.

Weinard (3) stated "if 100 lbs./A.....is to be taken as a favorable level, then approximately 38% of the samples tested showed a need for additional phosphorus." Using the 100 lb. figure (mostly from Kentucky bluegrass lawns) for bent greens, then only a very small percentage would be expected to show problems from low soil P. In all probability, if P problems are to be encountered on greens, it would be due to low levels. High levels of phosphorus seem to be of little consequence.

The data presented here indicates that most greens would test 150+ lbs., and that the P used in routine fertilizer applications should prove sufficient in most cases. A comparison of tests from 2 greens from 5 courses (Table 1) indicates the greens to be in the same general P range. However, when comparing the time of sampling 3 of 5 greens were relatively close 3 times and 2 were close 2 times (Fig. 3). Variability was much greater than with pH.

K--Recently much emphasis has been given to the importance of potassium in providing toughness and durability of grass on the greens. The movement of K in greens soils, and the relatively high amounts in the grass--usually second to N--should be considered when applying fertilizers and examining K levels in the soil. Some manufactures advocate the use of straight goods potassium chloride or sulfate periodically with their fertilizer.

To again quote from Weinard (3), "assuming that 300 lbs./A of available (exchangeable) soil potassium is desirable, then the need for additional potassium was shown by approximately 42% of the samples tested." If this arbitrary 300 lb. figure is used, approximately the same number of greens as lawns would need additional K. In some instances in more recent times, fertilizers with higher K ratios have been recommended.

In 4 out of 5 greens, the K tests were relatively close at the 3 sampling times and in the other green, 2 out of 3 were close, with a tendency for the fall samplings to be slightly higher than spring or summer (Fig. 4). The comparison of two greens from five courses had only a slight variability from one another (Table 1).

SS--The soluble salt in the soil is often associated with the water quality, amount of rain or irrigation water, and fertilizers applied. The soluble salt in the soil solution has long been associated with problems in greenhouse production. Flooding and leaching of greenhouse soil is the common method of reducing soluble salts. An arbitrary figure of 2000 ppm or above is often used in greenhouse production as a point where trouble could be anticipated. The soluble salts in field soils commonly run only a few hundred (usually 300-700) ppm.

Taken on an average, the SS found on greens would not seem to be in the danger zone (Fig. 2). However, when considered on an individual basis, Fig. 5 shows 1 reading of 2508 ppm during the summer of 1966. This would be considered a possible problem. The SS might be lower in the spring, especially if it has been a rainy season, than at other seasons. Again Table 1 indicates no great difference when SS were averaged together between greens on the same course. The great differences in the SS at different seasons should be considered.

Ca and Mg--Calcium and magnesium are important in crop production. Ca is usually present in sufficient amount or supplied in fertilizer, ground limestone, or through limited use of hydrated lime--$Ca(OH)_2$. Both Ca and Mg may be supplied by adding dolomitic limestone $(Ca\ Mg)CO_3$. Ca and Mg varied quite a lot for the 3 sampling periods, with the amount extracted of each generally being higher in the fall than in spring or summer (Fig. 4, 5). The ratio of Ca to Mg varied widely, with smaller ratios at lower test levels (Table 1).

The samples for Fig. 3, 4, 5 were drawn at random from the 20 courses (1 each from 5 courses) but not necessarily the same course or green for the 6 comparisons. The data in Table 1 were likewise from 5 courses drawn at random.

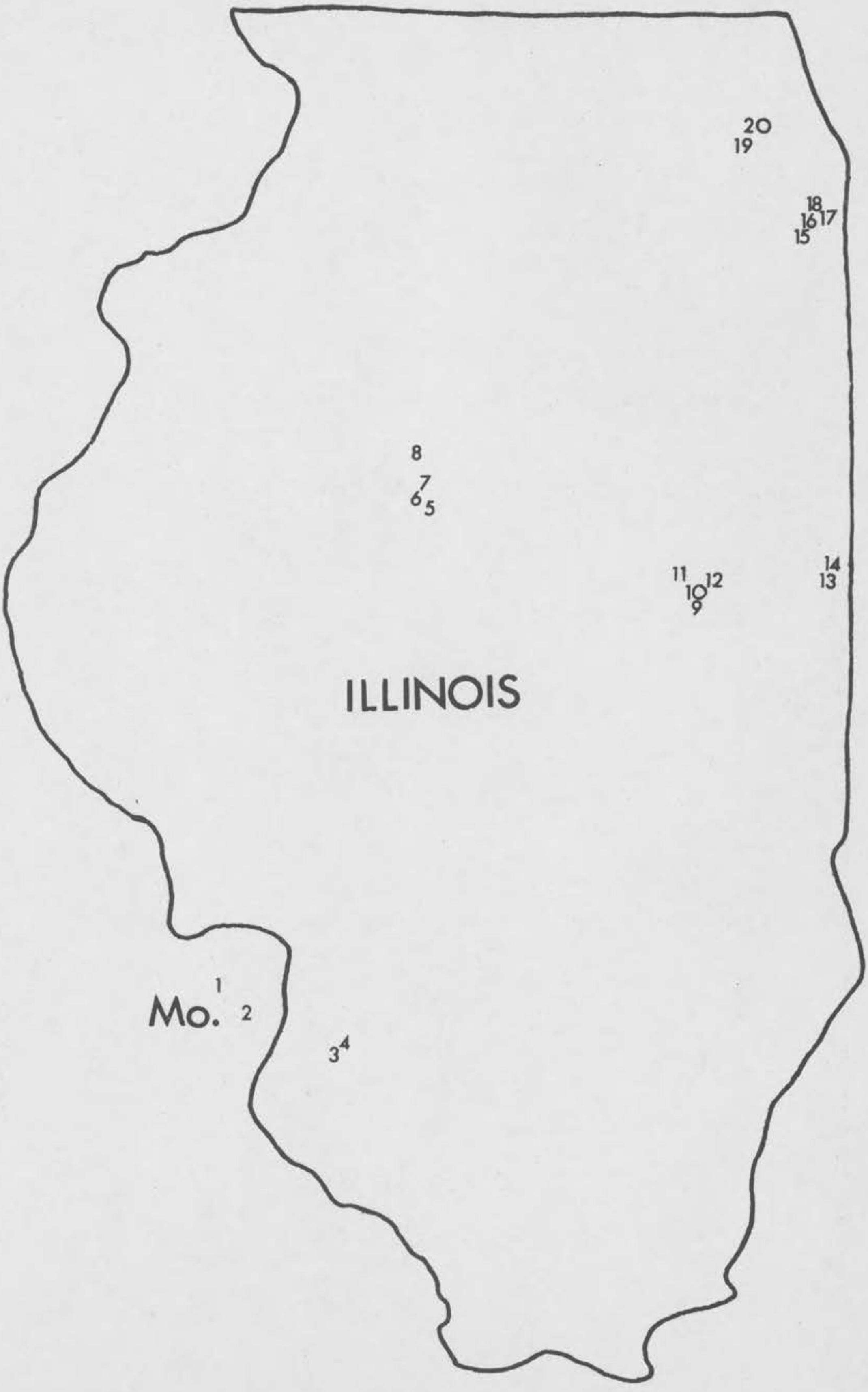
Literature Cited

1. Jackson, M. L. 1958. Soil Chemical Analysis. Prentice-Hall, Inc. 363.

2. Musser, H. B. 1962. Turf Management. McGraw-Hill Book Company. 25.

3. Weinard, F. F. 1961. Soil testing facilities at the University of Illinois. Ill. Turf Conf. Proc. 2:15-16.

Fig. 1. Location of golf courses where samples were taken.



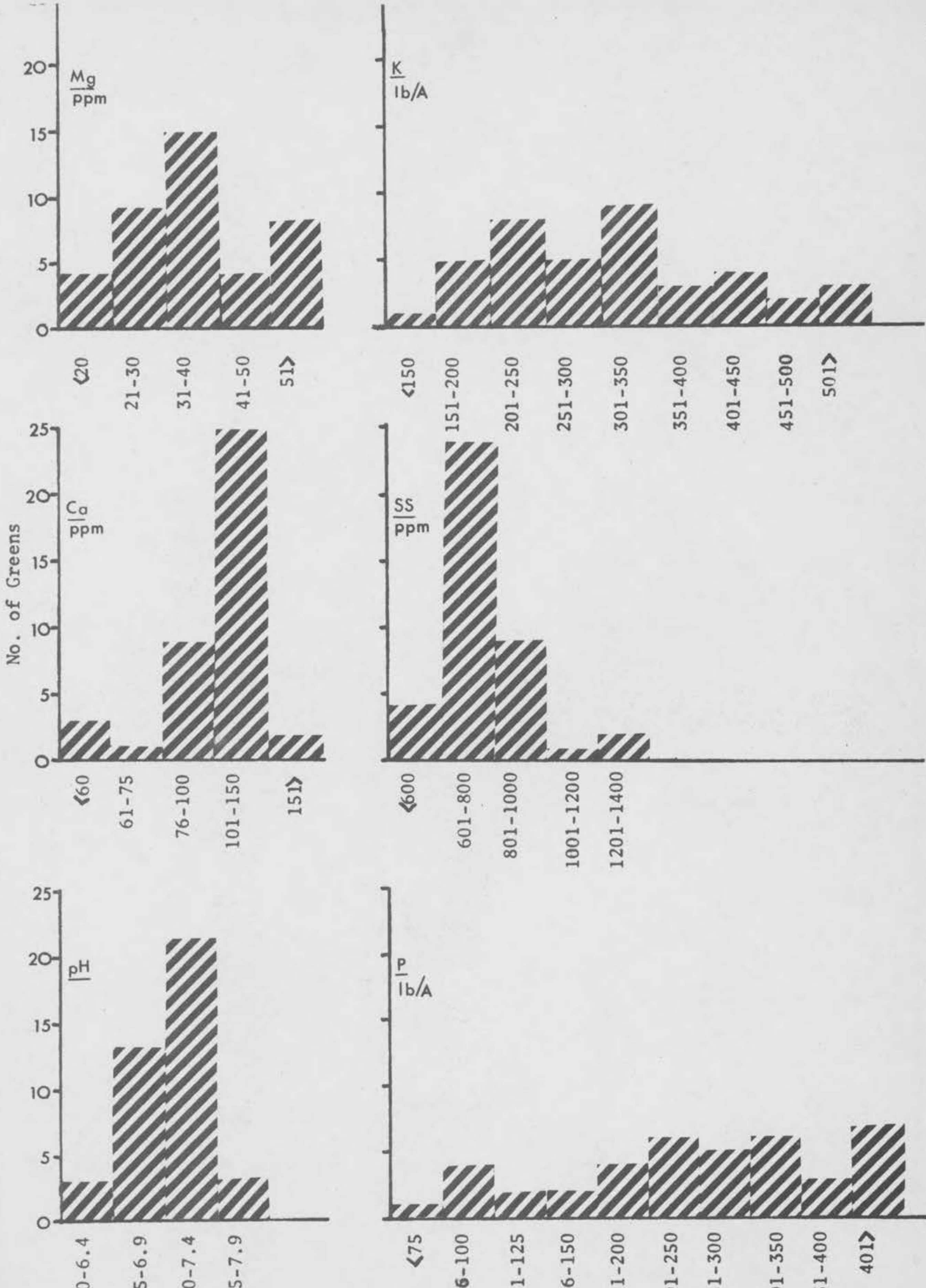


Fig. 2. Soil tests from 2 greens from 20 golf courses where samples from fall, apring and summer are averaged together.

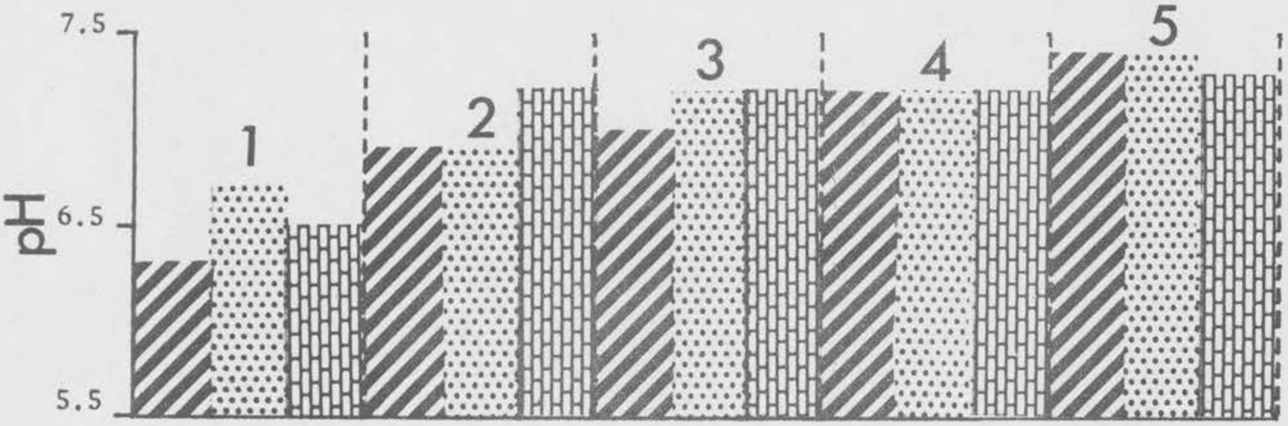
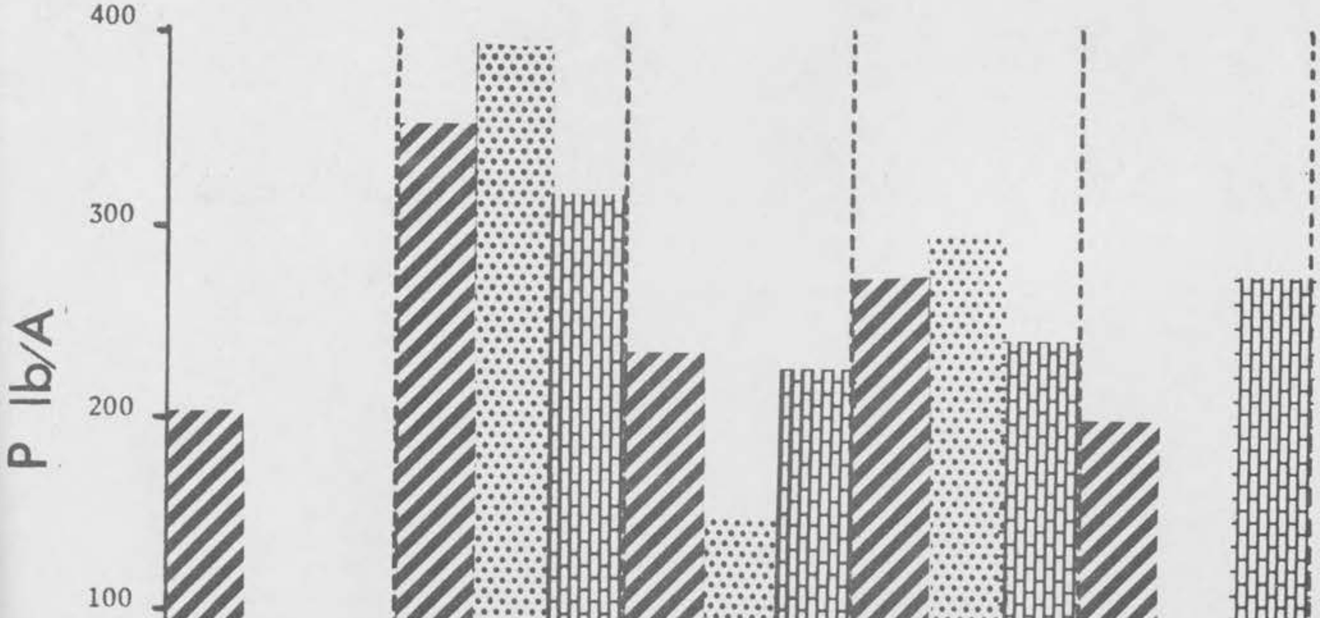


Fig. 3. Variability in soil pH and P as influenced by time of sampling. Samples from green from 5 courses.



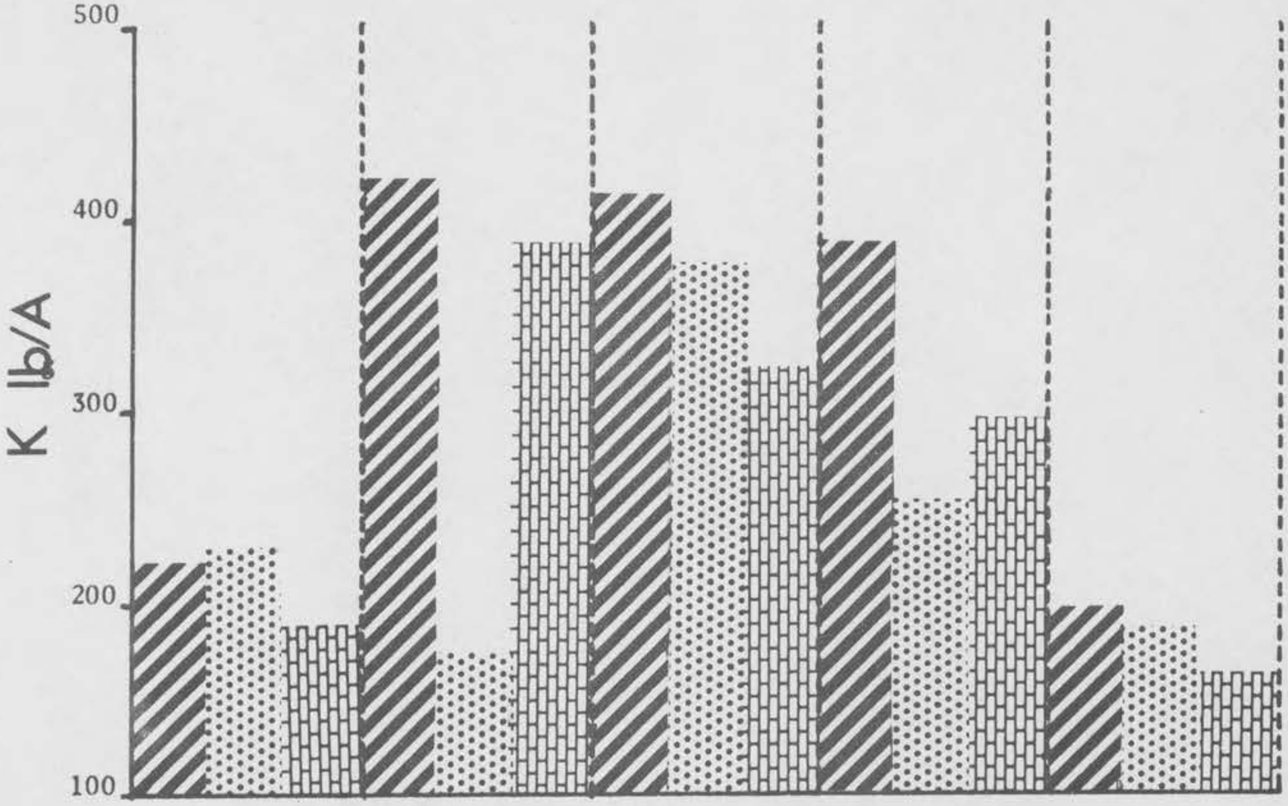
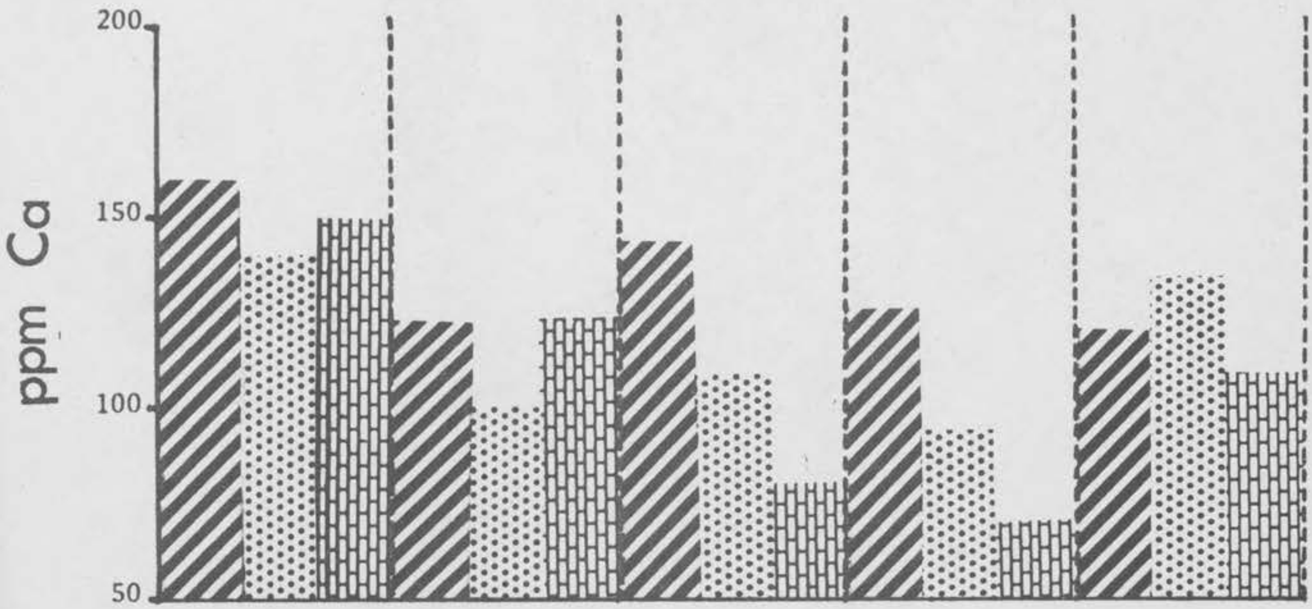


Fig. 4. Variability in soil K and Ca as influenced by time of sampling. Samples from 1 green from 5 courses.



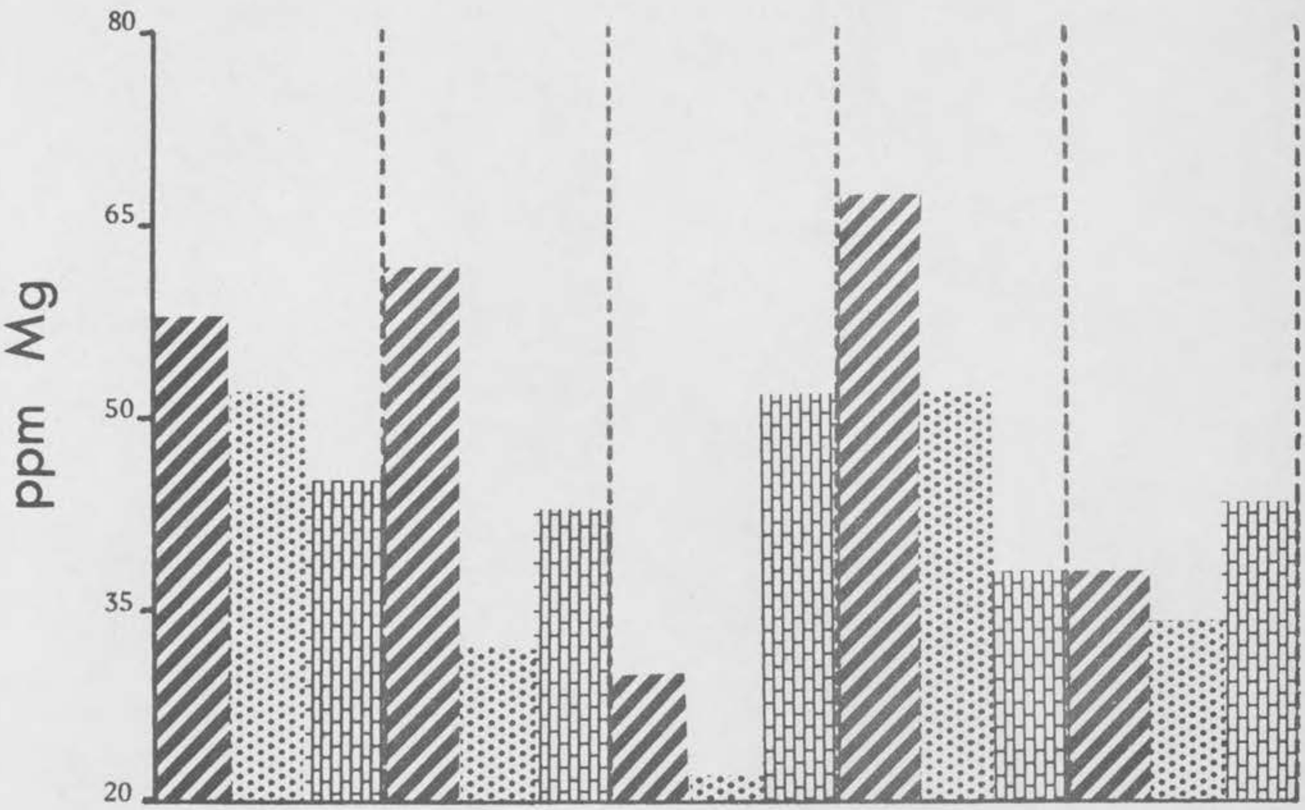


Fig. 5. Variability in soil Mg and SS as influenced by time of sampling. Samples from 1 green from 5 courses.

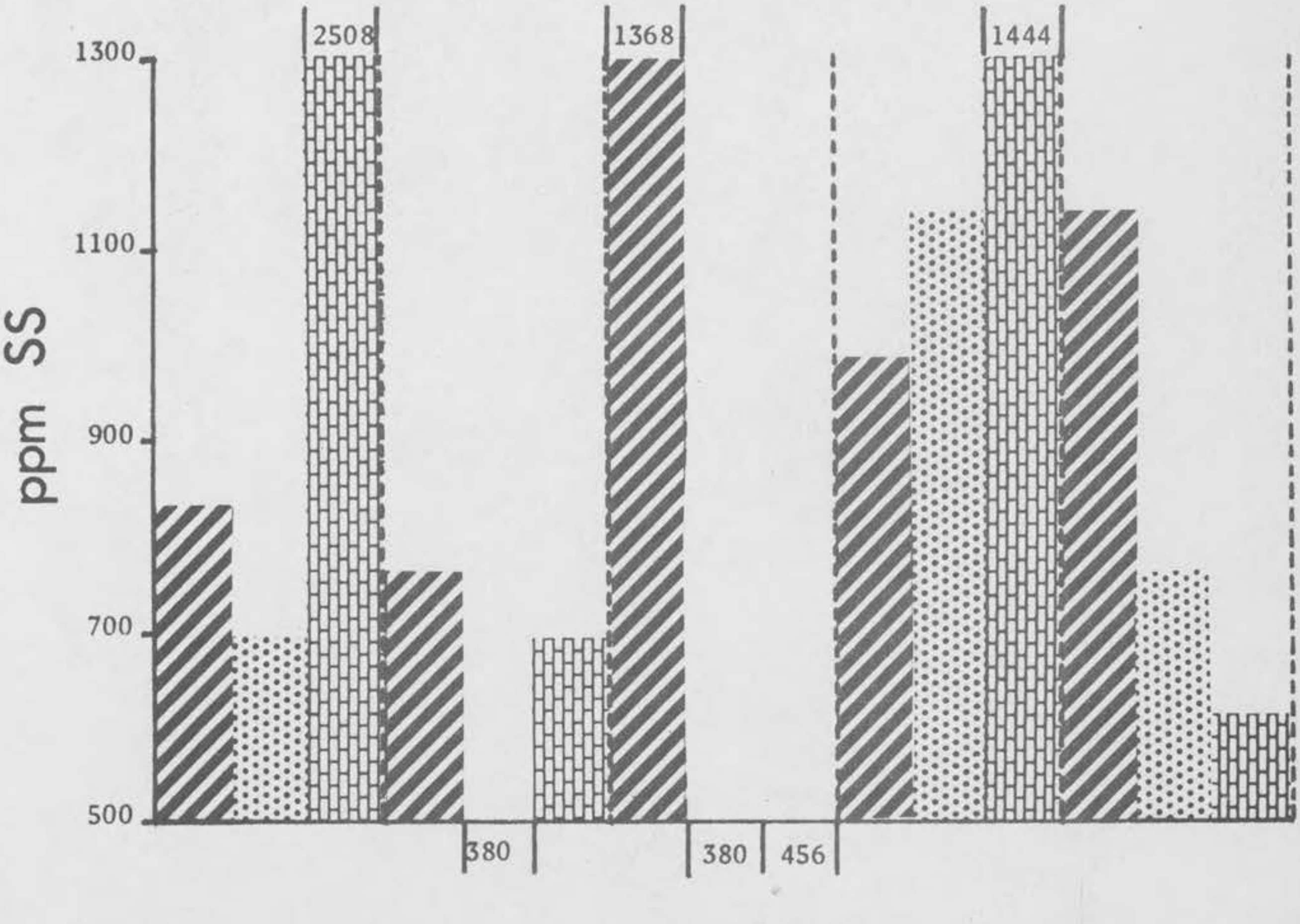


Table 1. Comparison of soil tests from 2 greens from 5 golf courses when samples taken 3 different times are averaged together.

1						2					
pH	P	K	Ca	Mg	SS	pH	P	K	Ca	Mg	SS
6.5	179	316	59	23	760	6.5	205	295	60	20	760
6.7	450	249	169	22	684	6.6	504	305	169	29	937
7.0	302	337	126	28	709	6.8	287	327	121	27	760
6.4	266	442	39	15	633	6.6	207	403	42	18	815
7.0	321	340	136	53	713	7.3	298	305	121	40	583

LANDSCAPE CRITERIA FOR GOLF COURSES

William R. Nelson, Jr.
Extension Landscape Architect

On several occasions I have appeared before this conference discussing landscape planting considerations for the golf course. The frustrating part of such a presentation is the time limitation which certainly does not allow for in-depth solution to problems that you face. Once again it is necessary to use a six inch brush instead of a two inch brush. My purpose is to delineate a broad picture of the objectives and opportunities for design on the golf course, rather than attempting to detail specific design materials or solutions. Hopefully, the examples of design materials and solutions in the slide presentation will help you to better understand the landscape opportunities on the golf course.

I have great sympathy for those superintendents who have the responsibility for golf courses which include nothing more than the skeletal necessities for the game of golf--tees, fairways, traps, and greens. Obviously the developers of these courses have been duped into a false economy by developing on minimum acreages and providing nothing more than what is absolutely necessary for the play of the game. This has been described as the great American tradition of making a fast buck and get out. But I question if this fast buck is for the making on the type of course described. This is particularly true if our level of affluence continues. Presently we are experiencing a unique social phenomena--a quality revolution. And there are two major manifestations of this quality revolution. First the demand for better and more complete recreational facilities, and second, the selection of facilities where the activities will be conducted is undergoing alternation and refinement on the part of the general population. The research points out that with an increase in levels of education and purchasing power there is an increase in the search for aesthetic, social, and cultural satisfactions on a higher plane than ever before experienced. People have become highly selective and they demand quality in their recreational environment.

This points up the importance of initiating plans for a well-designed, complete golf course. This is as vital to the success of a course, physically and economically, as is the quality of fertility and chemical programs for a course. But to expect a golf superintendent to be capable of doing this job of design is unfair and unrealistic. In this age of great specialization it is difficult to keep up in our specialized areas, let alone try to be competent in another speciality. Therefore my objective is to provide you with clues and insight into the basic design opportunities on a golf course. This will also help to establish a basis for communications between the golf superintendent and the landscape architect or golf course architect. This is the person who should be responsible for developing the landscape design for your golf course.

In essence what we are talking about is the golf course environment. This is the aggregate of all physical conditions and influences which affect the human being psychologically and socially. Time does not permit me to support this statement with a citation of research and studies supporting this fact, but let me give you just this one example to illustrate its importance (Saint Peters Square).

Your course is no different from Saint Peters Square except that the emotions evoked by moving from your golf club house to the course, and through the fairways are somewhat different, but just as forceful whether good or bad. As a starting point, let me just itemize a few of the design opportunities that exist on nearly every course. These design opportunities serve to meet basic functional needs of playing the game, and at the same time fulfilling the basic human needs for scale relationship, enclosure, and privacy. For example at the clubhouse, landscape design must be included to:

1) Soften harsh architectural lines and supplement architectural patterns inherent in the design.
2) Integrate architecture to the landscape and bring out the most pleasing elements in both.
3) Aid in the efficient movement of people in desired directions in this public area and on the golf course itself.
4) To humanize and give visual relief to dreary roads, entrances, and vast parking areas.
5) Provide opportunities for socialization and relaxation.

I would like to stop here and briefly elaborate on these five landscape opportunities. The site of the club house is related to the layout of the course, and is an item of top priority to the landscape architect in designing the course. It must be recognized that the clubhouse sets the standard against which the public and the golfer judges the character and quality of the course. The cost or size of the building has nothing to do with this specific goal. The hallmark of the clubhouse should be its treatment as a transition from pressures and tensions of everyday life. It should signal a change from the visual pollution of surrounding streets, urban centers, and neighborhood developments to order and beauty. In this situation we are trying to compliment the building, make it look appropriate for the site in which it has been planned, and at the same time direct the movement of people according to our pre-designed circulation patterns. The importance of the details of design and planning for parking areas and entry ways can not be over emphasized. Screening of parking areas and the placement of trees throughout the parking spaces helps to reduce the ugliness and makes the space aesthetically pleasing and inviting. May I also ask that you pay close attention to the fifth item. This is an area of the environment that we have generally ignored around the golf course. The first factor for consideration here is relaxation. Relaxation of an active and passive nature is common in today's golf game. It is active relaxation in a recreational sense of driving a ball and sinking a putt, but it is passive recreation when we sit on the terrace and enjoy the play of a foursome coming in on the eighteenth green. The use of plant material to aid in this relaxation is an important facet in the design of the golf course and adjacent clubhouse areas. Still another factor involved is socializing. How extensive this is is evident in locker room talk, lingering around the pro shop, and replay of various fairways and greens on the terrace, or at the tee. There are always a number of individuals standing around or sitting on the benches (if they are fortunate enough to have them available), waiting for friends or golf partners, or the opportunity to tee off. It is in these situations where we have a tremendous opportunity for landscape design. Here we can create well-designed benches, organized in such a pattern that will stimulate socialization, conversation, relaxation, and further accomplish our ultimate goals of designing for people and meeting their basic human needs of the suggestion of enclosure, scale, and to a certain degree, privacy. In this situation we will utilize structural materials as well as plant materials to enhance the intimacy and association that is important for this type of human activity.

As you move away from the clubhouse and onto the course itself, it becomes immediately apparent that plant materials are the bulk of the landscape materials used to create the golfing environment. Once again let me list some of the functions that plant materials can serve on the golf course as a part of our landscape design opportunities. These are:

1) To enclose and thereby reduce the scale or visual expanse of a scene creating a more intimate or interesting atmosphere.
2) To introduce variety and interest to the man made landscape.
3) To relieve monotony in the landscape.
4) To give the landscape depth, vistas, or create illusions of open space in small areas.
5) To shelter and protect areas from winds and general climatic influences or possibly wild shots by golfers.
6) To accentuate the topography, or to mask the lack of interesting topography.

In considering the use of plant material, you should evaluate:

1) The function a plant is to serve and determine if it is suitable for this purpose.
2) If it is relative to the design form (for example masses, screen, or softening architectural lines), or is it merely an ornamental amenity.
3) Is plant adapted to soil, exposure, and climate.
4) Will this specific plant material successfully integrate into what is already in existence.

I have already commented about the importance of the clubhouse as a transitional feature between the community and the golf course. The planting design on the course must be created with this idea in mind, too. The goal is to establish a good scale relationship with the most important element of our design--the human being. The balance of the presentation considers in general terms the procedures, philosophy and techniques involved in developing the planting design for the golf course.

In the preliminary phase of golf course design all existing plant material on the site should be analyzed as to its potential value. This evaluation is helpful when the designs are being developed. Integrating this existing material can reduce costs significantly. If skillfully done, it helps to keep the naturalistic appearance we would like to have, as opposed to a more contrived, man-made type of planting. Integration of existing material with newly planted material might be included in designs for green enframement, in background plantings, tree plantings to indicate fairway direction, and protective plantings around trees, greens, and between fairways.

Integration may be achieved through clump plantings. A clump planting is a group of closely spaced trees. To accomplish a clump planting increase the number and density of the individual planting units without any obvious internal arrangement. By applying this planting technique, the character of the golf course is given a more natural appearance. The objective is a series of spaces (fairways) with varying degrees of enclosure created by masses of existing and new tree plantings.

Protective planting is essential to the safety and well-being of the golfers. It is of importance between tees, fairways, and greens. Protective plantings might also be appropriate around shelters and the clubhouse, depending upon their proximity to the pattern of play on the course.

Adjacent fairways are certain to receive a number of shots from the tees and fairways of other holes. For this reason trees are planted in the rough area between fairways to reduce some of the overlap of shots. If this space is limited, more fastigiate (upright) type of trees will be used.

Fairways and greens when adjacent to roads should have protective plantings between the road and the golf course. This protective planting should also serve as a transition from adjacent properties. This planting would incorporate trees with dense crowns, and may include shrubs as an underplanting in order to develop a complete foliage wall. Such a foliage wall prevents the intrusion of noises and conflicting activities bordering the course, and also protects these activities from overshots by the golfer.

When greens are adjacent to tees, there is need to protect the player in both areas from overshots of the other. Protective planting should be designed for the maximum amount of safety from overshots. If there is a chance of wild shots into pedestrian or vehicular areas near the clubhouse, there should be an adequate protective planting designed for these areas.

Lines of direction must also be planned as a part of the planting scheme. Lines of direction help to orient and improve movement of the players. They establish the direction of the goal, and the path that one must take. The flat site has no natural focal point, and lines of direction are not present as they are where topography is uneven. In such cases lines of direction are created by proper placement of plant material. The forms of the plant material used is very important. They may add to or detract from the directional pull. It is recommended that stepping down from the tallest tree to intermediate, and finally low trees would be the best technique.

Fairway plantings may be placed in the fairway, and in the adjacent rough areas. As a player moves down the fairway, the planting silhouette is continually changing. This makes the problem of good, continuous composition very complex. It is at this point where the thorough understanding of the principles of art must be understood and applied. For example a fairway composition may include a tree, or clump of trees used as ball or distant markers. These trees are points of emphasis but they should not conflict or compete with the focal point of the design, which is the green. To avoid this, there should be a good transition in scale and character between the marker trees and adjoining trees in the rough. Trees used for this purpose are usually accent plants. This means they are distinctive in either form, habit, or color. Don't forget trees are effective as deterents in short cuts to the green. For example a planting to force the play around the dog leg rather than allowing a cross shot. Planting arrangements can serve dual functions. They can be used to force the play of certain shots in desired directions and at the same time serve as a protective device.

Another design consideration is the transition between the fairway and the green. The green should be composed and inframed with compositional lines of direction leading to the cup area. These lines are formed by the planting which will also function as a protective planting. The green should be compositionally balanced in a unified design. The cup area is considered the focal point, and since the cup is often moved, the composition should be flexible enough to include a majority of the green area.

Finally, a few comments about shrubs must be included. Shrubs and high grass, like water, are annoying. The loss of balls and the impossibility of recovering shots is an aggrevation to say the least. This slows down play considerably. Shrub material used as a hazard should be avoided. Shrubs can be used in extreme cases where monotony might occur, or as I pointed out, where the planting is adjacent to a roadway. Shrubs do have their place around the tee area, particularly where seating areas have been designed. These shrubs might be from three to four feet in height, and would be placed to provide the suggestion of enclosure around the bench seating area as we have illustrated in slides. In areas of this type where we stop and linger for a longer period of time, smaller interesting plants can be introduced because we have time to view them for the details of foliage or twig character, form or texture.

The successful planting of trees and shrubs on a golf course depends on the ability of the designer to be able to analyze the physical layout of the course as it is designed to play. These patterns of play must be complimented not destroyed, or confused by planting design patterns.

Finally keep in mind you are designing for people. It is the impact of the golf course environment combined with the challenge of the play that will be judged. It is not a do-it-yourself job, but it is an important job to do.

A FUNGICIDE INVENTORY FOR THE TURF MANAGER

Malcolm C. Shurtleff

The fungicides you should stock depends on several factors. These include the type of turfgrass or grasses being grown, disease problems expected, acreage to be sprayed, and the cost of the chemicals. You can probably list other factors including your local distributor or dealer and what chemical companies he works with, past experience with turf fungicides, and whether nearby flowers, trees, and shrubs need to be treated for foliar diseases.

Turf disease problems vary greatly depending on the grass or grasses being grown (see Table 1 below) and how the turf is managed. In general, the more lushly grass is grown--high nitrogen level and frequent watering--and the lower the height of cut, the more prone to disease it becomes.

Table 2 lists the more common and serious diseases of grasses grown in Illinois and surrounding states and the better fungicides known to be effective in controlling them. A number of the newer products have not been thoroughly evaluated for several diseases listed in Tables 1 and 2.

Table 1. Major Turfgrass Diseases in the Midwest Controlled by Fungicides

	Lawn-type grasses (Bluegrasses, Fescues)	Fine turf grasses (Bentgrasses, Redtop)
1.	Helminthosporium Leaf Spots and Melting-out	Helminthosporium Leaf Spots and Melting-out
2.	Sclerotinia Dollar Spot	Sclerotinia Dollar Spot
3.		Brown Patch
4.	Snow Molds	Snow Molds
5.	Powdery Mildew	
6.	Rusts	
7.	Fusarium Blight	
8.		Pythium Disease
9.	Seed Decay and Seedling Blights	
10.	Leaf Smuts	Leaf Smuts

Table 2. Common or Serious Diseases of Turfgrasses and the Better Fungicides for Their Control

Fungicide	Helminthosporium Leaf Spots and Melting-out	Sclerotinia Dollar Spot	Brown Patch	Snow Molds	Powdery Mildew	Rusts	Fusarium Blight	Pythium Disease	Seed Decay, Seedling Blights	Leaf Smuts
	Disease									
Acti-dione-Thiram	Yes	Yes	Yes			Yes				
Benlate (DuPont 1991)		Yes	Yes	?	Yes	?				Yes 1/
Cadmium compounds 2/		Yes								
Daconil (DAC 2787) = Diamond	Yes	Yes	Yes	Yes	?	Yes		Yes	Yes	
Dexon								Yes	Yes	
Difolatan	Yes		Yes						Yes	
Dinocap (Karathane, Mildex)					Yes					
Dyrene	Yes	Yes	Yes	Yes		Yes			Yes	
Fore, Dithane M-45, Sears Lawn Fungicide	Yes		Yes			Yes	Yes			
Kromad (+ mercury), Kroma-clor, Ultra-clor		Yes	Yes	Yes		Yes			Yes	
Maneb 3/	Yes					Yes	Yes			
Mercuries, Phenyl 4/		Yes	Yes	Yes					Yes	
Mercuries, Inorganic 5/		Yes	Yes	Yes					Yes	
Ortho Lawn & Turf Fungicide	Yes	Yes	Yes	Yes		Yes				
Parnon (El-241)					Yes					
Thiram 6/		Yes	Yes						Yes	
Thiram-Mercury mixtures 7/	Yes	Yes	Yes	Yes		Yes	Yes	Yes	Yes	

1/ Benlate in preliminary trials in Illinois and elsewhere looks very promising for the control of Leaf Smuts.

2/ Cadmium compounds - Cadminate, Caddy, Vi-cad, Cad-trete (also contains 75% thiram), Puraturf 177

3/ Maneb - Manzate and Manzate D Maneb Fungicide, Dithane M-22, Ortho Maneb 80 Fungicide, Niagara Maneb 80 Wettable Powder, Chem Neb Maneb 80% Wettable Powder

4/ Mercuries, Phenyl - PMA, PMAS, Panogen Turf Fungicide, Phenmad, Semesan Turf Fungicide, Liquephene Turf Fungicide, Puraturf 10, Memmi, Chipman Merbam Turf Fungicide and Chipman Mercury Turf Fungicide

5/ Mercuries, Inorganic - Calocure, Calo-clor, Calo-Gran, Fungchex, Woodridge Mixture 21

6/ Thiram - Spotrete, Tersan 75 Thiram Fungicide, Thiramad, Thiuram-75, Roberts Thiram 75, Chemform 75% Thiram WP

7/ Thiram-Mercury mixtures - Tersan-OM, Thimer, Mercuram, Thiuram M

A. Lawn-type Grasses

If you are maintaining lawn-type grasses such as lawns, athletic fields, parks, cemeteries, sod farms, fairways and tees, you may wish to stock one or more broad-spectrum turf fungicides such as Acti-dione-Thiram, Daconil, Dyrene, Kroma-clor, Ultra-clor, Ortho Lawn and Turf Fungicide or a thiram-mercury mixture. All of these control Helminthosporium diseases and Sclerotinia dollar spot as well as other less important grass diseases.

If Powdery mildew is a problem on susceptible bluegrasses in the shade you may wish to add dinocap or Parnon to the above listing.

If Rusts are serious in dry weather, maneb and Fore (Dithane M-45) do an excellent job as do several broad-spectrum fungicides (see Table 2).

Snow molds damage turf in shady areas and where snow is slow to melt. Inorganic mercuries probably still do the best job where disease attacks are severe.

Fusarium blight is apparently become more severe in the Midwest each year on bluegrass and fescue turf in sunny drouthy areas. We have no experience with its control in Illinois, but Fore, maneb and thiram-mercury mixes (Tersan-OM) have been reported elsewhere to give control where thatch has been removed, nitrogen is applied, and turf is watered during dry periods.

Seed decay and Seedling blights are only a problem with low-germinating seed, an overly wet seedbed, and unseasonable temperatures. Most turf fungicides (Table 2) will do a good job, alone or mixed with Dexon, when applied right after seeding and a week to 10 days later.

If you stock only one broad-spectrum turf fungicide, choose between Daconil, Dyrene, Kroma-clor or Ultra-clor, Ortho Lawn and Turf Fungicide, and a thiram-mercury mixture. Then supplement the broad-spectrum product with one or more disease-specific chemicals when other disease problems are expected.

Leaf smuts (largely Striped smut and Flag smut) are now of major concern throughout the Midwest. In preliminary trials during 1967 and 1968, the only fungicide to provide lasting control has been the new systemic--Benlate (DuPont 1991). Additional research must be done in Illinois, however, before a recommendation can be given.

B. Bentgrasses

If you are growing bents on golf greens, low-cut tees, fairways, or lawn areas you can choose a broad-spectrum fungicide to control Helminthosporium diseases, Sclerotinia dollar spot and Brown patch (e.g., Acti-dione-Thiram, Daconil, Dyrene, Kromad-clor or Ultra-clor, Ortho Lawn and Turf Fungicide, or a thiram-mercury mixture). Daconil and Dyrene have been outstanding against these diseases on our University bentgrass plots.

In hot humid weather, when Pythium is active, Dexon is probably your best bet--but free water must first be absorbed or removed (such as by adding dry topdressing). To be effective, Dexon must be applied at night. Dexon is often mixed with Daconil, Dyrene or Fore to give more broad-spectrum disease control in hot humid weather. Other fungicides reported effective against Pythium disease in other states include Daconil, thiram-mercury mixes (Tersan-OM), chloroneb (Demosan or DuPont 1823), and Terrazole.

For Snow mold and Leaf smut control, the same comments hold as for lawn-type grasses above.

Where Sclerotinia dollar spot is a serious problem on a susceptible creeping bent, cadmium compounds give the longest and best protection. But be on the lookout for cadmium-resistant strains of the dollar spot fungus. It is also suggested that maneb or Fore not be added with cadmium in the same spray tank since these products stimulate dollar spot when used at normal rates (2 to 6 ounces per 1000 square feet), probably due to killing or suppressing of fungi antagonistic to the dollar spot fungus.

C. Trees, Shrubs and Flowers

Where you are also responsible for the care of ornamentals, the following fungicides are suggested:

1. Fungus leaf spots and blights, Anthracnoses, Downy Mildews, Leaf and Fruit scabs - captan, Daconil, difolatan, Fore, maneb, thiram
2. Blossom spots and blights, Botrytis blights, Gray-mold - captan, Daconil, difolatan, Fore, maneb, thiram
3. Seed decay, Damping-off, Seedling blights, Cutting rots - Same as for turf.

4. Powdery mildews - Acti-dione PM, Daconil, dinocap, Parnon

5. Rusts - Daconil, Fore, maneb, thiram

In practically all cases, the same formulation of the fungicide you use on turf can be applied to ornamentals. But check label directions and precautions to be sure.

Again you may wish to stock a multi-purpose fungicide (e.g., captan, Daconil, difolatan, Fore, maneb, thiram) and supplement it with another fungicide where Powdery mildews or Rusts are special problems.

HOW PREEMERGENCE HERBICIDES CONTROL WEEDS

James A. Tweedy

Discussions about preemergence herbicides may be confusing unless the meaning is fully understood. A preemergence treatment is any treatment made prior to emergence of a specified crop or weed. I emphasize crop or weed because the treatment can be applied preemergence to both the crop and weeds, or to just the weeds. Therefore, a statement as to "preemergence to the crop," "preemergence to the weeds" or "preemergence to both crop and weeds" will clearly establish the timing of the treatment. For example, let us consider the two herbicides Tupersan and Dacthal as preemergence herbicides for control of crabgrass. Tupersan can be applied at seeding or in established Kentucky bluegrass sod. However, Dacthal should not be applied preemergence to Kentucky bluegrass.

Preemergence herbicides are applied to the soil. Any chemical applied to the soil for action on plants is confronted with two factors of great magnitude. First, the soil weighs on an average, approximately 3.5 million pounds per acre foot. If one were to mix 3.5 pounds of a herbicide into the top foot of soil, the concentration present would be 1 P.P.M. (part per million). This would be the equivalent concentration of mixing one "shot glass" of whiskey to 7,812.5 gallons of water. There are few chemicals that affect plants at this rate.

A second factor is the great "fixing" power of the soil for certain chemicals. For example, arsenic is a good herbicide but it is fixed so strongly by soil colloids that rates of several hundred pounds per acre are necessary to attain a toxic concentration in the soil solution.

The water holding capacity of soil varies according to soil type and may require variation in rate of preemergence herbicide application. The water holding capacity of most agricultural soils will vary from 300,000 to 1.5 million pounds per acre foot. A preemergence herbicide could possibly attain a concentration five times as high in the first as compared to the second soil.

Clay soils hold more water than sandy soils and the dilution effect is one of the reasons why higher rates of preemergence herbicides are required on heavy clay soils than on light sandy soils.

After considering these soil properties it is interesting to note that several chemicals applied to the soil at extremely low concentrations will effectively control weeds when applied prior to or during seed germination. There are a number of other factors which influence the effectiveness of preemergence herbicides in the soil in addition to soil type. Factors such as herbicide formulation, species susceptibility, rainfall and others tend to complicate the procedure and if the herbicides are not used correctly the method is subject to failure. Rainfall is often a problem because it cannot be accurately predicted or controlled. If there is no rain following treatment, the chemical will not be leached into the zone of germinating weed seed and with slight rain it may be dissolved in a very shallow layer of soil to a concentration that may be toxic to the crop. These are some of the reasons why a light irrigation following preemergence herbicide application is recommended for maximum herbicidal effectiveness. With excessive rainfall or flooding the chemical may be leached past the zone where weed seeds are germinating.

The action of preemergence herbicides on plants is often not understood. One of the erroneous assumptions is that a preemergence herbicide kills weed seeds. This is not true. This class of herbicides will not control weeds until the germination process has started. These herbicides may vary in their mechanism of killing plants. Some may injure growing root tips while others may interfere with various growth processes in the shoot. Among the many preemergence herbicides there are undoubtedly many mechanisms of toxic action. However, all of the compounds applied to the soil are subject to the common factors of dilution and fixation. All must be washed into the soil layer in which the weed seed germinates and persist long enough to kill one set of seedlings.

An understanding of what is meant by a "selective" preemergence herbicide is also important. Selective means that it controls some plant species but not others. This doesn't necessarily mean that a chemical will kill all the weeds and not injure the desirable crop plants. It is essential that the user know the weeds that are to be controlled. There may be several chemicals that will not injure the desirable crop species but some may be effective primarily on broadleaf weeds while others are mostly effective on weedy grasses. There is also the possibility that there is no chemical that will selectively control a particular weed. For instance, at present there are no reported preemergence herbicides that will selectively control tall fescue in Kentucky bluegrass sod. The weeds that a particular chemical will control will be printed on the container label.

For the individual in turf who is just starting or expanding his operation into crop lands, these soil-applied chemicals should be limited in use to prevent accumulation of persistent toxic residues. For instance, if you plan to seed Kentucky bluegrass in land that has been used for corn, check the history of herbicide application. Atrazine is a good preemergence herbicide for corn because it persists for a fairly long period and does an effective job of controlling many weeds without injuring corn. It may persist in the soil long enough to injure bluegrass seeded one year after application. There are many preemergence herbicides used in row crops which may cause injury to turfgrasses if the land is used for turf production purposes the year following herbicide treatment.

In summary, my objective has been to cover some of the principles of how preemergence herbicides work. A better understanding of the principles of how preemergence herbicides kill plants, the effects of rainfall and soil type, and the weeds that a chemical will kill should enable a user to plan a more effective weed control program.