UNIVERSITY OF ILLINOIS
DIVISION OF UNIVERSITY EXTENSION

1961

ILLINOIS TURFGRASS CONFERENCE PROCEEDINGS

COLLEGE OF LAW
Auditorium

arranged and conducted by the

COLLEGE OF AGRICULTURE

with the cooperation of the

ILLINOIS TURFGRASS FOUNDATION

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SECOND ILLINOIS TURFGRASS CONFERENCE

December 4 and 5, 1961
Auditorium, Law Building
Urbana, Illinois

PROGRAM

MONDAY, DECEMBER 4 - FIRST SESSION

9:00 - 12:00 noon — Registration

10:30 - 11:30 A.M. — Illinois Turfgrass Foundation Business Meeting

Mr. B. O. Warren, President

11:30 - 1:15 P.M. — Lunch

MONDAY, DECEMBER 4 - SECOND SESSION

Moderator - Mr. B. O. Warren, Palos Park, Illinois

1:15 - 1:25 P.M. — Welcome - Dr. T. S. Hamilton

1:25 - 2:00 P.M. — Understanding Soils

Dr. C. Y. Arnold
University of Illinois

2:00 - 2:30 P.M. — Turfgrass Disease Identification

Dr. M. C. Shurtleff
University of Illinois

2:30 - 3:00 P.M. — Soil Sterilization and Fertility Studies

Mr. H. R. Kemmerer
University of Illinois

3:00 - 3:20 P.M. — Coffee Break

Moderator - Mr. John Jensen, Chicago, Illinois

3:20 - 3:50 P.M. — Identification and Control of Turfgrass Insects

Dr. H. B. Petty
University of Illinois

3:50 - 4:30 P.M.	Golf Course Problems Mr. J. L. Holmes Midwest Agronomist U. S. Golf Association
6:30 P.M.	Banquet

Toastmaster - R. M. Williams, Supt. Bob-O-Link Golf Club

TUESDAY, DECEMBER 5 - THIRD SESSION

Moderator - Mr. James Brandt, Danville, Illinois

8:30 - 8:50 A.M.	1961 Turf Disease Research Dr. M. P. Britton University of Illinois
8:50 - 9:20 A.M.	Turfgrass Management Dr. R. R. Davis Ohio State University
9:20 - 9:40 A.M.	What is Ureaformaldehyde and How Does it Work? Dr. S. R. Aldrich University of Illinois
9:40 - 10:00 A.M.	Rate of Seeding Studies Mr. J. D. Butler University of Illinois
10:00 - 10:20 A.M.	Coffee Break

TUESDAY, DECEMBER 5 - FOURTH SESSION

Moderator - Mr. Paul E. Burdett, Lombard, Illinois

10:20 - 10:40 A.M.	Turfgrass Weed Control Dr. F. W. Slife University of Illinois
10:40 - 11:00 A.M.	Arsenic Residues in Soils Dr. S. W. Melsted University of Illinois
11:00 - 11:15 A.M.	Soil Testing Facilities at the University of Illinois Dr. F. F. Weinard University of Illinois

11:15 - 11:45 A.M.	<u>Turf Management vs. Renovation</u> Mr. Tom Mascaro West Point Products Corp. West Point, Pennsylvania
11:45 A.M.	Adjourn

LIST OF SPEAKERS

Mr. B. O. Warren
Warren's Turf Nursery
Palos Park, Illinois

Dr. T. S. Hamilton
Associate Director,
Agriculture Experiment Station
University of Illinois

Dr. C. Y. Arnold
Professor of Vegetable Crops
Horticulture Department
University of Illinois

Dr. M. C. Shurtleff
Associate Professor of
Plant Pathology
University of Illinois

Mr. H. R. Kemmerer
Assistant Professor of Horticulture
University of Illinois

Mr. John Jensen
Jensen Floral & Landscaping Service
Chicago, Illinois

Dr. H. B. Petty
Professor of Agricultural Entomology
University of Illinois

Mr. J. L. Holmes
Midwest Agronomist
U. S. Golf Association
Room 241
LaSalle Hotel
Chicago, Illinois

Mr. R. M. Williams
Superintendent,
Bob-O-Link Golf Club
Highland Park, Illinois

Mr. James Brandt
Superintendent,
Danville Country Club
Danville, Illinois

Dr. M. P. Britton
Assistant Professor of Plant
Pathology
University of Illinois

Dr. R. R. Davis
Professor of Agronomy
Ohio Agricultural Experiment Station
Ohio State University
Wooster, Ohio

Dr. S. R. Aldrich
Professor of Soil Fertility
Extension
Agronomy Department
University of Illinois

Mr. J. D. Butler
Assistant in Horticulture
University of Illinois

Dr. F. W. Slife
Professor of Crop Production
University of Illinois

Dr. S. W. Melsted
Professor of Soil Chemistry
Agronomy Department
University of Illinois

Dr. F. F. Weinard
Professor of Floriculture
Horticulture Department
University of Illinois

Mr. Tom Mascaro
West Point Products Corporation
West Point, Pennsylvania

Helen Carol Hechler
Research Assistant in Plant Pathology
University of Illinois

Mr. R. C. Wicklund
Division of University Extension
University of Illinois

UNDERSTANDING SOILS
(Aggregation)

Charles Y. Arnold

Respiration is going on in every living cell. It is essential in plant cells because it supplies the energy which is used in the building of new cells, the absorption of food, and other necessary reactions. No cell can live without it; and whether the cell is in a grass plant or a human being, the process is basically the same. The chemist would describe it like this:

Food + Oxygen ⟶ Carbon Dioxide + Water + Energy

Supplying oxygen to all cells is quite a problem. In a human being the oxygen is inhaled and diffuses through the walls of the lung into the blood stream. It is then pumped to all the cells in the body. Plants do not have such an elaborate circulating system and the oxygen that is easily absorbed by the leaves cannot be circulated to the roots fast enough to keep respiration going at a normal rate. The roots must therefore absorb oxygen directly from the soil. Hence keeping an adequate supply of oxygen in the soil is a most important objective.

What determines the oxygen supply in the soil? Obviously it must come from the spaces between the soil particles. Let us assume for a moment that the soil is saturated with water, as it would be after a heavy rain. Now all the pore spaces between soil particles are filled with water. The plant roots in this soil are going to suffer from a temporary oxygen deficiency. However, if drainage is good, many of the pore spaces will quickly empty and become filled with air. It is through these pore spaces that the plant root absorbs its oxygen.

A good question at this point is: "Which pore spaces drain?" The answer is the large or noncapillary pore spaces. The small or capillary pore spaces retain water against the pull of gravity. Hence we have this picture: The plant roots depend primarily on the large pore spaces as a source of air and on the small pore spaces as a source of water.

What, then determines the percentage of large pore spaces in a soil? In large part it is determined by the size of the soil particles. The larger the particles, the larger will be the pore spaces between them. Hence a sandy soil which has a high percentage of large-size sand particles will have a high percentage of large-size pores, and the problem of aerating such a soil is usually a simple one. However, it should be noted that a large number of the large number of the large pores means a small number of small pores and consequently a low water-holding capacity. The ideal soil condition is one in which the proportion of the two is properly balanced.

On our heavier soils, the silt loams and silty clay loams, the problem is different and frequently serious. Here a large percentage of the soil particles are very small. A typical silty clay loam will contain 30 percent or more clay particles, and these are so small that they cannot be seen with a high-powered microscope. The result is a tendency toward a large number of small pore spaces and a deficiency of large ones. One way to correct this condition is to get the small particles of clay to group together and form larger sized granules and thus large pore spaces. In other words, it is a problem of making big ones out of little ones. The process is called aggregation.

Stable aggregate formation may involve three steps. First, it may be necessary to treat the soil so that the clay particles can get close together. This step is necessary in the, so called saline soils where the clay particles are covered with sodium ions. These ions, when wet form a thick enough coating to hold the clay particles too far apart. The usual treatment is to add to the soil some calcium material such as gypsum. The calcium ion, which is much smaller when wet, replaces the sodium ions which may then be leached away. This problem is not important except in a few isolated spots in south central and southern Illinois. However, it is well to recognize that it is not a problem, because materials have been sold as soil conditioners in Illinois which are designed primarily to accomplish only this first, and unnecessary step in aggregation.

The second step involves the action of forces in the soil which will compact the soil in a particular area and then cause it to fracture into aggregate particles. Plant root action, freezing and thawing and wetting and drying are probably involved in this step.

The third step is the production within the newly formed aggregate of a material which will cement the particles together. It is believed that by products of the decay of organic matter in the soil by microrganisms are materials which do the job.

Unfortunately, these by products which create stability may also be decayed by soil microrganisms. In order to retain stability, then, a continuous production of these materials must take place. This means that there must be a continuous addition of fresh plant material to the soil. The annual production and decay of grass roots provides both root action to create new aggregates and supply of the by products to stabilize them. It is no wonder that soils under a sod are frequently the best aggregated ones.

It was the discovery of these by products of organic matter decay, in basic soils research, that led to the production of Kriluim and other soil conditioners. Biochemists observed the characteristics of the by products and determined how similar products could be produced synthetically. They even improved on them by producing chemicals which were active and also resistant to decay.

Even at best, however, such aggregates are not completely stable. They can be crushed - especially when they are very wet. The classic example of this occurs when an exposed soil is subjected to heavy rain. The wetting action of the rain plus its impact against the surface aggregates disperses then and when the surface dries again - presto - a crust, a hazard to any newly seeded lawn.

In sodded areas the problem is not the same. The turf absorbs the impact of the raindrops and allows the water to trickle gently into the soil. Here the problem is traffic. Whether it be traffic on foot or on wheels, if it is great enough the aggregates in this soil will be broken down faster than they can be formed and compaction takes place. Compaction results successively in the reduction in pore space size, decreased aeration, reduced microbial activity and, therefore, reduced aggregate formation.

WEED CONTROL IN TURF

F. W. Slife

Weedy lawns or turf areas are usually a result of poor management. The common practices that contribute to weedy lawns are cheap seed, little improper fertilization, close mowing, frequent light watering, and too much shade. Even with the best turf management, weeds are usually present but seldom will become a primary problem. Weed control chemicals combined with good management will eliminate most of the weed problems in lawns.

Crabgrass continues to be the most serious and widespread annual grass problem in turf. New pre-emergence compounds, however, are highly effective if used properly. During 1961, most of the available and experimental pre-emergence compounds were applied to turf. Materials were applied on March 17 and again on May 1 to new plots. The results are given below:

March 17 Applications

		Percent Crabgrass Control		
Material	Rate/A	July 1	August 1	September 15
Diphenatrile	30 lbs.	100	95	90
Diphenatrile	60 "	100	100	100
Zytron	15 "	100	100	99
Zytron	22 1/2 lbs.	100	100	100
Rid	10 lbs.	100	100	99
Rid	20 "	100	100	100
Halts FB2	60 "	80	75	50
Halts F111	60 "	80	80	80
Cal As	688 "	100	100	100
Cal As	860 "	100	100	100
Pax	860 "	100	100	100
No Crab	43 "	70	60	50
No Crab	86 "	95	85	80
Trifluralin	2 "	100	100	100
Trifluralin	4 "	100	100	100
Dipropalin	4 "	100	99	95
Dipropalin	8 "	100	100	100

May 1 Applications

Material	Rate/A	Percent Crabgrass Control July 1	August 1	September 15
Diphenatrile	30 lbs.	100	95	90
Diphenatrile	60 "	100	100	100
Zytron	15 "	100	100	100
Zytron	22 1/2 "	100	100	100
Rid	10 "	100	100	100
Rid	20 "	100	100	100
Halts FB2	60 "	85	70	50
Halts F111	60 "	85	70	60
Ca AS	688 "	100	100	100
No Crab	43 "	95	90	85
No Crab	86 "	100	99	95
Trifluralin	2 "	100	100	100
Trifluralin	4 "	100	100	100
Dipropalin	4 "	100	99	95
Dipropalin	8 "	100	100	100
Niagara 6370	6 "	0	0	
Niagara 6370	9 "	10	10	10
T.D. 242	10 "	0	0	0
T.D. 242	20 "	60	60	60
Upjohn 4513	2 "	70	60	50
Upjohn 4513	4 "	90	90	90

Injury to the turf was noticeable on the Calcium Arsenate, Lead Arsenate, and Trifluralin plots. Trifluralin produced severe turf injury at the 4-lb. rate, but only slight and temporary injury at the 2-lb. rate. Calcium Arsenate produced slight injury soon after application. This was not noticeable during June and July but with extreme dry weather during August and September, both the lead and calcium Arsenate plots showed damage. This injury could well have been an interaction between Arsenate injury, no insect control, and dry weather.

Results with Calcium propyl Arsonate were disappointing because of lack of crabgrass control. Using 2 lbs. per 1000 and applying closer to the time when crabgrass germinates gave better results than the earlier application.

These tests simply confirm previous work in that there are now available good materials for pre-emergence crabgrass control.

The greatest need in the crabgrass control field is a chemical that could be used on new turf seedings in the spring.

Broadleaf weeds continue to be a problem in turf. More emphasis should be given to the use of 2,4,5-T or 2,4,5-TP to replace 2,4-D. Since these compounds control the same weeds as 2,4-D does and are considerably better on many others, they should be substituted in many cases.

Special weed problems

Tall fescue continues to be one of the worst weed problems when not seeded as a solid stand. Dowpon at the rate of 1 lb. in 3 gallons of water applied to the clump will eliminate tall fescue. The treated area can be reseeded in 4 to 6 weeks.

Violets frequently become turf weeds in old shady lawns. Repeated treatments of 2,4-D, 2,4,5-T, or 2,4,5-TP will eventually eradicate them.

Quackgrass can be controlled with the same treatment prescribed for tall fescue but some regrowth may occur.

Nimblewill can be retarded and eventually eliminated with repeated treatments of liquid Zytron or endothal. Treatments should be at 2-week intervals. For small spots, Dowpon may be preferred.

Research planned for 1962 includes work on the control of *Poa annua* in bent grass and a study of arsenic residues in turf. There is little doubt about the effectiveness of various forms of Arsenic for crabgrass control, but there is considerable doubt on how soon treated areas should be retreated. With the help of Dr. S. W. Melsted, we hope to study this problem in detail.

Weed Pest	Chemical	Trade Name	Now Used	Remarks
Chickweed & Henbit	2,4,5-TP	Numerous	Post-emergence Fall and/or early spring applications	Controls most weeds susceptible to 2,4-D
Crabgrass	Dacthal	RID	Pre-emergence	- - - - - - - - - - - - - - - - - -
	Calcium Arsenate	Numerous	Pre-emergence	May thin grass
	Lead Arsenate	Numerous	Pre-emergence	- - - - - - - - - - - - - - - - - -
	Chlordane	Halts, etc.	Pre-emergence	Reduces mole activity
	Zytron	Zytron	Pre-emergence	- - - - - - - - - - - - - - - - - -
	Disodium methyl-arsonate & related arsonates	Sodar, Methar DSMA, Benzar, DiMet, AMA, Clout, etc.	Post-emergence Spray or granular	Rate must be reduced under high temperatures and drought conditions
Dandelions, dock, plantains, and most other broad-leaved weeds	2,4-D 2,4,5-T 2,4,5-TP	Numerous Numerous Numerous	Post-emergence Spray or granular application. Fall and spring applications required	Will injure flowering and vegetable plants and ornamental shrubs. Use only amine salt
Foxtails, barnyard grass and other annual grasses	Disodium methyl-arsonate & related arsonates	Sodar, Methar, DSMA, DiMet, AMA, Cloud, Benzar, etc.	Post-emergence	Two applications at weekly intervals usually necessary
Knotweed	2,4,5-TP	Numerous	Post-emergence while knotweed is young	Use amine at 2X rate for dandelions, etc.
	Endothal	Penco Endothal Turf Herbicide	Post-emergence	Knotweed is difficult to wet. Add additional wetting agent.
Nimblewill	Endothal	Penco, Endothal Turf Herbicide	Post-emergence	Two applications needed at 10-day intervals (results variable).
	Zytron	Zytron	Post-emergence	Two appl. needed (results variable).
White Clover	2,4,5-TP Endothal	Numerous Numerous	Post-emergence	Repeated application may be necessary for eradication
Wild Garlic and onions	2,4-D	Numerous	Post-emergence Fall and spring applications	Use low valatile ester at 2X rate for dandelions. Will require three or more years to eradicate

NOTE

READ THE LABEL. FOLLOW MANUFACTURER'S DIRECTIONS CAREFULLY. EXCESSIVE RATES WILL CAUSE INJURY TO LAWN GRASSES.

UREA-FORMALDEHYDE NITROGENOUS FERTILIZERS

Samuel R. Aldrich

"The need for water-insoluble nitrogen fertilizers that will release available nitrogen at rates approximating crop requirements has been recognized" ---------

"Before World War II, urea ammonia - liquor - 37 was marketed for ammoniation of fertilizers. (By E. I. DuPont De Nemours). The liquor contained a small amount of formaldehyde for the purpose of forming water-insoluble nitrogen materials during ammoniation and subsequent storage of the product. The urea-formaldehyde compounds thus formed were sources of slowly available nitrogen."1/

Ratios of Urea to Formaldehyde

The possibility of using different combinations of urea and formaldehyde to obtain a synthetic nitrogen fertilizer with controlled rates of release was first thoroughly explored by Yee and Love about 1945 at the Beltsville Research Center of the United States Department of Agriculture. They prepared combinations of the two with urea: formaldehyde ratios of 0.88 to 2.01 and measured the rates of nitrification, figure 1.

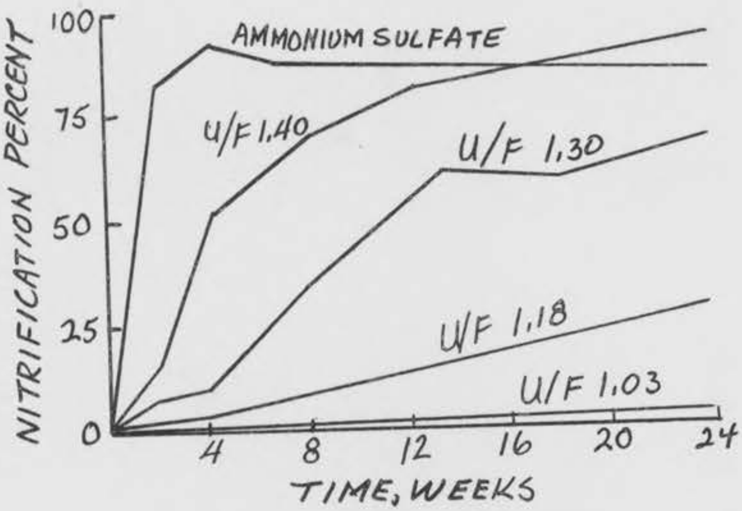

Figure 1. Nitrification rates of urea-formaldehyde products compared with ammonium sulfate at 30° C.

They concluded that urea: formaldehyde ratios in the range of 1.18 to 1.36 had the most promise as controlled nitrogen release fertilizers. When the proportion of urea was above 1.36 parts to 1 part of formaldehyde, the rate of nitrogen release was too rapid; when it was as low as 1.03 there was practically no release of nitrogen.

1/ J. Y. Yee, Katharine S. Love. Soil Science Soc. Proceedings, Vol. 11, 1946, p. 389.

These researchers also made the practical suggestion that readily available nitrogen fertilizers be used to fortify urea-form fertilizers to supply nitrogen until the urea-form fertilizers have time to react in the soil and begin to release nitrogen.

Urea-Form Safe at High Rates

"The low solubility of urea-form greatly reduces the hazards involved in exceptionally heavy applications of nitrogen. The application of as much as 800 pounds of nitrogen per acre as urea-form (equivalent to two tons of ammonium sulfate) was made without any evidence of "burning" or other detrimental effect. One-half this amount of nitrogen, however, was sufficient to produce a complete kill when applied as urea."2/

Effect of Soil pH on Availability

Figure 2 shows that urea-form fertilizers nitrify and thus release nitrogen more rapidly at pH 6.1 (slightly acid) than at 7.3 (slightly alkaline) or pH 5.0 (moderately acid).

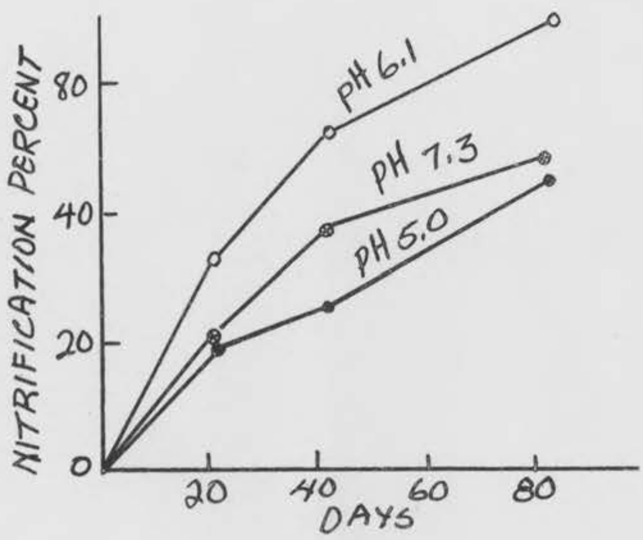

Figure 2. Effect of initial soil pH on nitrification of a urea-form fertilizer. R. D. Kralovec and W. A. Morgan, AGRICULTURE AND FOOD CHEMISTRY, Vol. 2, p. 92, January 20, 1954.

2/ K. G. Clark, CROPS AND SOILS, June-July, 1952, p. 15.

Adequate Moisture Needed

An experiment in Florida using centipede grass as an indicator crop gave rather disappointing results, as the urea-form materials did not measure up to our expectations. The ammonium sulfate, uramon and Milorganite all exceeded the urea-form ratios over the entire period of the test, which ran for about five months.

We finally checked the data and found that we could explain the fact because the season down there had been very dry. For urea-form to be effective, there must be ample rainfall. At its best, it is a slowly available material. As the rainfall was low in Florida during the season, the ammonium sulfate and other readily available materials stayed in the soil throughout the whole season and gave much better results.

The experiment was also run in Georgia on Bermuda-grass. We found that the same thing held true in Florida. A dry season resulted in that the urea-form did not show up well. This was also conducted for a period of approximately five months.3/

Effect of Temperature

The results of an experiment in Texas with Bermuda-grass were quite a bit better. The urea-form materials were somewhat handicapped at the start because of low temperature during the latter part of March through the middle of May. During this period there was very little growth from the urea-form materials. In fact, they were just about even with the check for about the first sixty days, whereas the ammonium sulfate and other readily available materials tests had very good production. At the end of 96 days, the temperature had warmed up and there was plenty of rainfall. Ample decompositions were taking place in the soil and the urea-form materials were then becoming readily available.

At the end of the 195 day period of the experiment, we found that the urea-form materials were far superior to the other materials used in the test and it was double the yield from Milorganite, ammonium sulfate and sodium nitrate. This proved that there must be ample rainfall and good temperature conditions of around 60 degrees.4/

Summary of Pennsylvania Research

Comparisons on turf over the three-year period 1947-1949 included urea-form, activated sludge (Milorganite), nitrogenous tankage (Agrinite), sulfate of ammonia, and urea. Rates varied from 1.5 to 5 pounds per 1000 square feet all applied in the early spring. The grass was clipped weekly.

"The results were:

1. The urea-formaldehyde formulations showed more uniform rates of nitrogen release throughout the growing season than any other material tested.

3/ W. H. Armiger, USDA, at 19th National Turf Conference, p. 32. The Greenkeeper's Reporter.

4/ Ibid., p. 32.

2. The growth increases produced by the urea-formaldehyde formulations, activated sewage sludge and nitrogenous tankage were adequate to maintain a good quality turf throughout the growing season with a single spring application.

3. Single spring applications of soluble nitrogen resulted in excessive growth during the early part of the season with subsequent reductions to levels no better and sometimes poorer than the untreated turf.

4. Split applications of soluble nitrogen made at monthly intervals (except July and August) gave growth responses similar to single applications of slowly available forms of nitrogen.

5. Results of these experiments and findings of other investigators, as reviewed in the cited literature, indicate that urea-formaldehyde products of the ratios tested, are satisfactory sources of slowly available nitrogen for use on turf and can be used advantageously to replace or supplement supplies of natural organic nitrogenous fertilizers."[5/]

General Remarks on Urea-Form Fertilizers[6/]

The usual synthetic nitrogen fertilizer is water-soluble and almost immediately available. It is argued that unless small, frequent applications are made, some of this nitrogen may be denitrified, leached, taken up by weeds, or otherwise unused by the crop. Furthermore, a large amount of nitrogen is present for the small crop at the beginning of the season, but little may be left later in the season for the larger crop. Consequently, a nitrogen material like urea-form that has low immediate solubility but releases nitrogen gradually would have advantages under some conditions. In addition, such a material should neither injure germination if applied too close to the seed nor burn leaves if applied in contact with the plant.

Different urea-forms have been prepared and tested, but all those marketed at present meet the definition of the American Association of Fertilizer Control Officials which states, "Urea-formaldehyde fertilizer materials are reaction products of urea and formaldehyde containing at least 35 percent nitrogen largely in insoluble but slowly available form. The water-insoluble nitrogen in these products shall test not less than 40 percent active by the nitrogen activity index for urea-formaldehyde compounds as determined by the appropriate AOAC method." (Dictionary of Plant Foods. Ware Bros. Co., Philadelphia, 1958.)

5/ From Pennsylvania State University, Bul. 542, H. B. Musser, J. R. Watson, Jr., J. P. Stanford, and J. C. Harper, II. Reported in USGA Jour. and Turf Management, June 1952, p. 32.

6/ L. T. Kurtz in Agronomy Fact Sheet SF-55, University of Illinois, 1958.

CONTROLLING SOIL PEST PROBLEMS BEFORE THEY DEVELOP

H. R. Kemmerer

For almost 100 years chemicals have been used as soil fumigants. There are several materials that are available for use in soil pest control. Here we will discuss five of the more commonly used temporary seedbed sterilants.

I. Chloropicrin

"Tear gas" came into use as a soil fumigant shortly after World War I. It is a drastic and expensive method of soil treatment; however, it is generally considered to be the most fungicidal and herbicidal of the soil fumigants. For the last twenty years or so this material has been used as a yardstick with which the other fumigants are compared. Following the use of chloropicrin, a marked stimulation of newly seeded grass has been noted. It has been reported that if the soil is treated when cold, and then warms up after being planted, the plants may be damaged. This results from the fact that chloropicrin is more soluble in cold water than in warm.

Chloropicrin may be injected into the soil, then the soil surface thoroughly wet down. A tarp may be used to retain the gas in the soil, but it has been estimated that 85% of the gas will remain in the soil when only a water seal is used.

From 14 pounds to 16 pounds of chloropicrin are used to treat 1000 sq. ft. Twenty days should pass after treatment before the soil is seeded, and an even longer wait may be required if the soil is very cool.

II. Methyl Bromide

This is a material which is used a great deal for seedbed fumigation. One of the greatest advantages of methyl bromide is the short time which lapses between treatment and seeding. A very important milestone in the use of this chemical was the development of plastic films, which are used to confine this colorless, odorless, and deadly gas. The seal must be gasproof in order to confine the methyl bromide.

Methyl bromide is used at 1 pound per 100 sq. ft. The cover is left on from 24 to 48 hours. Seeding may be done 48 hours after the cover is lifted. If the soil temperature is between 50 degrees F. and 60 degrees F., exposure and aeration time should be doubled. The bromide is released, by using applicators which are commercially available, into evaporating pans under the seal. Releasing of the methyl bromide into evaporating pans should not be attempted below 50 degrees F.; however, the "hot gas" technique of methyl bromide application gives good results when the soil and air temperature are as low as 40 degrees F.

The hot gas method is simply a rapid vaporization of the methyl bromide by warming it in water. The temperature of the water should be between 160 degrees F. and 170 degrees F. When only small areas are to be treated, the can of methyl bromide can be plunged into warm water immediately after opening. With larger areas a vaporizing unit can be constructed by coiling copper tubing in a vat of water, which is heated with a blow torch, and then allowing the bromide to pass through the coil in the hot water before it flows under the cover. The rapid vaporization or hot gas method of application of the bromide gives a more rapid kill of vegetation and weed seed. Six hours of hot gas is better than 48 hours exposure where the methyl bromide is more slowly vaporized.

Unsatisfactory growth of certain crops such as carnations, snaps, conifers, etc., has resulted following the use of methyl bromide.

III. Calcium Cyanamide

This material contains 20% nitrogen and 70% hydrated lime equivalent. On many soils the basic nature of this material would be objectionable; also, there is a very large amount of nitrogen applied when this material is applied in quantities sufficient for sterilization purposes. The free cyanamide which is formed in the soil is toxic to weeds and weed seed. At low soil temperatures, or inadequate moisture, the material is broken down and doesn't supply the toxic concentration required. Calcium cyanamide is most effective on weeds germinating when it is breaking down and toxic. Application of this material in early spring gives good control of early spring weeds, but is only partially effective on crabgrass which germinates late in the spring. Peat or other organic material mixed in with calcium cyanamide may improve the soil and tie up released nitrogen.

From 50 pounds to 80 pounds of this material may be applied per 1000 sq. ft. Half of the material should be raked into the soil and the rest applied on the surface. A 3 week to 4 week interval should lapse before seeding.

IV. Mylone

This material is a wettable powder which can be applied with a watering can or dry in a lawn spreader. Three-fourths pound of Mylone is used to treat 100 sq. ft. The treated area should be irrigated with 1 acre inch of water (2/3 gal. per sq. ft. of soil) within 4 hours after application to obtain penetration of the chemical. A 3 week waiting period should lapse between treatment and seeding. Mylone should not be used when the soil temperature is above 90 degrees F.

V. Vapam

This rapidly decomposing material is highly toxic to most living organisms. Vapam may be watered in, applied with a soil probe, or a chisel tooth applicator. Care must be taken to get an even application with this material. Immediately after application, enough water should be applied to wet the soil 4" deep (15 to 20 gal. of water per 100 sq. ft.), in order to form a water seal to hold the gas in the soil. If injections are made to a depth of 8", there is no need for a water seal. In some cases a cover is applied after application.

This fumigant is applied at the rate of from 1 to 1 1/2 quarts per 100 sq. ft. and a waiting period of from 2 weeks to 3 weeks is required before seeding.

In order to obtain the best results with soil fumigation one should:

<u>Till the soil</u>. The soil should be worked to a depth of 6" to 8" in order to allow the fumigants to more easily penetrate into the soil.

Consider the soil moisture. For best results with soil fumigants the soil should be fairly moist. If the soil is very dry a 30% to 50% increase in amount may be required for good results; whereas wet soil will not let the fumigant diffuse through it. If the soil is dry it should be irrigated for several days in order to allow the weed seeds and other pests to be more susceptible to the fumigant.

Consider the soil temperature. Fumigants should usually not be used below 60 degrees F., except for methyl bromide, nor above 85 degrees F. Below 60 degrees F. the material stays in the soil for a longer time, and more time between seeding and application should be allowed; while at temperature above 85 degrees F., the fumigants leave the soil too rapidly to do much good.

Consider soil type. It has been found that more fumigant material may be required in clay and organic soils than in sandy soils; therefore, the dosage in these types of soils may have to be increased.

Fertilize after treatment. Fumigation sometimes slows down nitrification. In order to counteract this, use a nitrate form of nitrogen after fumigation. This doesn't hold in all cases.

Preliminary findings of research at the U. of Ill. on the establishment of turfgrasses with the aid of soil sterilants will be brought into the discussion.

SEEDING RATES AND SOME FACTORS IN THE SPRING ESTABLISHMENT OF TURF

Jack Butler

The amount of grass seed to be sown and when to sow it has long been a subject for discussion. Fall is considered by many to be the best time for seeding, but many people prefer to seed in the spring.

There are several factors which will influence the amount of seed to be sown. Of course, the amount of seed will vary with the kind and quality of the seed. However, the most important consideration is probably one of competition from annual weeds, particularly crabgrass. With soils which are weedy, the rate of seeding should be increased in order to increase competition for the weeds.

It is generally felt that at least three pounds of seed per 1000 square feet is best for spring seedings. Although weeds might be somewhat better controlled at very high rates of seeding the cost of doing this would be prohibitive.

In a seeding study at the University of Illinois this spring, chemical and mechanical weed control were used along with different rates of seeding in order to determine their effects on spring-seeded grass. Also, since the amount of fertilization applied would be expected to influence the stand, various fertility levels were used. Four different strains of Kentucky bluegrass were used in this study.

Table 1 gives a summary of the findings obtained with Merion and Kentucky bluegrass grown on soils infested with both broadleaf and grassy weeds. The grassy weeds were predominantly crabgrass, with an occasional plant of yellow foxtail.

The seedings for this study were made on May 18 at five different rates -- from 120 pounds per acre down to four pounds. Ten pounds of 10-8-6 per 1000 square feet were applied before working the soil. Then 10 and 20 pounds of 10-8-6 were applied at the time of seeding and again on July 13 to randomized strips in a split block design. The check strips had only the application which was disked into the soil.

The area was sprayed with 2,4-D amine for broadleaf weed control on July 14. This one treatment of 2,4-D gave perfect broadleaf control. On August 3 a vertical cut (Henderson) mower as well as DSMA (Sodar) were used on the strips. The strips were gone over only one time with the machine and twice with DSMA. The DSMA was applied the second time seven days after the first application at a rate of one pound of the material as it comes from the container to 25 gallons of water, and two gallons of this solution were used on a 210 square foot plot. The irrigation system was turned on for a while in the evening after the DSMA was applied in the morning. The plots were irrigated all summer and mowed at a height of two inches. Coverage was determined on September 15 and September 17.

The data in Table 1 seemed to indicate that the coverage of bluegrass was increased little, if any, with increased fertility of the soil. The vertical cut mower gave a certain increase in the amount of grass coverage, and if it had been used more frequently better results might have been obtained. With the Merion, the coverage was much better at the lower rates of seeding than with Kentucky. Good coverage and weed control were obtained with all three rates where DSMA was used on Merion; whereas with Kentucky, only the two higher rates had much coverage. The DSMA gave good results in all cases by reducing the crabgrass and causing an increased stand of bluegrass.

Table 1

The effect of seeding rates, fertility, and weed control on the coverage of Merion and Kentucky bluegrass.

Rate of Seeding	Weed Control	10# of 10-8-6 1 application		30# of 10-8-6 3 applications		50# of 10-8-6 3 applications	
		Grass	Weeds	Grass	Weeds	Grass	Weeds
Merion							
	Vert. Mower	33%	64%	36%	60%	33%	62%
120#/A.	DSMA	81	3	70	13	78	2
	Check	18	79	13	83	20	79
	Vert. Mower	19	73	35	61	30	66
60#/A.	DSMA	70	16	64	10	77	6
	Check	26	72	22	71	21	68
	Vert. Mower	11	75	13	77	13	84
20#/A.	DSMA	88	1	63	2	61	0
	Check	7	88	0	96	1	96
Kentucky							
	Vert. Mower	40%	60%	39%	57%	42%	52%
120#/A.	DSMA	68	0	70	0	73	3
	Check	17	78	22	77	33	70
	Vert. Mower	39	48	44	45	54	35
60#/A.	DSMA	68	5	69	2	71	0
	Check	12	91	8	85	25	67
	Vert. Mower	31	59	27	58	16	66
20#/A.	DSMA	38	24	30	20	23	36
	Check	7	86	2	88	6	89

The difference between the % grass plus the % weeds and 100 was bare space.

SOIL TESTING FACILITIES AT THE UNIVERSITY OF ILLINOIS

F. F. Weinard

The Department of Agronomy at the University of Illinois operates a laboratory at Urbana for the testing of farm soils. The methods developed in the Soil Fertility laboratories are used in some 80 extension and 45 commercial laboratories testing soil in Illinois. Anyone interested in having field crop soils tested is advised to consult their farm adviser or Dr. James C. Laverty, 129 Davenport Hall, Urbana.

Turfgrass, garden, and greenhouse soils are tested in the Floriculture and Ornamental Horticulture division, Department of Horticulture, 100 Floriculture Building, Urbana. The customary tests of turfgrass soils include tests for acidity (pH), nitrate nitrogen, available phosphorus (P_1 extract), and exchangeable potassium. Acidity tests are made with a Beckman pH meter. Tests for plant food levels are made by methods developed by Dr. R. H. Bray and his associates in the Agronomy department. The photoelectric photometer is used in making colorimetric determinations. A charge is made of $1.00 per sample.

It is recognized that the usefulness of soil tests is dependent to a great extent on the representative nature of the sample. Many samples are received at the laboratory without previous notice from the sender. However, whenever possible, suggestions are made for the collection of turfgrass soil samples. These include taking soil from several different spots in the area, to a depth of two to three inches. These samples to be combined to form the sample(s) of air-dry soil to be sent to the laboratory for testing.

The results of tests on 290 turfgrass samples taken in 1961, mostly from individual home lawns in northern and central Illinois, are of interest in this connection.

Table 1. Distribution of acidity determinations (pH)

6.0 and below (%)	6.1-6.4 (%)	6.5-7.0 (%)	7.1-7.4 (%)	7.5 and above (%)
12.4	13.8	38.3	23.1	12.4

Table 2. Distribution of nitrate nitrogen determinations (Pounds of N per acre)

25 lbs. and under (%)	26-49 lbs. (%)	49-74 lbs. (%)	74-99 lbs. (%)	100 lbs. and over (%)
81.4	11.8	4.5	0.6	1.7

Table 3. Distribution of available phosphorus determinations (Pounds of P per acre)

50 lbs. and under (%)	51-99 lbs. (%)	100-149 lbs. (%)	150-199 lbs. (%)	200 lbs. and over (%)
23.8	14.5	14.5	13.1	34.1

Table 4. Distribution of exchangeable potassium determinations (Pounds of K per acre)

100 lbs. and under (%)	101-199 lbs. (%)	200-299 lbs. (%)	300 lbs. and over (%)
5.9	16.2	20.0	57.9

Taking pH 6.0 as the point below which liming is to be recommended, we note that the majority of the soil samples were in the pH 6.1-7.4 range, with only 12 per cent of the samples indicating a need for lime. Hence, a large number of owners who might otherwise have limed or overlimed their lawns were saved that trouble and expense.

Admittedly, the value of nitrate determinations is somewhat questionable. However, there is a well-founded idea that available nitrogen is usually low in turfgrass areas, and commonly, special importance is given to fertilization with nitrogen. It is significant that 81 per cent of the samples tested showed less than 25 pounds per acre of quickly available nitrogen.

If 100 pounds per acre of available (adsorbed and water-soluble phosphorus) is to be taken as a favorable level, then approximately 38 per cent of the samples tested showed a need for additional phosphorus. To what extent arsenic accumulated in the soil following weed killer applications may have interfered with the phosphorus tests is not known.

Similarly, assuming that 300 pounds per acre of available (exchangeable) soil potassium is desirable, then the need for additional potassium was shown by approximately 42 per cent of the samples tested. Approximately 24 per cent of the samples were low in both phosphorus and potash, and about 43 per cent were high in both of these elements. Individual samples were found to be high in phosphorus and low in potassium more often than vice versa. This is to be expected due to differences in the rates of leaching from the soil. Where both phosphorus and potassium show high levels, consideration may well be given to the use of nitrogen fertilizer alone, perhaps alternating with complete mixtures. In general, it is suggested that soil tests can be of definite value in planning fertilizer programs for turfgrass areas, resulting in improved efficiency and savings in time and money.

Unfortunately, many people apparently have the idea that a soil test will solve all of their lawn problems even though they refer to the testing laboratory as a last resort. Such individuals are not likely to understand bare figures on a report, and frequently their letters contain a series of questions. Therefore, we have followed the practice of commenting briefly on the laboratory report with suggestions for an appropriate lime and fertilizer program.

TURF INSECTS OF 1961

H. B. Petty

WEBWORMS

Webworms were more common and did more damage to grass sods in 1961 than for the past several years. Several species, belonging to the genus Crambus, were involved. They are native insects.

Several species of this genus are reported in the literature as damaging to turf.

1. The vagabond webworm, Crambus vulgivagellus, is the most common webworm in grass pastures during August and September.

2. The leather-colored sod webworm, C. trisectus, is often a serious pest of young corn, lawns, golf courses, and grass pastures and occurs from mid-May to late October.

3. The bluegrass webworm, C. teterrellus, is very common and at times is destructive to lawns and golf courses from May to mid-September.

4. The striped webworm, C. mutabilis, may be very abundant from mid-May to late September and is a common pest on lawns and seeding corn plants.

5. The silver-striped webworm, C. praefectellus, is very common and is an occasional pest of corn and grass land during July to October.

6. The corn root webworm, C. caliginosellus, is common but seldom abundant, appearing primarily in weedy areas from mid-June to September.

However, all webworms can be treated in a similar manner since they generally resemble each other, cause the same type of damage and are controlled in the same way.

General life cycle: Webworms winter primarily as larvae in silk-lined burrows in the soil surviving mild winters better than severe winters. In the spring they may feed a short time, then pupate and soon emerge as moths that do not feed, but do drink water. Each female moth lays a few hundred eggs, dropping them individually in the sod where they are almost impossible to find. The eggs hatch in a few days and the tiny worms immediately begin to build a silken case or tunnel and chew at the grass. While most worms chew off a blade of grass and pull it into the burrow or case, some actually eat on the blades as they stand. The worms continue to feed until full-grown when they pupate in a cell in the soil, soon to emerge as a moth.

The length of the life cycle may vary from 35 to 60 days and there are usually two generations and in some instances a partial third each year.

Damage: Brown, irregularly-shaped patches appear in turf grass. Close examination may reveal dried-up blades of grass which have been partially eaten. The worms or pupae can be found in the silken cases. This requires careful examination.

If moisture is generally plentiful, well fertilized turf usually continues to outgrow the damage throughout the season. Damage is much more evident and serious, however, during dry seasons as the drought-weakened plants may die or be seriously weakened by the depredations of the webworms. During a drought, well watered areas, as lawns and golf greens, appear to attract the moths as an egg laying site. Since the moths deposit their eggs in select spots, the damage is also concentrated in spots. There are literally hundreds of these worms concentrated in these small areas. Each worm in its lifetime has been estimated to consume 7 to 13 linear feet of bluegrass leaf or its equivalent. When the sod is growing slowly, this concentration of worms literally shaves the sod.

Detection: Eggs are usually deposited each evening from shortly before dusk to a few hours before midnight. Webworm moths zig-zag in flight and fold their wings closely about their body when at rest. Light colored moths with these characteristics, when abundant over and in grassy areas, are an indication of an impending outbreak. Examine brown spots when first noticed for these webworms. Examine the sod and ground carefully. Damage may mushroom within a few days if the webworms are very abundant.

Control: The most consistent control will be obtained with 5.0 pounds of actual DDT per acre. Chlordane will also be satisfactory but there have been reports of failures in the southern states.

Aldrin, dieldrin and heptachlor are also recommended in many areas at the rate of 3.0 pounds per acre.

Thorough coverage is needed for good control. Sprays that stick to the grass blades will give the most consistent control. Soil treatments have been very erratic and should not be depended upon to give control.

GRUBS

A few cases of grub damage were reported this year. The recommendations in the attached table will control these grubs. For immediate results, drench the material into the soil. Granules may not give good control at the time of application but usually provide protection from reinfestation.

LEAFHOPPERS

Several species of these tiny wedge-shaped pests suck sap from plants. During dry periods, they lower the vitality of plants. They may be more numerous and severe after applications of aldrin, chlordane, dieldrin or heptachlor. DDT provides adequate control.

References: Decker, Geo. C.; Ia. Acad. of Sci. 50, 337-339, 1943.

Ainslie, Geo. G.; USDA Farmers Bulletin 1258, 1922.

CONDENSED INSECTICIDE RECOMMENDATIONS FOR INSECT PESTS OF TURF

Insects	NHE No.	Approximate time of attack	Insecticides: Name	Lb. actual per 10,000 sq. ft.	Lb. actual per acre	Placement	Timing of application
True white grubs	23	May-Oct.	Aldrin	0.75	3.0	On soil surface	Established sod: if used as a spray, water in thoroughly. Apply preferably in early spring or late fall. New seeding: mix in soil prior to seeding.
Annual " "	23	May, Aug.-Oct.	Chlordane	2.5	10.0		
Japanese beetle larvae	32	" " "	Dieldrin	0.5	2.0		
Green June beetle larvae		" " "	Heptachlor	0.75	3.0		
Ants		May-Oct.					
Cicada killer wasp	79	June-Aug.	........as for grubs........			On soil surface	As for grubs. For individual nests, pour 3% chlordane in nest after dark. Seal in with dirt.
Earthworms		April-July	Chlordane	2.5	10.0	On soil	As for grubs.
Sod webworms	42	July-Oct.	DDT	1.25	5.0	On grass	As a spray. The more water used, the better the control.
			Chlordane	1.25	5.0		
Armyworms and cutworms	21 77	May-June & Sept.-Oct.	Dieldrin	0.125	0.5	On grass	As spray or granules.
			Toxaphene	0.50	2.0		
Chinch bugs	35	June-Aug.	Dieldrin	0.125	0.5	On grass	Sprays or granules. Use plenty of water as a spray.
Leafhoppers	22	July-Aug.	DDT	0.25	1.0	On grass	As a spray.
Mites	58	July-Sept.	Kelthane	0.125	0.5	On grass	As a spray. Thorough coverage needed. 75 to 100 gal. water per acre.
			Malathion	0.4	1.5		
Chiggers		May-July	Chlordane	0.6	2.5	On grass	Good coverage required. Use minimum 20-25 gal. water per acre.
			Dieldrin	0.5	2.0		
			Lindane	0.125	0.5		
			Toxaphene	0.5	2.0		
Thrips		July-Sept.	DDT	0.5	2.0	On grass	As a spray. Control rarely needed.
Slugs	84	June-Oct.	........Slug baits.........			Scatter in grass	Where slugs are numerous.
Sowbugs		June-Oct.	DDT	0.5	2.0	On grass	As a spray. Lots of water needed. Control rarely required.

Precautions: Most insecticides are poisonous. Be sure insecticides are clearly labeled. Keep them away from children and pets. After applying an insecticide, do not allow children and pets on the lawn until the insecticide has been washed into the soil by sprinkling, and the grass has dried completely. To protect fish and wildlife, do not contaminate streams, lakes, or ponds with insecticides.

One gallon of insecticide contains the following amounts of active ingredient: 25% DDT, aldrin, or heptachlor, 2 lb.; 45% chlordane, 4 lb.; 15% dieldrin, 1.5 lb.; 55-57% malathion, 5 lb.; 18 1/2% kelthane, 1.5 lb.; 60% toxaphene, 6 lb.; 20% lindane, 1.6 lb.

Prepared by entomologists of the Illinois Agriculture Extension Service and Illinois Natural History Survey.
For additional copies see your county farm adviser.

TURF FUNGICIDE TRIALS FOR 1961

M. P. Britton

Fungicide testing for the control of turfgrass diseases was begun in Illinois in July, 1961 at Palos Park. Approximately 2000 sq. ft. of Washington bentgrass mowed at 5/16 inch was available for this study. Because of the limited amount of space it was necessary to restrict both replications and the number of treatment rates. Consequently only two replications were used and each material was applied at the curative or high rate suggested by the manufacturer. Insofar as possible, fungicide applications were made at weekly intervals beginning on July 24 and ending September 5. All materials were applied in water at a gallonage equivalent to 5 gallons of spray solution per 1000 sq. ft. of turf.

The only disease that occurred in a significant amount during the testing period was brown patch (Rhizoctonia solani). Data on the incidence of brown patch (Table 1) were taken on the dates indicated. The data are expressed in square inches of diseased grass and represent an average of diseased area in the two replications.

Discussion of Results:

Outbreaks of brown patch developed in early August and again in the first half of September. In both cases brown patch incidence coincided with periods of high rainfall and temperature (Table 2). Conditions during early September were extremely favorable as indicated by the disease occurrence in the unsprayed control plots.

TP 225, an experimental fungicide caused injury to the bentgrass and applications were discontinued after August 15.

Merbam 10 and Dexon-Dyrene were not noticeably better than the unsprayed control plots.

Kromad applied at 7-day intervals did not give complete control of brown patch during extremely favorable conditions for disease development. More frequent applications at the same or higher rates of application probably would have given much better control.

Tersan OM, Tersan OM + Parzate and Actidione-thiram were controlling brown patch on September 11, 6 days after the last fungicide application, but were not on September 14, 9 days after the final application. It is probable that an additional application of these fungicides on September 11 or 12 would have kept these plots free of brown patch.

The Ortho Lawn Fungicide and the Stauffer Experimental Turf Fungicide gave complete control of brown patch in September, even 9 days after the final spray application.

Table 1. Fungicide treatments for brown patch control, Palos Park, Illinois, 1961

Fungicide	Rate of Application per 1000 sq. feet	Square inches of diseased bentgrass on:*					
		Aug. 2	Aug. 9	Aug. 30	Sept. 5	Sept. 11	Sept. 14
ORTHO LAWN FUNGICIDE	6 oz.	0	0	0	0	0	0
STAUFFER EXPERIMENTAL FUNGICIDE	6 oz.	31	0	0	0	0	0
TERSAN OM	5 oz.	26	0	0	0	0	28
TERSAN OM PLUS PARZATE	3 oz.+3 oz.	20	0	0	0	0	28
ACTIDIONE-THIRAM	3 oz.	131	0	0	0	0	56
KROMAD	4 oz.	167	0	0	14	28	98
DEXON-DYRENE	6 oz.	113	0	0	84	65	238
MERBAM 10	2 oz.	1	0	0	70	70	336
PENN SALT TP 225	4 oz.	112	0	0	Dropped due to plant toxicity		
UNSPRAYED CONTROL	None	62	trace	0	108	101	318

* Averages of two replications

Table 2. Weather data Chicago Midway Airport.

Week of:	Total Weekly Precipitation	Ave. Weekly Temperature °F.	Max. Temp. For Week °F.	Min. Temp. For Week °F.
July 21-28	.40	77	92	62
July 29-Aug. 4	4.06	74	89	59
Aug. 5-11	1.55	76	89	59
Aug. 12-18	0	72	90	54
Aug. 19-25	.43	73	94	57
Aug. 26-Sept. 1	.70	79	93	68
Sept. 2-8	3.83	80	93	67
Sept. 9-15	5.28	65	83	45

THE OCCURRENCE OF NEMATODES IN GOLF COURSE GREENS IN ILLINOIS

M. P. Britton and Helen Carol Hechler

The widespread occurrence of root parasitic nematodes in bentgrass greens of 17 golf courses in Rhode Island was reported in detail by Troll and Tarjan in 1954 (1). Since this time considerable speculation has arisen in regard to the possible damaging effects of root parasitic nematodes to bentgrass. Some work has been directed toward the control of nematodes in putting greens with nematocides. However, relatively little is known about the direct or indirect damage that these nematodes may cause in bentgrass greens.

As a first step in studying this problem a survey to determine the kinds of nematodes in golf greens in Illinois was conducted in 1961. In this study root and soil samples were obtained from 26 putting greens on six golf courses. Three of the golf courses were in Central Illinois and three were in the Chicago area. Soil and root samples were obtained from several locations on each green. The nematodes in a 1/2 cup composite soil sample from each green were identified to genera and counted (Table 1).

The average nematode population per 1/2 cup of soil was 6181. However, root-parasitic nematodes made up only 5.6% of the total population. The average number of parasitic types was 348 per 1/2 cup of soil. Of the root-parasitic nematodes found, the stunt nematodes (*Tylenchorhynchus* spp.) were the most widespread and generally the most abundant. These nematodes were found in every green sampled. Spiral nematodes (*Helicotylenchus* spp.) were also widespread, but were found in only 77% of the greens. It is significant that in Rhode Island the stunt and spiral nematodes were also found to be the most widely distributed parasitic nematodes in bentgrass putting greens (Table 2).

From the data presented it would seem probable that the stunt and spiral nematodes may be responsible for devitalizing bentgrass in putting greens. However, so far as the authors are aware, neither of these nematode groups has been shown to feed on creeping bentgrass (*Agrostis palustris*) although they do feed on roots of closely related grasses. Work is presently under way to determine whether these nematodes are parasites of creeping bentgrass.

Reference

1. Troll, J., and A. J. Tarjan. 1954. Widespread occurrence of root parasitic nematodes in golf course greens in Rhode Island. Plant Disease Reporter 38:342-344.

Table 1. Nematodes found in root and soil samples from bentgrass putting greens in Illinois in 1961.

Types of Nematodes	Percent of Greens Infected	Ave. No. of Nematodes Per 1/2 Cup Soil	Greatest No. of Nematodes Found in 1/2 Cup of Soil
Tylenchorhynchus			
Stunt Nematode	100	279	1000
Heliocotylenchus			
Spiral Nematode	77	26	200
Paratylenchus			
Pin Nematode	15	23	40
Pratylenchus			
Lesion Nematode	11	20	48
Haplolaimus			
Lance Nematode	46	12	30
Trichodorus			
Stubby Root Nematode	1 green	1 nematode	1 nematode
9 genera of non-parasitic nematodes	100	5833	16,150

Table 2. Nematode occurrence in putting greens in Illinois and Rhode Island.

Nematode	% of Greens in Which Nematodes Were Found	
	Illinois	Rhode Island
Tylenchorhynchus		
(Stunt Nematode)	100	73
Helicotylenchus		
(Spiral Nematode)	77	51
Hoplolaimus		
(Lance Nematode)	46	12
Paratylenchus		
(Pin Nematodes)	15	7
Pratylenchus		
(Lesion Nematode)	11	24
Trichodorus		
(Stubby Root Nematode)	4	None

GOLF COURSE MANAGEMENT PROBLEMS

James L. Holmes
Mid-Western Agronomist

Problems encountered when maintaining turf are uniquely diversified. If a superintendent is asked each fall what his outstanding problem was for that year he is likely to report a different problem each time. What he considered his greatest headache in 1959 may not be an important consideration in 1961 and vice versa. Therefore, when discussing this subject we must be cognizant of the extremely diversified subject matter with which we are dealing.

As an example, in 1955 severe attacks by turf disease causing fungi was certainly the paramount problem. In 1961, diseases were of minor concern and scalping received top priority. When one reviews the situation as a whole for the past seven or eight years, it is amazing to note the full scale diversification encountered. In my experience dealing with golf course turf I would list the following as top golf course management problems during the past decade:

1. Diseases
2. Excessive traffic
3. Winter kill
4. Weeds
5. Poor greens construction
6. Trees
7. Inadequate equipment and finances
8. Water

Of the golf course superintendents present, 25% would not agree that any one of the items listed above is consistently their problem of greatest concern. However, each one of the items would be specified by at least one man. Therefore, the diversification of problems is perhaps the greatest problems. In other words, one of the problems of greatest concern to turfmen is to determine "what is going to be my most serious problem this year?" The man who is capable of determining this early in the season and counterattacking accordingly is going to be the most successful superintendent.

How does a golf course superintendent counterattack a problem? This is where results of research and personal experience are put into use. Of course we are aware that there is no substitute for personal experience which is by and large the result of keen observation. Perhaps it is not inaccurate nor presumptious to say that a turfman is not worth his salt until the time he reaches a certain level in relation to personal experience of acquires "observation of time." This will vary dependent upon the individual man and could develop into a psychological discussion.

What has research and personal observation done to alleviate or affect the problems listed above. Let's discuss them individually and try to determine what has been accomplished during the past decade.

Diseases: More has been done through basic research to counterattack this paramount turf problem than in any other facet of turf management with the possible exception of weed control. Perhaps this is true simply because this problem lends itself to basic research better than do other problems encountered in turf. As a matter of fact, the turf grower himself is not equipped nor qualified to determine basic disease data but must depend upon trained chemists and pathologists. The real beginning of scientific control of turf diseases rests with the U.S.G.A. Green Section through Dr. John Monteith in the late 20's. Since that time surprisingly little has been added. Dr. Monteith's mercury salts are still the basis for disease control programs. Thiram, phenyl mercuric acetate, antibiotics and various mixtures of these and mercury salts are in general use today. However, these simply have complemented Dr. Monteith's donation to the turf field and have not replaced it. A staggering amount of research is still needed in this area. A greater number of basic research people are becoming interested in this problem. Surely they will obtain information relating to better control of recognized diseases, root and crown problems, and synergistic or other associations of disease causing organisms including nematodes in the not too distant future.

Excessive Traffic: One of the most difficult or severe problems in maintaining a golf course is golfers. Without them the turfman's life would be quite simple. However, we must admit that the course is maintained for the golfers' enjoyment and go from there. Basic research is associated here but less directly and through:

1. Development or selection of grasses which will better withstand traffic.

2. Development of soil mixture which will support a superior turf under conditions of heavy play.

3. Development of anything which will assist grasses in their struggle to develop a healthy, vigorous, resistant turf.

The golf course superintendent through his experience and observation has in part countered this problem. If this was not true many courses would be devoid of turf during the latter part of the season. Such things as the following are examples, to list a few:

1. Asphalt cart paths

2. Enlarging greens and trees

3. Directing traffic around and away from heavy traffic areas through various means such as chains, signs, trap locations, etc.

4. Changing cups twice daily or placing two cups in each green.

The traffic problem will become more acute as play increases - which it is doing, and I foresee the time when more drastic steps must be taken such as restricting play, closing the course at specific times, building alternate tees and greens, etc.

Winter Kill: Winter kill as a result of dessication or ice cover is a serious problem in areas of the country where irrigation systems must be drained. Death of turf from dessication results from lack of soil moisture and death from ice cover is the result of excess water or lack of soil oxygen. Therefore, if a soil mixture and building procedure could be developed which held both sufficient moisture and oxygen to supply dormant turf but which also drained when excess water was present would accomplish a considerable amount in this regard. It is believed that a method of building greens has now been developed through research which will allow this to happen.

Turfmen, through observation, trial and error, have divised a number of ways to counterattack this serious problem:

A. Excess Water

1. Insuring surface drainage and/or installing tile thus reducing the degree of ice cover

2. Breaking and/or removing ice cover

3. Aerating or "opening" poorly drained areas in the late fall thus encouraging drainage and increasing levels of soil oxygen

B. Dessication

1. Apply water with a large tank at critical times. Usually 250 to 500 gallons to a 5000 sq. ft. area once or twice during winter

2. Use of brush cover or snow fence or both

3. Care not to aerate late in the fall thus encouraging excess evaporation

4. Turning - on and using water system early in the spring even if the system must be re-drained.

Weeds: Objectional plants, plants out of place or weeds are another area where research people have been of greater assistance than have turf growers through observation. As in disease work, the chemical control of weeds is better approached through scientific methods than through the practical aspects of turf management. Tremendous strides have been made in this area. Most golf courses have gone from dandelions, crabgrass, clover and plantain patches to well grassed areas thanks to chemical herbicides. However, various weeds such as silver crabgrass, nimblewill, nut grass, *Poa annua* and others remain to be effectively controlled. The signs are good and I believe it is only a matter of a short time until all undesirable plants can be controlled as necessary.

Poor Greens Construction: A considerable amount has been accomplished in this area. However, much more remains to be done. In order to improve poor basic construction the area must be redesigned and rebuilt. This is being done in all areas of the country and will continue.

Equipment manufacturers cooperating with golf course superintendents have developed vitally necessary tools to temporarily relieve compaction and slightly encourage drainage. However, correction of these basic problems lie with the original installation of a soil mixture in an overall building procedure which will insure proper and continuous drainage and guard against compaction. Valuable and necessary data is now available and it would appear that information on methods of how to construct greens in order to circumvent these most serious problems is at hand. In no other area of turf management has the personal experience and observations of golf course superintendents assisted basic research people to arrive at acceptable conclusions.

Trees: The elimination or reduction of this turf problem results solely from observations and experiences of turfmen. It has been determined without doubt that shade and tree root competition is extremely deleterious to the development of desirable turf. The process of trimming trees in order to improve sunlight and air circulation and the pruning of tree roots around green and tee areas benefits the development of turf. Alternatives to overcoming this problem are to remove offending trees or use grasses which will develop in shade, when possible.

Inadequate Equipment and Finances: Of course this is recognized immediately as a serious problem but one which research people and golf course superintendents are limited to correct. Club memberships must be made aware that by and large the overall condition of their course is proportional to the financial assistance they give their superintendent. Superintendents have received valuable assistance in this regard from U.S.G.A. Green Section agronomists who are in an excellent position to make the meaningful membership aware of this. However, this problem remains one of membership education and obviously depends upon the actual availability of funds. The consideration of the availability of funds is quite paradoxical; in case after case club memberships are of the opinion that funds are not available to purchase necessary equipment or improve conditions on the course. Nonetheless, funds are always mysteriously available to add another bar or to improve the ladies locker room or to install air conditioning or to rebuild the swimming pool.

Water: Perhaps water is the least understood of any facet of golf course management. Certainly the most successful turfman is one who has determined proper watering procedures. It is becoming more apparent to me that overwatering is a far more serious problem in turf management than underwatering and that many turf growers are guilty of the practice of overwatering. The frequent and careless use of water encourages such weeds as crabgrass and *Poa annua* and weakens desirable grass such as bluegrass and bentgrass. Thus all weeds are indirectly encouraged when overwatering occurs. We have all heard that bluegrass and fescue are weakened as a result of frequent irrigation. During the past five years I have seen bentgrass turf gradually transpose to a *Poa annua* turf after a watering system has been installed or especially after one which is considered inadequate is improved.

Low areas which do not drain are invariably the first to "die out" during periods of adverse weather conditions. (It is believed that effects on the soil-oxygen relationship are largely responsible.) After desirable turf has been killed, any number of weedy plants encroach. Thus considerable time and funds are directed to improving drainage. It seems reasonable to me that as much or more time and effort should be spent to develop more optimum watering practices. In this regard, how many men present have actually observed either bluegrass or bentgrass die from lack of water? Perhaps they become "dormant" but they almost invariably recover do they not?

We could discuss watering practices for the remainder of the day and still have ground to cover. I personally believe that overwatering is the greatest mistake made by turfmen and remains our supreme problem. Almost any problem in growing fine turf can be traced either directly or indirectly to a water relationship.

Conclusions: One can readily see that each of the above problems are interwoven. Any one affects the others. Therefore, is not the most consistent and ever present problem in golf course management "what is going to be my greatest problem this year?".

A. CHEMICAL CONTROL OF BENTGRASS DISEASES

Malcolm C. Shurtleff
Extension Plant Pathologist
University of Illinois

Great strides have been made in recent years, by industry and agricultural experiment stations, in providing the Golf Course Superintendent with a more complete arsenal of disease-fighting chemicals. Somewhat lost in the shuffle of this wealth of new chemicals -- and putting increased emphasis on fungicides for controlling turfgrass diseases -- is the importance of sound cultural practices. All the fungicides in the world cannot replace a poor management program.

Before outlining what chemicals are suggested for specific disease problems, let's go over some management practices which will reduce your fungicide bill and, in the long run, be better for your greens.

1. The more often grass is wet, and the longer it remains wet, the greater will be the chance of a disease problem. Greens should be kept as dry as your greens committee and membership will allow. Perhaps you will need to provide them with an educational program. Or have them take lessons on how to hold an iron shot without a soggy, water-logged green to absorb a poorly played shot.

2. Poling, brushing, or hosing greens shortly after daylight removes the dew and guttated water in which disease-producing fungi thrive. Avoid as much evening watering as possible.

3. Perennial problem greens (such as those with a trough running through the center, poor surface and subsoil drainage, built down in a hollow or pocketed by trees which shut off sunlight and/or air movement, poor soil mix or compaction problem, weedy, etc.) should be remade or relocated. The location of new greens, and what goes into and under them, should be the responsibility of the Superintendent and the greens committee. If you have the responsibility of maintaining greens, you should also play a major role in determining the construction of these greens.

4. Greens with a high percentage of sand provide excellent surface and subsurface drainage. These greens have the fewest disease problems because they drain excess water quickly and allow for plenty of pore space in the root zone.

5. If at all possible, keep large trees at least 50 feet away from all greens. Keep trees and shrubs pruned and thinned out to provide for maximum air flow across the green.

6. Fertilize to maintain as uniform a level of soil nutrients in the root zone as possible. This may mean more frequent but lighter applications than you are doing at present. The three major nutrients, N, P, and K, should be in balance with one another. When fertility is high and grass is making rapid growth in hot weather, watch out! You may be in serious trouble from Brown Patch, Melting-out, Pythium, or some disease.

7. Keep thatch at a minimum by using a "vertical mower" at regular intervals. Greens without thatch generally have the fewest disease problems and require the fewest fungicide applications.

8. Mow your greens as high as your greens committee and membership will allow. To produce a deep, vigorous root system remember that it still takes green leaves for grass plants to manufacture food. Too close mowing invites scalping and disease plus slowing recovery from ball marks, traffic around cups, disease, going-out of Poa annua, etc.

9. Use fungicides on a preventive schedule, based on your past records. There is no substitute for accurate records on each of your greens. Apply fungicides in 5 to 10 gallons of water per 1,000 square feet. High pressures (above 100 p.s.i.) are not necessary since the majority of disease-causing fungi invade healthy grass from the thatch or underlying soil. Five or 10 gallons of water is sufficient to soak the thatch and the soil surface.

When using fungicides which may burn, apply equally in two directions. Apply at dusk or early evening, on a decreasing temperature. This provides for maximum benefit, safety, and freedom from golfers.

Fungicides should be applied according to the manufacturer's directions. The interval between sprays will vary from 3 to 5 days (during hot, rainy weather) to 3 or 4 weeks (cadmium materials for Dollar Spot control). Many Superintendents follow a regular, weekly protective program.

The choice of chemicals to use becomes wider each year. See below. Considerations for choosing fungicides should be based on effectiveness, range of diseases controlled, safety to grass, interval between applications, resulting turf color and vigor ("eye appeal"), visible deposit on grass or not, cost, compatability with other fungicides and pesticides, availability, ease of going into and keeping in solution, irritation to eyes or skin, and other factors. If you don't like how a chemical acts, let your distributor know about it and he'll pass on your comments to the manufacturer. This is the best way of getting better formulations of more effective fungicides for you to use in the future. The tendency is strongly towards using mixtures of fungicides in each spray.

10. Be sure your sprayer is adequate for the job. Does it have an agitator? Is it big enough? An 18-hole course should have a sprayer with a tank capacity of 300 gallons or more. Otherwise, you're wasting valuable labor filling the spray tank every few greens. If an emergency arises (e.g., Pythium), you'll be in trouble with a 50-gallon sprayer!

11. Everything you do to your greens can be put on the plus side or minus side of the ledger as regards disease. When disease appears, think back and check your records. It means there is a weak spot in your cultural or chemical control program. Find that weak spot, correct it, and you've covered one more hurdle in becoming a topnotch Superintendent.

Fungicide		Trade Names
1.	mercury chlorides	Calo-clor, Calocure, Woodridge Mixture 21, Fungchex, Bical, Calogreen
2.	phenyl or organic mercury	PMAS, Liquephene Turfgrass Fungicide, Panogen Turf Spray, Puratized Agricultural Spray, Tag, Semesan Turf Fungicide, Merbam 10, Metasol P-6, Fermer, PMA Solubilized No. 10, Purfturf, etc.
3.	cadmium	Cadminate, Caddy, Puraturf 177, C 531, Chipman Cadmium Turf Fungicide, Cadox
4.	thiram	Tersan 75, Spotrete, Thiram, Panoram, etc.
5.	mercury-thiram (prepared)	Tersan OM, Thimer
6.	cadmium-thiram	Cad-trete
7.	complex 3 or more chemicals	Kromad, Ortho Lawn and Turf Fungicide
8.	captan	Captan 50-W, Orthocide 50 Wettable, Orthocide Garden Fungicide, Captan 75 Seed Treater, Orthocide 75 Seed Protectant, etc.
9.	zineb	Parzate Zineb Fungicide, Parzate C, Dithane Z-78, Blightox 65-W, Ortho Zineb Wettable, etc.

How to Collect and Send Turf Specimens for Disease Diagnosis

Using a 2" or 4" plug cutter, take several samples (2" to 4" deep) from the edge of the active disease area and from apparently healthy turf. Wrap plugs immediately in wax paper, newspaper, or paper toweling to keep from drying out. Do not add moisture. Pack samples tightly in an ice cream container, soil mailing tube, etc. and mail to:

Dr. M. P. Britton
244N Davenport Hall
University of Illinois
Urbana, Illinois.

Enclose a letter with each sample giving the following information: date collected; variety and kind of grass; when symptoms first evident; prevalence, degree and severity of damage; recent fertilization, watering, and pest control practices; fungicides used - rate, frequency of application; - and other phases of your management program which you feel will aid in diagnosis and suggestions for correcting the problem.

Remember - An accurate diagnosis is essential. And diagnosis can often only be as good as the specimens and information you send.

Chemical Control for Bentgrass Diseases

Disease	Disease active	Suggested Chemicals to Use	Remarks
Snow Scald Gray Snow Mold; Fusarium Patch, Pink Snow Mold	25° to 65°F.	Mercury chlorides*, thiram, phenyl mercury, phenyl mercury-thiram, cadmium-thiram, phenyl mercury-cadmium	Apply before first heavy snow or cold drizzly weather is forecast. Also treat aprons, tees, and other critical areas. Keep phosphate level up. Avoid late fertilizer applications, especially with nitrogen.
Dollar Spot	60° to 85°F.	Cadmium, phenyl mercury, Dyrene, Kromad, Ortho Lawn and Turf Fungicide, Acti-dione, mercury chlorides, phenyl mercury-thiram, cadmium-thiram	Maintain adequate to high fertility. Cadmium materials last longest. Grasses differ in resistance. Zineb increases Dollar Spot if used alone. Same cultural practices as for Brown Patch (below).
Brown Patch	70° to 95°F.	Mercury chlorides, phenyl mercury-thiram, Ortho Lawn and Turf Fungicide, mercury chlorides-thiram	Dyrene, Acti-dione, and Kromad may increase Brown Patch if used alone. Avoid overwatering, especially in the evening, and overfertilizing with quickly available, high N fertilizer. Increase air movement. Remove dew.
Melting-out, Helmintosporium	40° to 95°F.	Zineb, phenyl mercury, phenyl mercury-thiram, zineb-thiram, Kromad, Ortho Lawn and Turf Fungicide, Acti-dione-thiram, Dyrene	Zineb or captan soil drenches, 1 lb./1,000 sq. ft. provide emergency control. Best to follow a protective schedule. Same cultural practices as for Brown Patch (above).
Pythium	90° to 110°F.	Needs more research. Zineb soil drenches (1 lb./1,000 sq. ft.) at weekly intervals, alternating with regular fungicide program has looked good, as has mixture of Acti-dione-captan and Acti-dione-zineb	Same cultural practices as for Brown Patch (above). Shorten up spray program in hot, humid weather. When Pythium is active, do not mow, water, or go on greens before spraying. Keep greens as dry as possible. Dusting with lime may help.
Seed Rot, Seedling Blight, Damping-off	40° to 95°F.	Treat seed with captan or thiram. Apply seedbed sprays of captan, zineb, thiram, Kromad, phenyl mercury, mercury chlorides	Plant fresh, best-quality seed or stolons in well-prepared, fertile seedbed. Avoid over-watering after planting. Good soil drainage. Avoid low spots in seedbed.
Nematodes		Nemagon, Fumazone (available as granules, dusts, wettable powders, emulsions, mixed with fertilizer, etc.). First apply to a small area, preferably in the turf nursery.	First determine if you have a nematode problem. This is a job for a competent nematologist in a well-equipped laboratory (e.g., Dr. Donald P. Taylor, University of Illinois). Fertilize and water to keep turf vigorous and growing steadily.

* For listing of trade names see below.

B. CHEMICAL CONTROL LAWN GRASS DISEASES

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The accepted standard for fine lawns (and golf course fairways, cemeteries, and other turf areas) has risen steadily in recent years. This has resulted largely from continued research in turf culture such as watering, fertilizing and other maintenance practices, grass mixtures, introductions of new grass strains, plus new weed, insect, and disease control chemicals.

Lawn grasses (primarily bluegrasses and fescues) are attacked by more than 100 disease-causing organisms. Injuries vary considerably from year to year and even within a given season. The prevalence of diseases depends on such factors as temperature, humidity, rainfall, soil texture and drainage, grass varieties or species, turf vigor, presence or absence of thatch, and such cultural practices as watering, fertilization, mowing, and aerification.

Lawn grasses, and the fungi which cause plant disease, are both living organisms that require nutrients, moisture, and sunlight. The fungi are different, however, in that they cannot make their own food like living grass plants, but must obtain it from either living or dead plant material. When fungi attack living plants they cause disease.

When disease strikes your lawn or turf area several interrelated phenomena must have occurred: presence of a disease-producing organism, presence of a susceptible grass, correct temperature, moisture, state of turf vigor, and other factors which tended to favor the disease producing fungus over the grass host. Turf disease, then, is the end result of the interaction between a disease-producing fungus and a grass. In this case the fungus happened to get the upper hand.

Generally speaking, steadily growing grass that is established and maintained according to recommended management practices, is less likely to become seriously injured by disease attacks than grass which is not.

The severity of turf diseases may be kept at a minimum by following as many of the following practices as practical:

1. Provide for adequate drainage when establishing a new turf area.

2. Follow a recommended fertilizer program. Avoid excessive rates of fertilizers high in quickly available nitrogen during hot weather.

3. If possible, do not clip bluegrasses or fescues too closely - $1\frac{1}{2}$ to 2 inches in the spring and fall, and 2-3 inches during midsummer are usually recommended. Shorter clipping encourages a shallow root system. Creeping grasses such as Zoysia, Bermuda grass, and bent grass may be clipped $\frac{1}{2}$ inch or less.

4. Mow frequently so that no more than 1/3 of the leaf surface is removed at any one time.

5. Water 3 to 4 hours or more per setting in dry weather, so that the soil is soaked to a depth of 6 inches or more. Repeat in 1 to 2 weeks if the weather remains dry. Avoid overwatering, and water logging of the soil. The grass should be dry <u>before</u> evening. Remember that the more often grass is wet and the longer it remains wet, the greater will be the chance of a disease problem. This is because moisture is necessary for practically all fungi to penetrate grass leaves and stems and cause disease.

6. Remove clippings whenever possible. Nearly all parasitic fungi are capable of thriving in the damp mulch from clippings or thatch. Do not allow clippings to accumulate more than $\frac{1}{4}$ inch deep. Frequent mowing will help.

7. Prune or remove dense trees and shrubs which shade or border turf areas. This improves air circulation and light plus helping grass to dry off much more quickly.

8. Diseases spread and build up more rapidly in a pure stand of a single grass than where two or more grasses are mixed together.

9. Identify the disease correctly and apply the recommended fungicide spray when symptoms are first evident. The new broadspectrum fungicides, such as Ortho Lawn and Turf Fungicide, Thimer, Tersan OM, Kromad, Actidione, thiram, and Panogen turf spray are all effective for a number of the major turf diseases. We feel these are the chemicals which the home lawn enthusiast should use. Golf course superintendents and other professional turf people may well wish to check the list of chemicals recommended in the previous article, "Chemical Control of Bent grass Diseases."

10. Spraying is the preferred method of applying turf fungicides. Compressed air, knapsack, wheelbarrow-type force pump, trombone-type force pump or power sprayers may be used to deliver as low as $2\frac{1}{2}$ gallons per 1,000 square feet (for controlling Leaf Spot, Rust, Powdery Mildew) or as high as 10 gallons per 1,000 square feet (for controlling Snow Molds, Dollar Spot, Melting Out). The higher rate is usually used in hot weather to reduce injury from mercury-containing fungicides or other chemicals apt to cause burning. Turf injury may often be avoided by spraying in early evening, applying $\frac{1}{2}$ in one direction and the remainder in the opposite direction.

For a more complete discussion of lawn diseases, get a copy of "Lawn Diseases in the Midwest." Free copies are available by contacting your county extension office or by writing to the Department of Plant Pathology, 218 Mumford Hall, University of Illinois. The circular has 10 color plates of prevalent turf diseases and discusses a number of causes of poor turf which either resemble disease or which lead directly to disease. A summary of diseases controlled by various fungicides is presented in tabular form.

Chemical Control for Lawn Grass Disease

Disease	Suggested Chemicals To Use	Remarks
Leaf Spot, Melting-Out	Thimer, Tersan OM, Ortho Lawn and Turf Fungicide, Actidione-thiram, Zineb, Kromad, Panogen Turf Spray	Start applications in early spring when leaf spot is first seen. Repeat at 2- to 3-week intervals during spring and fall wet seasons.
Dollar Spot	Thimer, Tersan OM, Ortho Lawn and Turf Fungicide, Actidione-thiram, Kromad, Panogen Turf Spray	Attacks occur in warm (60° to 85° F.), moist weather in spring, early summer, and fall.
Powdery Mildew	Sulfur, Karathane, Actidione-thiram	Most prevalent in spring and fall in shady, damp location. If serious, affected turf may winter-kill.
Rust	Actidione-thiram, zineb	Water and fertilize to keep grass growing steadily during dry weather.
Snow Molds, Snow Scald, Fusarium Patch	Thimer, Tersan OM (apply once in late fall), Panogen Turf Spray	Attacks occur under snow at edge of melting snow, or during cold, drizzly weather. Avoid late fertilizer applications.
Seed Rot, Seedling Blight	After planting, apply seedbed spray of Kromad, Thimer, Tersan OM, Ortho Lawn and Turf Fungicide, Panogen Turf Spray	Plant fresh, best-quality seed in well-prepared, fertile seedbed. Avoid over-watering after planting. Avoid low spots in seedbed.
Fairy Rings	Thimer, Tersan OM, Panogen Turf Spray applied monthly in holes $\frac{1}{2}$ to 1 inch in diameter, 4 to 5 inches apart, and 6-8 inches deep in the ring of stimulated grass and about 6 inches outside the ring.	Very difficult and not always satisfying. Aerifying, fertilizing and watering breaks up the dense mycelial growth in the soil and "masks" the fairy rings.
Slime Molds	Same as for Leaf Spot, where practical	Non parasitic; will soon disappear. Wash or rake away.

Arsenic in Plants and Soils

Arsenic is found in all soils and plants. The quantity found in natural, or uncontaminated, soils varies somewhat with different regions; the dry to semiarid regional soils usually contain somewhat more arsenic than do soils of the humid temperate regions. Normal uncontaminated soils will usually contain less than 10 ppm (parts per million) total arsenic.

Arsenic, as a plant nutrient, has been studied extensively. Much of the early research work indicated that when small quantities, 5 to 10 pounds per acre, of arsenic were added to soils a plant-growth stimulus occurred, especially to vegetable crops. Therefore, the early introduction of arsenic-containing herbicides and insecticides in agriculture was not viewed with any expectation of serious damage to crops, although large amounts of arsenic were known to kill most plants. Later, arsenic was found to accumulate in soils and, with increased use of arsenical sprays, these soil accumulations eventually became harmful to all plants. Today many areas, especially old orchards and soils with a long history of vegetable production, are not producing maximum crop yields because of arsenic toxicity resulting from accumulated arsenic spray residues.

Plants are thought to absorb arsenic in the ortho-arsenate form. The available form is probably either the $HAsO_4^{--}$ or the AsO_4^{---} ion. Chemically, in many respects, the arsenate ions are quite similar to the phosphate ions. In soils, the arsenates are relatively immobile, being somewhat more strongly absorbed by soil colloids than the phosphates. This means that arsenates are not subject to leaching and that their downward movement in soil will be very slow.

Arsenic in Plants and Soils

Normal soils are usually quite low in total arsenic and most plants contain only a very few parts per million on a dry weight basis. Table 1 shows several typical total arsenic analyses of some common plants and the soils on which they grew. For most plants the normal arsenic content is usually under 2 ppm, although a very few may contain as much as 5 ppm without showing signs of toxicity. However, 5 ppm of arsenic in leaves or stems is toxic and detrimental to the normal growth of most agronomic crops.

Arsenic spray residues accumulate in the surface crust of soils. The depth to which they may accumulate is usually determined by the depth to which the land is worked or cultivated. The arsenates are not readily leached downward into a soil. This relative immobility is illustrated by the data in Table 2, where the depth of accumulation is shown to be largely restricted to the surface, or plow layer depth.

Table 2 shows the distribution of arsenic, by depth, in orchard soils as compared with untreated soils, and indicates that essentially no change in arsenic concentration has occurred below the cultivated depth, although these orchard soils have been sprayed for 15 years or more. Unfortunately, the exact quantities of arsenical sprays that have been applied are not known, but all of the "treated" soils are now toxic to crops like oats, beans, and peas. In undisturbed orchard soils, that is, where cultivation between or around the trees is not practiced, the arsenic accumulation in the first inch, or surface crust, of soil often exceeds 1000 ppm.

Table 1. Normal Arsenic Content of Some Crops and Soils

	Arsenic Content	
	Plant ppm. As	Soil ppm. As
Western wheatgrass	2.3	9.3
Blue grama	1.7	9.0
Sunflower	4.2	8.6
Red clover	1.0	7.0
Barley	1.0	5.0
Cocklebur	1.0	7.0

Table 2. The Accumulation and Movement of Arsenic in Some Orchard Soils*

Soil Texture	Untreated		Treated	
	Depth inches	As ppm	Depth inches	As ppm
Clay loam	0-12	11	0-8	61
	12-16	9	8-16	18
			16-24	9
Silt loam	0-12	7	0-8	63
			8-16	8
			16-24	7
Sandy loam	0-12	7	0-8	45
	12-16	9	8-16	9
			16-24	11

*Represents approximately 15 years of normal orchard spray accumulations.

Roots preferentially accumulate arsenic in greater quantities than do the leaves or stems; for this reason, total analysis of the above-ground parts of a plant reflect arsenic toxicity less strikingly than does root analysis. The selective accumulation of arsenic in roots is illustrated by the data in Table 3, which shows some root and plant-top analyses for both natural and contaminated soils. In all cases, the "treated" soils are old orchard soils that exhibit toxicity to the respective crops shown in the table.

Table 3. Arsenic in Soils and Plant Parts

Crop	Plant part	Arsenic (As) content: Native Conditions, Soil part	Native Conditions, Plant ppm	Old Orchards, Soil ppm	Old Orchards, Plant ppm
Beans	Vines	3.0	0.18	66	1.8
	Roots		0.29		5.7
Vetch	Hay	3.0	1.2	66	1.9
	Roots		7.1		15.8
White clover	Pasture	4.5	3.6	95	6.3
Corn	Stalks	4.5	0.7	95	2.7
Alfalfa	Hay	4.0	2.0	105	3.4
	Roots		0.8		63
Beets	Tops	4.0	1.4	115	3.5
	Roots		1.3		20
Oats	Tops	6.0	2.3	30	4.5
	Roots		6.0		135
Cowpeas	Tops	6.0	2.3	30	8.0
	Roots		7.5		30

Testing Soils for Arsenic

Little attention has been given to testing soils for available arsenic. Early investigators usually determined the total arsenic in the soil. Later, such extractants as 0.1 N NaCl, Morgan's ammonium acetate, and Bray's P-2 phosphorus extracting solutions have been used to extract arsenic from soils, and to evaluate its toxicity. Table 4 gives a comparison of the quantities of arsenic extracted from various soils by these extractants. None of these extracting solutions has been tested adequately enough to permit a critical evaluation of its effectiveness in predicting arsenic toxicity.

Table 4. Extractable Arsenic in Soils

Soil	Total ppm As	0.1N NaCl ppm As	Morgan's Extractant ppm As	Bray's P-2 Extractant ppm As
Toxic	106	5.8	12.5	100
Toxic	385	1.7	9.5	281
Toxic	702	8.3	3.3	618
Non-toxic	13	0.6	1.0	11
Non-toxic	6	0.1	1.0	4

Arsenic is difficult to determine chemically in the presence of phosphorus. Both give a blue color in the molybdenum blue procedure. Each interferes with the other in its chemical determination. Therefore, arsenic is usually separated from the phosphorus through reduction and distillation procedures, reoxidized to arsenate, and then determined colorimetrically with molybdenum blue.

Reclaiming Arsenic Toxic Soils

Reclaiming arsenic-toxic soils is a difficult and time-consuming task that is seldom completely successful. Two approaches are usually taken; (1) the mixing and diluting of the surface-crust accumulation with the rest of the soil, and (2) the applying of large amounts of phosphorus fertilizer to minimize the absorption of arsenic by the plant. Since the arsenical sprays accumulate on the surface of the soil, seed germination and early growth are severely inhibited unless this surface-crust accumulation is diluted either by being thoroughly mixed with the rest of the tillable surface soil or partly buried through deep plowing. If, at the same time, large applications of phosphate fertilizers are applied and incorporated into the soil, the amount of arsenic absorbed by the crop can be reduced to a minimum. The quantity of phosphate needed will depend upon the amount of arsenic in the soil and how well it has been distributed through the surface soil. Suggested recommendations for old orchard soils have varied from 200 to 600 pounds of P_2O_5 per acre, depending upon the severity of the arsenic toxicity. The results obtained, while encouraging, have been variable and never completely successful.

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TURFGRASS MANAGEMENT versus RENOVATION

By: Tom Mascaro

Renovation has received a great deal of attention in recent years. The definition of "Renovation", according to Webster, is "To renew or bring back to its' original state."

Many times turfgrass areas which are extremely good to start with gradually degenerate through the years. When this happens, then we must renovate -- renew -- or bring back to its' original state.

It seems to me that much more thought should be given to Turfgrass Management rather than Renovation. Renovation, of course, is necessary when turf areas have degenerated so badly that it is better to start over again. However, after renovation has taken place, then we should direct our thinking to Turfgrass Management in order to eliminate the need for renovation. Assuming that the turfgrass selected for an area is the right one, fertilization and irrigation is adequate, we can assume that the two greatest enemies of turf are compaction of the soil and thatch.

I believe that most of you are familiar with compaction, and what it can do to restrict root and plant growth. Let us elaborate on compaction for a moment. If you were given a plot of land, you would require one basic tool in order to grow a crop. This basic tool would not necessarily be a tractor since you can always use a mule. The basic tool, of course, is the plow. The farmer knows that he must renew soil structure each year to eliminate compaction that has formed through the growing season. Soils, regardless of their texture, naturally become compacted. If the farmer thought that all he needed to do was to punch a hole in the ground and drop in the seed, he would certainly not go to all the trouble of plowing, disking, and leveling. He knows, however, that if he doesn't renew soil structure with the plow, he isn't going to get much of a crop. Turfgrass areas become compacted too, whether they are heavily used or not. The degree of compaction, of course, is accentuated when a turf area is heavily used. Therefore, if we are going to think in terms of turfgrass management, it becomes vital that we think in terms of renewing soil structure. This can be accomplished quite easily with modern up-to-date equipment, especially designed for this purpose. There is no excuse for compaction of turfgrass areas. Soil structure can be renewed without taking the areas out of play.

The second problem I mentioned is thatch. "Thatch" is a comparatively new word that has gained popularity in turfgrass terminology. Thatch simply means an excess crop of grass. Thatch is the accumulation of clippings, dead leaves, and stems that accumulate on the soil surface. Present day mowers, either reel or rotary cutters, are horizontal cutting units. These mowers clip not more than 20% of the growing grass. The rest of the plants lay below the height of the cut and as the plants develop, these old leaves slough off and die. Since the height of the cut is determined by the mower wheels and these wheels ride on the surface of the accumulated thatch, heights of cut vary considerably from one turf area to another in spite of the fact that mower setting is the same. Height of cut for each grass is determined from the soil surface to the tip of the grass blade. Accumulated thatch can alter this height considerably.

In the early days of Turfgrass Management, Superintendents did two things which were mighty important. They top dressed the areas wherever possible and they raked out the accumulated thatch with their rakes. Today we have modern equipment that does these jobs quickly and efficiently.

There is a great deal of evidence to support the thinking that Turfgrass Management without Renovation can be a reality. Aerification not only relieves compaction but it, also, deposits a great deal of soil on the turf surface. This soil mixes with the accumulated thatch to help decompose it into usuable humus. In order to assist in the decomposition of accumulated thatch, nitrogen and lime should be added to make conditions favorable for controlled decomposition. Excess thatch can be removed periodically with modern equipment.

A program of Turfgrass Management, such as I have outlined, not only insures a continuing stand of good turf but, also, insures against the need of periodic renovation. There are, of course, many factors other than those that I have mentioned which will adversely affect a turfgrass area from time to time. However, if the root system is extensive and the turf is growing in the soil, instead of on a thatch layer, chances are much better to survive adverse conditions.

TURFGRASS MIXTURES - INFLUENCE OF MOWING HEIGHT AND NITROGEN

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I. Bentgrass in Mixtures:

Bentgrass has completely taken over any grass used with it in tests at Wooster. Furthermore, it spreads into adjacent plots and eventually takes them over. Table 1 shows the percent of the sod area occupied by bentgrass five years after seeding the various grasses and mixtures in a Wooster test.

Table 1 - The bentgrass content of selected treatments five years after seeding.

Mixture or Grass	Height of Mowing 3/4" %	2" %
Bluegrass-bent-redtop	100	100
Common Ky. bluegrass	74	45
Chewings fescue	35	42
Red fescue-Merion	49	19
Merion Ky. bluegrass	55	12
Creeping red fescue	41	24
Pennlawn fescue	17	0

Bentgrass was more competitive when the grass was mowed at 3/4 inch than when mowed 2 inches. However, bentgrass spread in all plots regardless of mowing height. This test was not irrigated. Bentgrass would probably be even more aggressive under irrigation.

II. Bluegrass Varieties:

Eighteen varieties, common lots and breeder's selections of Kentucky bluegrass were seeded in September, 1956. They have been mowed at 3/4 inch and 2 inches since establishment. Three pounds of nitrogen per 1000 sq. ft. as ammonium nitrate have been applied annually, half of it in September and half in April. Table 2 shows the weed content in 1960 and 1961 as influenced by variety and height of mowing. The only herbicide treatment was an application of 2,4-D in October, 1957.

Table 2 - The weed content of selected varieties of Kentucky bluegrass.

Variety	Weeds per 10 sq. ft. October, 1960 Mowed 3/4"	Weeds per 10 sq. ft. October, 1960 Mowed 2"	Weeds per 10 sq. ft. October, 1961 Mowed 3/4"	Weeds per 10 sq. ft. October, 1961 Mowed 2"
Breeder's Merion	8	0	22	1
Penn. K-1	10	1	21	1
Wash. Poa	38	2	82	2
Minn. Common lot	103	3	198	6
Delta	102	11	114	6
Park	105	8	145	6
Ky. Common lot	108	5	98	1
Neb. Common lot	150	6	186	6

Merion, Penn K-1 and the selection from Washington make a tighter sod which offers more resistance to weed invasion than Delta, Park and the common lots. At least one reason for the tighter sod is their resistance to leaf-spot (Helminthosporium vagans). All of the varieties contain less weeds when mowed 2 inches high than when mowed 3/4 inch. There is less advantage to mowing Merion, Penn. K-1 and the Washington selection 2 inches than the other varieties and common lots.

The bluegrasses which are better able to keep out weeds also generally contain less white clover (Table 3). The height of mowing has not affected the degree of clover invasion.

Table 3 - The percent clover in selected varieties of Kentucky bluegrass.

Variety	% Clover Oct., 1960 3/4"	% Clover Oct., 1960 2"	% Clover Oct., 1961 3/4"	% Clover Oct., 1961 2"
Breeder's Merion	11	1	5	1
Penn. K-1	2	2	4	4
Wash. Poa	1	15	4	9
Minn. Common lot	15	6	4	12
Delta	5	18	6	8
Park	9	17	16	12
Ky. Common lot	26	18	6	10
Neb. Common lot	20	29	14	19
Avg. (All plots in test)	13	14	9	9

III. Lawn Grasses and Mixtures:

Twenty grasses and mixtures were seeded August 28, 1958. Each received two levels of nitrogen fertilization ($1\frac{1}{2}$ and 5 lb. N/1000 sq. ft./year) and two heights of mowing (1" and 2"). The resulting sods were analyzed the fall of the seeding year and each fall thereafter. One point of interest is the influence of mixture, mowing and nitrogen on the amount of redtop remaining in the sod (Table 4).

Table 4 - The influence of mixture, mowing height and nitrogen on the % redtop in the sod, October, 1960 and 1961.

Mixture	Seeding rate/1000 lb.	Year	High Nitrogen Mowed 1"	High Nitrogen Mowed 2"	Low Nitrogen Mowed 1"	Low Nitrogen Mowed 2"
Merion bluegrass 85%		1961	3	3	2	3
Redtop 15%	1	1960	0	0	0	1
Common Ky. bluegrass 85%		1961	34	48	18	25
Redtop 15%	1	1960	7	24	6	22
Domestic ryegrass 50%						
Red fescue 25%						
Ky. bluegrass 15%		1961	45	54	6	10
Redtop 10%	3	1960	37	67	6	26
Domestic ryegrass 70%						
Ky. bluegrass 20%		1961	44	76	21	52
Redtop 10%	3	1960	78	91	45	64

Redtop has difficulty surviving the competition of Merion bluegrass, but it is a prominent part of other mixtures in which it was seeded. The coarse texture of redtop makes it undesirable in a bluegrass sod. Redtop is favored by high mowing and a high rate of nitrogen, the same treatment that bluegrass needs. Redtop has been observed to survive with common Kentucky bluegrass for more than 10 years, making its "short lived perennial" classification very doubtful for the Wooster, Ohio area. Where redtop and ryegrass were used in the same mixture, redtop dominates the sod after the death of ryegrass. Other mixtures containing only ryegrass and bluegrass now have as much bluegrass as where bluegrass was seeded alone, if no more than one pound of ryegrass per 1000 sq. ft. was seeded. A light seeding of ryegrass appears to be a better quick growing companion for common Kentucky bluegrass than redtop. Of course, where the situation does not demand a quick growing grass, both ryegrass and redtop had best be left out of the mixture.

Another point of interest is the influence of mixture and mowing height on the crabgrass in the sod (Table 5). There is little crabgrass in any mixture when mowed 2 inches high. It took only 3 seasons of differential mowing to show the large difference in crabgrass infestation. Nitrogen had little influence on crabgrass content.

Table 5 - The effect of selected mixture and mowing on the % crabgrass in the sod, October, 1961.

Mixture	Mowed 1"	Mowed 2"
Merion bluegrass-redtop	3	0
Delta bluegrass	8	1
Pennlawn fescue	20	0
Creeping red fescue	19	1
Common Kentucky bluegrass	20	1
Domestic ryegrass-Ky. bluegrass-redtop	31	1
Domestic ryegrass-Ky. bluegrass	36	2
Avg. 20 mixtures	15	1

IV. Nitrogen Fertilization and Weed Content of Merion Bluegrass:

Three forms of nitrogen, many rates, frequencies and time of application are being used in a test with Merion bluegrass. If all the other variables are grouped, the influence of nitrogen rate on the weed and clover content of Merion is shown in Table 6. All plots were treated with silvex in October, 1959 after the weeds were counted. No other herbicide treatments have been applied. The Merion is mowed 1-1/4 inches high.

Table 6 - The weed and clover content of Merion bluegrass as influenced by nitrogen fertilization.

N/1000 sq. ft. per year 1-lb.	Weeds/10 sq. ft.		% Clover in sod	
	1959	1961	1959	1961
10	0	4	0	0
7	1	2	0	0
5	4	7	1	1
2	8	18	5	5
0	22	43	15	20