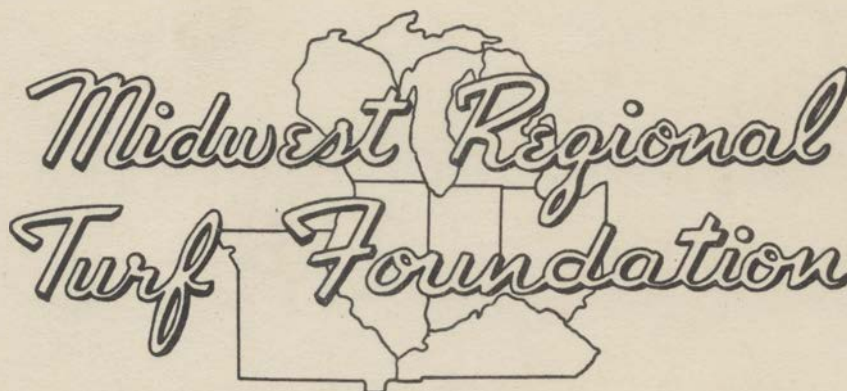


PROCEEDINGS
of
1958 TURF CONFERENCE

Sponsored by the



and

PURDUE UNIVERSITY

LAFAYETTE, INDIANA

March 3, 4, 5, 1958

PROCEEDINGS OF THE
1958
MIDWEST REGIONAL TURF CONFERENCE

The 38 articles included in these Proceedings are condensations of 44 talks by speakers before sections and divisions of the 1958 M.R.T. Conference. We appreciated the willingness of the speakers to participate and prepare material for your reading. See Table of Contents next page. Proceedings of each annual Conference since 1948 have been prepared. A limited number of 1955, 1956 and 1957 Conference Proceedings are available at price below.

A copy of these Proceedings were mailed to:

1. The 536 attending the 1958 Midwest Regional Turf Conference.
2. The Superintendents of Member Organizations in the Midwest Regional Turf Foundation not attending the Conference.
3. List of those in educational activities.

Additional copies are available at \$ 1.00 each from:

W. H. Daniel, Executive-Secretary
Midwest Regional Turf Foundation
Department of Agronomy, Purdue University
Lafayette, Indiana

Attendance divided by interest as
judged by registration card

Golf Courses	294
Turf Materials and Supplies	93
Sod and Landscape Service	54
Parks (most have golf courses)	26
Industrial Grounds	18
School Grounds	10
Cemeteries	6
Non-profit & Universities	<u>35</u>
Total	536

Distribution by states

Indiana	117
Illinois	208
Ohio	98
Michigan	28
Wisconsin	34
Kentucky	9
Missouri	19
Outside Midwest	<u>23</u>
Total	536

Attendance by area represented by
the 13 Golf Course Supts. Ass'n.

Midwest	164
Indiana	64
Northern Ohio	39
Cincinnati	31
Michigan	21
Miami Valley	15
Mississippi Valley	23
Wisconsin	34
Michiana	22
Kentuckiana	15
Central Illinois	38
Central Ohio	13
Western Michigan	7
Outside Midwest	23
Purdue	<u>24</u>
Total	536

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PRESIDENT'S REPORT

(Before business meeting)

The Midwest Regional Turf Conference has gained the reputation of being the largest and finest, with an attendance of 511 in 1957. The membership has made a steady climb to reach a high of 298. We are proud of our rapidly growing turf program at Purdue. As 1958 begins, we have six graduate students working on turfgrass problems. Besides this we have 14 students taking an undergraduate major in Turf Management. Two of these are on a scholarship and 8 work part time in the Turf Research program.

I doubt if the few men who attended the first organization meeting could have visualized such a tremendous growth. The founders were mostly interested in golf course maintenance, and the first few Conferences were related to these subjects. But today we find that of the 511 who attended the 1957 Conference 224, or nearly one-half, were interested in other turf work. The present Turf Conference and research program is meeting this challenge with the continuity of the development of the total turf program.

The work of development of this program has fallen on the shoulders of a few. Our thanks to Dr. Peterson for his fine support and encouragement; Dr. Mött for his guidance and loyal friendship. Mrs. K. House and Norman Goetze have done a tremendous job throughout the year, keeping the office and turf program running smoothly. Mike Britton, Dr. Pickett and all the turf students have helped toward this success. But most of all we owe our gratitude to Dr. Daniel for his perseverance, leadership and loyalty.

If we are to continue to increase the turf program at the present rate we must have more operating funds. Your dues and registration have remained the same for many years, yet costs have continued to rise each year. If your organization is not a member I urge you to please get an application at the desk before leaving. Your support is needed.

It has been an honor and a privilege to serve you as President, and I look forward to helping in any way to keep this organization a success.

Respectfully submitted,
Marion Mendenhall,
President 1957-58

EXECUTIVE REPORT, 1958

Friends, may I thank you for coming this year to another Conference. Certainly you make the Conference a success by attending, listening, asking, and applying knowledge to your situation.

To my surprise, in checking over the last year, there were 22 trips made within Indiana, and 22 made outside of Indiana. This equals the average of the last four years. I would like to especially thank you who helped in your districts and drove cars, arranged trips and meetings.

Your Board of Directors will get a breakdown of our expanding turf program, but since 1951 it has tripled. As your Treasurer reports, we get about one-third of our cash support from your memberships in M.R.T.F. And you are encouraged to help promote our Foundation both among your friends - and enemies - if you're plagued with them.

Last night you met some of the students. They are learning - we expect much of them. It is to our mutual credit to have a strong student program. Today we have 14 undergraduates and 6 graduates. We have eight undergraduates working, plus the six graduate students. Norm Goetze, Jim Beard, Mike Britton have done and are doing an excellent job.

As we have increased student contact, it becomes necessary to reduce some travel and extension activities. You have been very kind about this.

The office secretary, Mrs. Kaye House, is due a special vote of thanks. Her tremendous assistance in M.R.T.F. affairs and sincere office work is appreciated. And when the Proceedings are delivered within two months, you will understand how fast she works.

May I thank your Board of Directors for their assistance and co-operation. Equally Dr. Peterson, Director Volk and the administration receive my expression of thanks for their able support.

William H. Daniel,
Executive Secretary.

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STRENGTH FOR TOMORROW

(Excerpts of Banquet Address)

Dr. Robert T. DeVore, Midwest Manager
Extension Division, DuPont Company

"A solid basis for confidence and faith" in the future of America may be found in "the record of the free economy in creating new opportunity for people in ever increasing numbers" and an "unsurpassed" capacity to produce for defense. A man looking for a job will find it difficult to reflect upon, much less be consoled by, the fact that the nation never had it better than in 1957. He will find little comfort in recalling that every generation of Americans has had great difficulties to overcome. Yet, lack of confidence will serve him worse than all other feelings he could have, save that of fear.

Industrial and agricultural productivity, rather than the first intercontinental ballistic missile, will prove to be the ultimate weapon. The central fact of our times seems to me to be that this still is the

strongest country on earth, in a way not only fundamental to its problems at home, but far more basic to its defense needs than its present position in the missiles race.

Man for man, hour for hour, the productive capacity of our industry is unsurpassed. Free America has done the best job in the world, up to now, in using science to develop more efficient methods and tools of production. Referring to big business, company size "largely is determined by the economic job for which it has accepted responsibility." Sometimes the brainpower of hundreds of scientists and specialists has to be focused upon "a succession of complex problems" and tens of millions of dollars have to be risked upon the success of a single research development.

American business is neither big, medium nor small. It is a great complex of all sizes, each incapable of existing alone, but adding up to the most productive and strongest national industrial plant in the world. Only by learning, through research, how to produce more goods for less time and effort can purchasing power be created. The purchasing power alone is to raise living standards, pay for the improvement of education, step up publicly supported research, buy new weapons for defense, and increase the support of our churches.

(Above are selected remarks.) Editor

NITROGEN MATERIALS AND THEIR UTILIZATION

Dr. D. W. Kolterman, Nitrogen Division, Polychemical Dept.
E. I. du Pont de Nemours & Co., Inc., Wilmington, Delaware.

(Each of the 4 major nitrogen suppliers were asked to present limited material on their materials and use. After this questions were answered).

1. Nitrogen nutrition is one of the most important phases of turfgrass management. Nitrogen means growth; nitrogen means color.
2. Special purpose grasses are somewhat unique in the plant world in that vigorous and attractive vegetative growth is demanded of them not only year after year, but also for the maximum period of time each year.
3. To fulfill this rigid requirement, grasses on even originally fertile soils must be given adequate nitrogen through repeated fertilization.
4. Too much available nitrogen can be disastrous faster than too little.
5. Source of nitrogen -- whether native soil fertility, soluble, natural organic, or synthetic organic fertilizers -- is immaterial to grass plant as long as it gets the right amount at the right time and in available form.

6. Nitrogen feeding can be accomplished with any of the three classes of nitrogen fertilizers -- soluble, natural organic or synthetic organic -- provided each is employed in accordance with its availability characteristics.
7. Soluble nitrogen -- Ammonium, nitrate, urea, etc. -- These are quickly available -- require frequent light applications -- low material cost, but high in labor cost, easily misused, require strictest use management.
8. Natural Organics -- Sewage sludges, vegetable proteins, tankages, etc. -- These have considerable advantage over solubles. More slowly available and require less frequent applications and are safer -- require less use management. However, they have low nitrogen content and are higher in cost.
9. Synthetic organics -- Ureaform fertilizers have more ideal release characteristics and a higher nitrogen content. These require the fewest number of applications, provide available nitrogen most nearly in accordance with growth conditions and grass needs, require least management effort. High in material cost, but lowest in labor costs.
10. Use of any nitrogen fertilizer must meet a single need -- adequate but not excessive available nitrogen in the root zone throughout the growing season. This may require a widely varying soluble or natural organic feeding program as dictated by climate and environmental conditions. It may mean supplementing a ureaform feeding program, particularly if feeding level has been incorrectly judged, with light applications of soluble nitrogen.
11. The Du Pont Company supplies two of the three classes of nitrogen fertilizers to the professional turf grower. Soluble urea nitrogen -- as "NuGreen" fertilizer compound. Synthetic organic ureaform -- as "Uramite" fertilizer compound.
12. Urea -- relatively long lasting soluble nitrogen source, ideal for solution or solid application; highest nitrogen content of solid fertilizers, 45%; leach resistant; non-corrosive; and compatible with pesticide sprays. Used widely to color up turf with light spray applications. Often applied as
13. Ureaform -- Methylene urea products formulated to release a gradual supply of nitrogen in the soil. Ureaform manufacture requires extremely precise process control since a slight deviation may result in severely lowered fertilizer quality. Buttons and telephone receivers, worthless as fertilizers even though finely ground, are made from the same ingredients as ureaform. The fertilizer value of ureaforms is determined solely by two factors -- amount and quality of the insoluble methylene urea nitrogen. Fortunately chemical methods exist (and have been adopted by State Fertilizer Control Chemists) for determining ureaform quality before their sale and application. Du Pont's "Uramite" fertilizer compound is consistently manufactured and sold at a quality level well above the minimum required by law.
14. Du Pont also supplies these two types of nitrogen to the fertilizer industry for manufacture of complete mixtures. Same high quality standards maintained for both.

15. "Uramite" fertilizer compound has gained widespread acceptance in the United States and Canada since its introduction to the trade in 1955. Results on turfgrasses, flowers and woody ornamentals have been excellent. A large number of golf courses have already standardized on "Uramite" for their basic nitrogen supply on greens and tees. Use is expanding at an ever increasing rate today.
16. The above has dealt with nitrogen only in turfgrass management. No intent to discount the importance of other phases -- other nutrients, watering, mowing, disease control, etc. -- is implied. No nitrogen fertilizer or application technique can give desirable turf alone. A complete management program -- from budget to play -- will always be necessary.

NITROGEN MATERIALS AND THEIR UTILIZATION

C. G. Wilson, Agronomist
Milwaukee Sewerage Comm., Milwaukee Wisconsin

(Second of 4 articles by nitrogen suppliers on their products and their use. After this questions were asked.)

As Dr. Daniel has told us to "pull no punches", it could be in order to regale you with facts and figures on why MILORGANITE is the world's best turf fertilizer. In our manufacturing process quality is controlled, not only at the plant, but also by governing what industry may, or may not, dump into our sewers. Our slow, expensive rotary kiln drying makes Milwaukee's activated sludge both granular and dust-free. And proper granulation is important to the user since dusty materials break down too rapidly to give the best results on turf. This same heating for granulation produces natural organic fertilizers. We can now produce a pharmaceutical grade of Vitamin B-12 by a simple leaching process with water. This has been approved by the Pure Food and Drug Administration for use in animal feeds.

You, the user, have helped us gather information throughout North America for a third of a century. We could give our views on the importance of all plant food elements - not just nitrogen, phosphorus and potash. In the true definition of the term, there is no other fertilizer any more complete than Milorganite because it contains every element proven to be necessary for growth. It contains better than 6 per cent iron in an organic or chelated form and there will never be any danger of a sulphur deficiency where MILORGANITE is used.

We may rely on what others report with respect to MILORGANITE and its unknown - yet every day more apparent - "plus" values which may be entirely separate from the field of nutrition and an unpaid for dividend that goes to any MILORGANITE user. Leo Feser has been a staunch believer in MILORGANITE ever since production started. For the purpose of this talk we are using some of the remarks made by Leo in our advertisement in the May, 1954 Golf Course Reporter. Here it is in his own words:

"More than twenty years ago dollar spot ceased to be a problem at Woodhill Country Club and at Orono Golf Course. Since then no fungicide has ever been applied to specifically control

this disease. Both courses are located near Lake Minnetonka, Minnesota.

A simple fertilizer program based on the use of Milorganite and a compost containing the equivalent of 450 lbs. phosphorus and 800 lbs. of potash (by quick soil test), plus ample calcium, was adopted in the early 1930's. At Woodhill some additional phosphorus and potash was applied in 1952; at Orono no other materials have ever been used. The Milorganite was applied at the rate of 10 to 15 lbs. per 1,000 sq.ft. at 10-day intervals; the topdressing at the rate of 3/4 yard per 5,000 sq.ft. from two to four times a season.

Our first check on the value of this practice came in 1942, when because of conditions due to the war, we discontinued the procedure. In August of that year severe attacks of dollar spot occurred on several greens. Applications of Milorganite immediately remedied the situation.

Our purpose is to show how Feser solved his problem. It is not our intention to imply that there is no place for fungicides in turf maintenance. We know that sensible feeding with Milorganite reduces the amount and severity of dollar spot and other diseases. That, in part, is how Milorganite promotes the efficiency of fungicides when they are needed.

More recently, the Department of Agriculture Experiment Station at Tifton, Georgia has been investigating various nitrogen sources on bermuda turf. Coincidental to this investigation they experienced a severe attack of "Cottony Blight" disease in December, 1956. Cottony Blight is caused by pythium, and occurs on ryegrass overseedings during hot, humid weather. In this respect it is similar to the pythium that takes its toll of bentgrass during hot, muggy weather in this area. The following chart indicates quite strikingly the influence of nitrogen sources on pythium disease.

NUMBER COTTONY BLIGHT SPOTS PER PLOT

"Tifton Turfgrass Conference April, 1957"
(Disease outbreak during Dec. 23-29, 1956)

Nitrogen Sources on Ryegrass	Number of Applications per year		
	12	4	2
1. Uramite	91.	107.	85.
2. Milorganite	76.	28.	36.
3. Ammonium Nitrate	124.	132.	98.
4. Urea	-	99.	-
5. No Nitrogen	-	-	-
			111.

18 lbs. Total N

- 12* - Applied June, July, August, September,
October, November and December (1½ lbs. N)
- 4 - Applied June, September and December (4½# N)
- 2 - Applied June and December (9 lbs. N)

These findings by Homer Wells, Plant Pathologist at Tifton indicate:

1. Milorganite causes an inhibiting influence on pythium that is not apparent in the other fertilizer materials used - especially at the heavier rates of application.
2. Milorganite can be applied at heavy rates without damaging tender young ryegrass.
3. Further research is needed on the relationship of fertility to hot weather diseases like pythium.

For many years Rutgers University in New Brunswick, New Jersey has carried on disease experiments on their turf plots. In the 1951 National Turf Fungicide Trials, Davis and Engel reported, "with all application rates of Milorganite, the brown patch was less than with the 8-6-4 fertilizer on both Colonial and Seaside bents." That same year they found Milorganite used at a rate to supply about $1\frac{1}{2}$ pounds of actual nitrogen per 1,000 sq.ft. per month of good growing weather resulted in dollarspot-free turf even without fungicide.

Last year the Sewerage Commission established a fellowship at Rutgers to investigate "The Effect of Nitrogen Source on Disease Incidence of Turfgrasses."

Ammonium nitrate, ammonium sulfate and urea were used as soluble nitrogen carriers; Agrinite represented leather tankage; Uramite represented urea formaldehyde; and Milorganite represented activated sewage sludge. The materials were used at rates to apply $3\frac{3}{4}$, $6\frac{3}{4}$ and $11\frac{1}{4}$ pounds of actual nitrogen per 1,000 sq.ft. for the season.

The preliminary findings of this project were reported at the New Jersey Turf Conference in January 1958 by Cook, Engel and Bachelder. Some of this material, in their own words, is given here.

"Conclusions can seldom be based on one season's results. However, several trends were observed during the first season's growth which will appear to be of considerable interest. They are as follows:

1. Organic (insoluble) nitrogen carriers in general gave a more uniform growth than inorganic (soluble) carriers.
2. A single heavy application of Uramite did not give as uniform growth pattern as equivalent amount in several lighter applications.
3. Regardless of the source or rate of nitrogen, great fluctuations in growth occur due to weather.
4. Dollar spot was favored by low nitrogen levels.
5. Leather tankage did not hold up well from mid-July to mid-August, and the heavier rate had more disease than the unfertilized check.
6. There was a definite trend as the season progressed with all rates of nitrogen fertilization for Milor-

ganite to produce a greater cumulative effect on growth than ureaformaldehyde. This is contrary to some proposed thinking, and it shows Milorganite may be producing healthier turf through disease inhibition or better balanced nutrition.

7. The high ranking of Milorganite plots with regard to dollarspot, supports the thesis that some factor other than nitrogen was inhibiting disease."

We trust the foregoing information will help explain why Milorganite has withstood the test of time. Without fanfare, little advertising and no high pressure methods, Milorganite remains the standard to which other turf fertilizers aspire. In summation, we like the recent report from one of our distributors. It seems that a new man hired by the local competition tried to get his foot in the door by appealing to the grower's professional competence. This chap's pitch was: "Anybody can grow good grass with Milorganite, but it takes real skill to make our product work."

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NITROGEN MATERIALS AND THEIR UTILIZATION

Charles W. Stewart, Corn Products Co., Argo, Ill.
(Presented before the Golf Section)

Our testing of products to feed turf began in 1951 by evaluating some of our products for expanding their use in other fields.

For turf work we prepared a plot and bought 120 square yards each of good bluegrass and Washington bent sods. As soon as these were established they were staked off into small plots and each treated with different rates of brand name fertilizers and other nitrogenous materials including urea, ammonium sulfate, tankage and corn gluten meal containing 8% N. All clippings were collected, weighed and analyzed for nitrogen.

The ammonium sulfate and urea jumped off to a fast start and soon dropped off. Other materials held up longer and the corn gluten meal applied at 3 levels continued good growth throughout the season. The next spring when this grass began to grow, we found the gluten had carried over and growth on these plots was well ahead of the others.

With this information I contacted Bob Williams, Supt. of Beverly Country Club, to come over and see the plots and go over the data. He brought Bill Daniel along. Williams treated half the 18th green at Beverly Country Club with corn gluten meal and the other half with regular fertilizer. About three weeks later Bob called and asked me to come over. We went out to the green which had been cut the day before. There Bob said, "What is in this stuff? I know if I put down nitrogen the grass grows better and faster. If I cut the grass I must wait for the grass to grow again to tell the difference in treated areas, but here, although this green was cut yesterday evening, I can close my eyes, walk across the green and tell the edge of the treated and untreated area. The grass is firmer in the gluten area."

Next he treated one-half of 3 tees, dividing them lengthwise with the fairway and watched them during the season. It wasn't long before 85-90 percent of the play - judged by scuff marks - was from the area treated with corn gluten meal. We also noticed that the scuffs on the treated section healed rapidly, while many of those on the untreated area had to be reseeded or patched.

In order to try corn gluten meal in different areas and on different soils, we contacted Ray Gerber of Glen Oaks Country Club and several other superintendents. At Glen Oaks one-half of a Washington bent nursery was treated in the fall. The next spring this section was green and growing 2-3 weeks before the untreated area.

A number of tees at Northmoor Country Club were treated by Frank Dinelli. Even into the second season they had to hold back the power mowers in the treated areas to prevent choking down.

We next contacted Howard Baerwald, La Grange Country Club, where all greens were treated at a rate of 25 pounds corn gluten meal, 8% N, per 1,000 sq.ft. This application was made late in October, about the end of the season. These pictures were taken on the 18th of March at the La Grange and Hinsdale Clubs, about 5 miles apart. La Grange had cut their greens 2 or 3 times and were open for play, while Hinsdale expected to wait another week or two before starting operations.

Two years ago when the Midwest Turf Foundation set up the tests on availability of nitrogen from different sources, corn gluten meal was included in the tests. I followed the work closely and since pictures are the best way to supplement a report, these slides show pots fertilized with gluten meal and with the other nitrogenous materials.

Those of you who were at the Turf Field Days in 1956 may remember the fairway tests at the Purdue Golf Course. Corn gluten meal did not show well in these tests since gluten meal at 2-1/2 to 3 pounds of nitrogen per 1,000 sq.ft. was in direct comparison with urea formaldehyde condensates at the rate of 10 pounds of nitrogen per 1,000 sq.ft.

In 1957 bluegrass plots on the farm and the experimental putting green were treated with gluten at the higher rates, and here the corn gluten meal gave a good account of itself. The next slide shows data obtained in 1957 on the experimental putting green here at Purdue. "Diamond Brand" Corn Gluten Meal is the material used in these tests.

NITROGEN MATERIALS AND THEIR UTILIZATION

Charles W. Stewart, Corn Products Co., Argo, Ill.
(Presented before the General Turf Section)

Early in 1951 I was assigned the job of taking a look at various products resulting from the wet milling of corn, to broaden their use and expand the market. The corn kernel, as you know, includes the hull, or pericarp, the germ - which contains most of the oil, and the endosperm, which contains the starch and protein. Our industry soaks the corn for

about 2 days in slightly acid water to swell and soften the grain. The water containing dissolved solubles, such as natural sugars, minerals, growth substances and soluble proteins, is drawn off and concentrated to a heavy syrup (called Steepwater) containing about 8 percent nitrogen. The corn is ground and separated into corn hulls; Gluten feed, 3%N; and Gluten meal, 8%N.

We all know that humus (organic matter) is an important item in soil tilth and fertility. Humus is nature's means of storing nitrogen in the soil. Humus is formed in the soil by the action of soil organisms on carbohydrate materials in the presence of available nitrogen. One product, corn hulls, is composed of two carbohydrates, cellulose and a gum material called hemicellulose, plus some residual starch and protein from the balance of the kernel. To form humus from carbohydrate material you need about one pound of available nitrogen for each 10-12 pounds of carbon in the carbohydrate. If adequate nitrogen is not present the carbohydrate breaks down to final products of carbon dioxide and water. Also, soil bacteria will use all the limited available nitrogen in the soil, causing nitrogen starvation of any plants growing on the soil. Having this information, it was possible to combine adequate nitrogenous materials (protein) from the corn to give the hulls the desired carbon-nitrogen ratio, 3%N.

Several mixtures were prepared and "roto-tilled" 6 inches, at 3 rates, into various types of soils, including a bare subsoil plot. Samples of soil from each plot were taken before the treatment and at two intervals afterward.

Table 1. Soil Aggregate Stability in water after Peat and Corn Hull incorporation.

<u>Test A.</u>		<u>18 mo. After Treatment</u>	
Black Clay Loam Soil - No Treatment		59% Stable	
2" Peat Moss Mixed 6" Deep		57% Stable	
2" Corn Hull Product		90% Stable	
<u>Test B.</u>		<u>10 da.</u>	<u>85 da.</u>
		<u>% Stable</u>	<u>% Stable</u>
Black Clay Loam	Control	63	81
Corn Hull Product	325 lb./1,000 sq.ft.	83	89
	750	86	96
	1500	95	95

The following was accomplished to determine if there were extra values from the use of the corn hulls-nitrogen combination (gluten feed) with 3% N in promoting the growth of Merion bluegrass. The soil selected had a low aggregation value and was packed. The whole area was tilled once and treated with complete fertilizer. Gluten feed was applied to parallel strips at rates of 0, 236 and 444 pounds per 1,000 sq.ft. One plot was treated with a synthetic polyacrylic soil conditioner, another with carboxymethyl cellulose. All plots were brought to the same level of N P K by applying a mixed fertilizer, plus gluten meal. The materials were thoroughly mixed with the soil to a depth of 6 inches by use of a rotary tilling machine. The soil was kept moist for 5 days, tilled again

and planted to Merion bluegrass in October, 1953. By the following May the grass had become very well established, but differences in height and thickness of grass were quite evident. Soil tests showed that all treated plots had better water stable aggregate values than the control. However, only the plots treated with gluten feed showed better growth of grass.

Table 2. Aggregate Stability and Clippings produced on conditioned Test C.

<u>Treatment</u>	<u>Water Stable</u>	<u>Green Weight</u>
	<u>Aggregates</u>	<u>of Clippings</u>
	<u>%</u>	<u>grams</u>
No treatment	76*	425
Gluten feed 236#/1,000 sq.ft.	91	810
Gluten feed 444#/1,000 " "	96	1250
Polyacrylate, 0.1%	96	480
CMC, 0.1%	92	480

*Measured in October, 1953, all others measured in May, 1954.

Twenty five or more lawns have been installed by employees and their neighbors using gluten feed, 3% N, at a rate of 250 pounds per 1,000 sq.ft. without a single failure. These lawns are always the best in the neighborhood.

We discussed these results with Bob Williams, Supt. of Beverly Country Club, and decided on incorporation of corn fiber materials in a section of a new tee. After the tee was graded, the gluten feed was spread over the right front quarter of the tee, varying depth from 3" down to 0. The material was then worked in and the entire area sodded. Water provided by the central sprinkler to maintain the untreated area caused the treated area to be too wet to use for the whole season, even though the construction was done in the spring. During December of that year, we examined the treated and untreated areas and took samples of soil for analysis.

Table 3. Depth of Roots and Water Holding Capacity of Tee Soil. Test 4.

<u>Treatment</u>	<u>Depth</u>	<u>Water</u>	<u>Water</u>	<u>Organic</u>
	<u>of roots</u>	<u>Aggr. Stab.</u>	<u>Holding Cap.</u>	<u>Matter</u>
	<u>inches</u>	<u>%</u>	<u>%</u>	<u>%</u>
None	less than 3	78	36	4.9
1" Feed	more than 8	88	39	6.6
3" Feed	more than 8	95	41**	10.2

** Increased water holding capacity from 36 to 41 percent is calculated to be equal to 10,000 gallons of water per acre.

The material used in these tests is marketed as "Buffalo Brand" Corn Gluten Feed.

NITROGEN MATERIALS AND THEIR UTILIZATION

Fred V. Grau, Nitroform Agric. Chemical Co.,
Woonsocket, Rhode Island

(This article and the preceding four were series of a panel).

I am to discuss the nitrogen product which we manufacture and sell through distributors and dealers.

"BLUE CHIP" NITROFORM is a granular, pebbly, free-flowing non-caking 38% nitrogen fertilizer which is a slow-release, long-lasting source of nitrogen. It originally was designed and made for use as the major source of nitrogen in complete fertilizers. It is recommended also for direct application for supplemental nitrogen feeding on open type turf, such as tees, fairways, lawns, parks and athletic fields.

"POWDER BLUE" NITROFORM has all the qualities of "BLUE CHIP" NITROFORM, but is sold as a fine powder, 80 mesh or finer. It is designed specifically for liquid application, such as power sprayers and proportioners on putting greens, bowling greens and similar closely-mowed dense turf. The fine powder sinks into the turf which avoids mower pickup. Its fineness favors immediate release of some nitrogen. By contrast granular forms may lay on the turf for days before the bacteria can begin to break it down.

For ureaforms we owe a debt of gratitude to Dr. K. G. Clark, Senior Chemist, U.S.D.A., Beltsville, Maryland. During World War II he was assigned the problem of finding a synthetic nitrogen material to supplement the short supplies of natural organics. Out of his studies came solid Urea-forms, which are the basis of our industry today. The information that he accumulated was given to three companies. Each is making Urea-form under a different process and under a different set of patents. Therefore, it is impossible to predict the performance of one Urea-form on the basis of another.

Our product is designed for maximum stability, for slow, steady, uniform release and for a definite carry-over. NITROFORM gives best results in the second year of use. Part of this is due to the carry-over, and part may be due to the bacteria in the soil. Constant supplies of available nitrogen will result in the maximum bacteria population in the soil, which will mean better soil aggregation. It should be mentioned that NITROFORM may be disappointing because it does not produce large amounts of top growth - in fact, growth may be slow because limited availability of NITROFORM builds density and roots rather than tops which require frequent mowing. NITROFORM produces a firm, slow growth of grass.

NITROFORM is slowly converted to nitrates through the usual processes involved in bacterial activity. They can feed nitrogen more uniformly according to the needs of the plant if they have a large available supply of the slowly-available nitrogen. When the weather turns hot and sticky, there is actually a slower release of nitrogen, due to the slower activity of the bacteria

Occasionally light supplementary feeding of nitrogen may be needed during the summer to restore a bit of color or growth, if they are desired.

For this the safest feeding is light applications of inorganic nitrogen. Nitrogen fertilizers work best when other good soil and management practices are favorable. Unless all growth factors are in harmony and in favorable balance, we cannot expect full performance from any fertilizer. Grasses differ in their needs. Some need more, some need less nitrogen. Watering practices may be unfavorable to bacteria. The color of NITROFORM is to help the operator see where he is going.

The balance that is the fundamental part of Nature's law is carried to the manufacture of complete mixed fertilizers. Today more than 15 major manufacturers are making complete "BLUE CHIP" fertilizers which contain 50 to 75% of urea-form nitrogen. The term "BLUE CHIP" has been given to these fertilizers that carry 75% of their nitrogen from NITROFORM nitrogen because "BLUE CHIP" means highest quality. Several companies make 2-1-1 fertilizers, such as 10-5-5, 12-6-6 and 14-7-7. Others are 8-6-2 and 20-6-4. At least two companies are including a minor element mixture.

In a "BLUE CHIP" feeding program one would use a mixed fertilizer for phosphate and potash. For supplemental nitrogen feeding on open turf use NITROFORM, and on close mowed, tight, dense turf, like putting greens and bowling greens, use the "POWDER BLUE". A single application of NITROFORM to provide 8 pounds of actual nitrogen per 1,000 sq.ft. has been proven to give a steadier feeding of nitrogen throughout the season than 8 separate applications of soluble nitrogen at the rate of 1 pound to 1,000 sq.ft. at each application. Single applications of NITROFORM are not recommended as ideal under all conditions.

In making 8 applications of a soluble fertilizer, which has the potential of burning the turf, one has 8 chances of making an error. With NITROFORM in 2 applications the chances for error are reduced. In establishing turf, it has been shown that 8 pounds of nitrogen from NITROFORM in the seedbed, plus adequate supplies of calcium, phosphorus and potash, in balance, has been a major factor in developing solid sod in the shortest space of time. At the University of Rhode Island, a May 29 seeding of a Merion bluegrass mixture produced solid turf in four months that could be cut, rolled and moved. This single application of fertilizer in the seedbed can carry the turf for at least a year, which will mean a tremendous saving in labor, in storage of materials and in costs of application.

Some of the first golf clubs to accept a complete "BLUE CHIP" feeding program is Williams Country Club at Weirton, West Virginia, Ledgemont County Club at Seekonk, Mass., and Merion Golf Club, Ardmore, Pa.

Every nitrogen fertilizer has its place.. Each must be used and handled according to its characteristics and its limitations. Adequate nitrogen feeding in balance with other elements will mean better color, denser turf, greater disease resistance, greater drouth tolerance and insect tolerance, more vigor and ability to heal injuries, deeper roots and a better cushion of turf. The effect of adequate nitrogen in reducing effects of drouth is important as a shortage of nitrogen often looks like drouth effects.

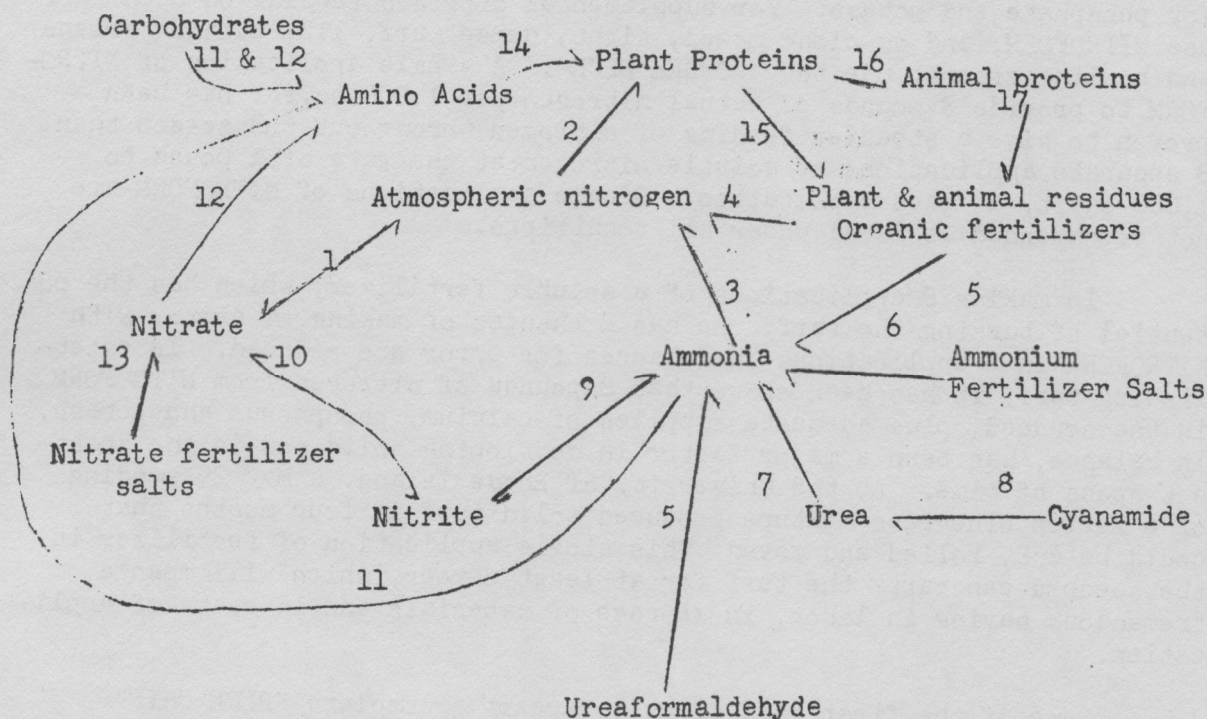
NITROGEN IN PLANT METABOLISM

Norman Goetze, Purdue University

(Presented before Basic Information Section)

Of all the fertilizer elements, nitrogen has been heralded as the most important because it is used in largest quantities by the plant. The other nutrients are equally important, but they may not be used in such a variety of plant functions, or in as large quantity as nitrogen. We are especially interested in nitrogen for quality turf production because the two are so closely associated.

Before discussing the role of nitrogen in plant tissue, we should investigate the various forms of nitrogen, and their inter-relationships in nature. This can best be expressed by use of a nitrogen cycle.



Each of these reactions is much more complex than pictured here, but only the essential features affecting turf management will be outlined here: Atmospheric nitrogen is the most prevalent form of nitrogen in the plant environment. In fact, 80% of the air we breathe is pure nitrogen which is not available directly for plant use. It may be converted to nitrate in reaction (1) by lightning discharges and rainshowers, or by free living nitrogen fixing bacteria. The amount of nitrogen fixed by this reaction is rather small and of no significance in turf management. Atmospheric nitrogen may be indirectly converted to plant proteins by symbiotic nitrogen fixing bacteria living in close association with legume plant roots. This reaction (2) is the very backbone of modern agricultural rotations, but is of no consequence in turf areas. Atmospheric nitrogen is converted to ammonia, as in reaction (3), by extremely high pressure reactions with gaseous hydrogen. This serves as one of the

prime sources of nitrogen in the modern fertilizer industry.

Nitrogen is continually re-entering the atmosphere by a reversal of reaction (1) called denitrification, and by the breakdown of plant and animal residues in reaction (4). Both of these reactions require bacteria and occur most frequently in poorly aerated soil conditions. We need not concern ourselves with a shortage of atmospheric nitrogen, but we should realize that part of our nitrogen fertilizer material does escape back into the atmosphere before use by the plants. The extent of this reaction might represent a considerable portion of some turf nitrogen fertilizer losses, although investigations of this sort have been lacking.

Ammonia occupies an important position in the nitrogen cycle. Usually the bacteria which decompose organic matter composed of plant and animal wastes, form ammonia as in reaction (5). This ammonification reaction is dependent upon carbohydrate supply and is slowed down in highly organic soils. Several common forms of nitrogen fertilizer compounds enter the cycle through ammonia. Ammonium fertilizer salts enter by simple ionization, as in (6), and urea is readily converted to ammonia in soils as in reaction (7). Cyanamide fertilizer is normally converted to urea by reaction (8) to enter the cycle. The exact mode of breakdown of the ureaformaldehyde fertilizers is not known, although most workers assume that it is broken down by reaction (5) in the same manner as plant and animal residues.

Large quantities of ammonia accumulate in soils below 40° F. temperature and soils that are poorly aerated. In most turf and agricultural situations the ammonia is quickly nitrified to nitrite and nitrate by reactions (9) and (10). These reactions require a complex array of bacteria and a proper balance of minor elements in addition to warm temperatures and a good soil aeration. Reaction (10) is usually much faster than reaction (9), so nitrite seldom accumulates. If conditions are not right for nitrification ammonia may be used by the plants, as in reaction (11) which involves the combination of ammonia and carbohydrate metabolic products to form amino acids. If nitrates accumulate in the soil they will be absorbed by the plants in reaction (12) and will be reduced back to ammonia before combination with the carbohydrate products to form amino acids. Once the nitrates, or ammonia, are made available to the plant, they can be handled equally well within the plant's metabolism. Nitrate fertilizer salts enter the cycle in reaction (13) as a direct source of nitrate. The old sources of naturally accumulated nitrate salts from South America were formerly the chief supply of artificial fertilizer, but their relative importance is declining with the advent of ammonia and urea fertilizers.

Within the plant, the amino acids are linked together to form complex proteins as in reaction (14). The plant may die to form plant residues in reaction (15), or be devoured by animals with the formation of plant proteins in reaction (16). In either event, following the organism's death, plant or animal residues result from reactions (15) or (17) to complete the never ending cycle.

To better understand the role of nitrogen in plant metabolism, the difference between plant and human metabolism should be outlined. Our cells are continually supplied with food, then waste products are removed from them by the circulating blood. Old cells are being continually replaced and rebuilt to keep our tissues intact. The waste nitrogen products are process in various organs and eventually are excreted as fecal

or urine nitrogen. Plants, on the other hand, do not replace their worn cells and have no active mechanisms for the excretion of nitrogen waste products. As the plants mature, the individual cell walls harden and an empty space called the vacuole within the cell, accumulates the waste products. These waste products are separated from the active part of the cells by only a thin membrane. If excess nitrogen is given the plant it may accumulate in the vacuole and cause damage to the active protoplasm of the cell. Humans who have eaten too much protein, merely excrete extra nitrogen in the urine with no permanent damage.

Nitrogen occurs in every plant cell as an integral part of many essential organic compounds. The plant proteins probably account for the largest single amount of plant nitrogen. Proteins are extremely long molecules of carbon, hydrogen, oxygen, nitrogen, sulfur and phosphorus. They are composed of from 75 to 10,000 simpler compounds called amino acids, and are arranged as long fibers, branched chains, spiral rings, or spherical globules. Since every cell contains protein, growth may be quickly limited by a short supply of nitrogen.

The amino acids are comparatively small, simply constructed compounds which are joined together to form the proteins. They are formed by the reaction of ammonia with organic acids. These organic acids are supplied by the respiratory breakdown of plant carbohydrates. Therefore, amino acid formation may be limited by either low nitrogen supply, or any condition which might restrict carbohydrate availability or respiration.

Nitrogen is also a necessary constituent of chlorophyll, which is the basic material enabling plants to convert sunlight into energy by the fixation of carbon dioxide. The chlorophyll molecules are rather large and complex, but the active site involves four nitrogen atoms arranged about a magnesium atom. The chlorophyll is a green pigment and imparts the green color to growing plants. Since nitrogen is a component of chlorophyll, the greening effect of nitrogen is rather easily explained by an increased rate of chlorophyll formation.

Most plant metabolic reactions are governed by specific rate controlling catalysts called enzymes. Enzymes are extremely active and are found in only minute quantities. They are composed of complex proteins and one or more metallic co-factors. Thus, nitrogen is also essential for enzyme formation because it is a component of the protein portion of the enzyme molecule.

Compounds used for the genetic control of plant growth and development are called nucleic acids. They are found in all cells and are composed of nitrogen containing carbon rings, sugars and phosphorus. These compounds are not altered by a shortage of nitrogen, so low nitrogen supplies do not change the genetic potential of an organism. However, nitrogen is essential for the perpetuation of the organismal generations.

Nitrogen containing compounds are also responsible for energy transportation within plant cells. If these compounds are lacking, energy mal-concentrations result and the overall metabolism is disturbed.

Nitrogen serves many other equally important functions in plants, but it can be seen from these few examples that plant growth is affected in many diverse ways by nitrogen supply. You are using several materials and repeated applications to get desired responses. Until these effects are completely understood in their relationship to turf management problems, much interesting research work still is ahead of us in order to gain maximum efficiency from nitrogen application to turf.

BUILDING AND REBUILDING GREENS

Clarence Wolfrom, Supt., Maple Lane Golf Club,
Warren, Michigan.
(Presented before the Golf Course Section)

One of our biggest problems in turf management today is 1920 greens trying to take 1958 play. We wouldn't be seen in a 1920 automobile unless it was in some historic museum, or at the County Fair, but that is where some of our greens belong. They have served their purpose and should be retired like an old automobile. With a few exceptions, greens built in 1920 are not large enough for today's play. I am sure they do not have the new strain of improved bents that we have today, and in most instances do not have the drainage or soil structure necessary for growing good turf.

For some reason or another we string along with a green that gives us trouble year after year. In the middle of the summer hot humid weather and too much rain takes out the turf and we say it should be torn up this fall and make the necessary changes in the drainage contour and soil to grow good turf. But, by the time fall comes, the green has come back and it looks pretty good and we let it go this year. The next year the green goes out again and we are in the same boat we were last year, the year before that, and the year before that.

There are two reasons for putting off rebuilding. One is cost, and the other the time the green will be out of play. If there is planning a year ahead neither of these need be objectionable.

In 1946 my greens chairman suggested, and the board approved, that we plan a program to change the turf on 3 greens each year. First, we increased our bent nursery from 6,000 sq.ft. to 21,000 sq.ft., and in 1947 we started with three greens. The program is still going with these exceptions: In 1948 we built a new nine holes. In 1950 the river was widened through our course. This required moving two greens and one fairway. In 1952 we built 9 more holes; and in 1956 we built 2 new greens to lengthen 2 holes. The other years we changed the turf on 3 greens a year.

This program has worked out well with better turf on our greens and only out of play from October 25 to April 1. Sod from your bent nursery mowed the same height as your putting green will make a putting surface at least 1 month quicker than sod mowed longer.

My Experience in Building New Greens

After the location has been established for the green, the topsoil is examined to determine if it will be of value for the topsoil on the green, or can be used in other places on the course. If it is good, it is pushed in piles on both sides of where the green is to be built, far enough back to allow plenty of room for any traps and a gentle slope of the banks away from the green. A bulldozer can do this job very economically.

If the subsoil is clay, 4" drain tile is put in 15 feet apart, sloping from the back of the green to the front, connecting with one tile crossing the front of the green to carry the water away. Backfill with some porous material - we use sand. The clay taken out of the tile trenches is graded to slope to the tile and not leave any pockets.

If traps are put in, we use this subsoil to make the bank of the green. Yellow (medium) sand is hauled in to bring the green up to the desired height. This is graded with a terrace blade on the tractor to the contours of the finished grade. The topsoil is then put on. If the topsoil piled at the side of the green is to be used, a crane can throw it on very economically. The terracing blade and spring-tooth harrow are used for the finished grade.

On the recommendation of O. J. Noer we always use a 3-way surface drain and reduce the storm water running off the front. We use a grade of 2" medium fall to every 10 ft. for getting the water off fast after a rain, yet allow the cup most everywhere and still have fair putting contours.

How to Rebuild an Old Green

Remove the sod from the green and take off as much of the sod from the banks as is necessary to accomplish the needed changes. Remove topsoil with an end loader. If it is to be reused on the green, pile it to the side, and if not, haul it away. Tile green, if necessary, and refill trenches with a porous material. (Coarse sand, or fine gravel - use cover over tile cracks). If fill is needed to recontour the green, sand may be used. This subsoil is graded the same as the final grade of the green. In our case a three way surface drain is used. Topsoil is put back on with the end loader, then graded with the terracing blade and springtooth harrow. Add the necessary sand and humus for the right soil texture.

Fertilizer the green. To reduce *Poa annua*, add 6 pounds sodium arsenate mixed well in water, per 1,000 sq.ft. For example, on a 6,000 sq.ft. green, we use 36 pounds of sodium arsenate in 150 gal. of water. In our sprayer, using the boom, we go over the green and follow with the spring-toothed harrow. We repeat this until all the spray is used up, usually 12 to 15 times over. Care should be taken not to get any of the sodium arsenate material on the turf around the green as it will kill the grass. To prevent this, we back up the sprayer to the next area to be treated and not pull it off the green until the solution is used.

In summary, I suggest to be sure of good drainage. Use sand for the subsoil, and grade it the same as the finished grade is to be. Use a good topsoil. We like black sandy loam. Use a 3-way surface drain. This can be accomplished by building the center of the green fairly high. The high point, however, should be one of the back corners of the green. Do not attempt to handle topsoil when it is too wet. Keep the contours of the green so the cup can be put most anywhere for fair putting and assure you the use of all the green. Keep all traps at least 20 ft. from the putting surface. This will allow seven-gang mowers through and traps will not draw moisture from the green.

Our approximate cost to rebuild a green:

Labor - 200 hrs. @ \$2.00	\$ 400.00
Gas, oil and equipment	50.00
Tiling - 300 ft. of 4" tile	21.00
300 lbs. fertilizer at \$ 3.00	9.00
36 lbs. of sodium arsenate @ 20¢	7.20
650 yds. sod at \$1.00 per yd.	650.00

Notes: Cost of fill sand to build new green - \$300.00, but we have our own sand pit. Growing our own sod, estimated at \$650.00. Green out of play from Sept. 1 to May 15, but this length of time is not necessary.

Total cost to completely rebuild green and resod the banks is \$1,136.50. This is taken from an average of three greens.

BUILDING OR REBUILDING PUTTING GREENS

Colin Smith, Supt. Shaker Heights Country Club,
Cleveland, Ohio

The subject can be lengthy and controversial, so I would prefer to direct my remarks to the preparations for rebuilding a green. When we think of rebuilding a green these questions come to mind:

1. The Reason -- Why do we have to rebuild?
2. The Date - What time of year is best?
3. The Plan - What type of green to construct?
4. The Materials - What are we going to use?

The reason could be to correct a mistake of a former builder, such as: poor drainage, bad contouring, unsuitable location, inferior strain of grass, or the common cause these days, that of making way for a super-highway, or housing developments. To tear up a green that the members have been playing for a number of years and still have their blessings is a tough thing to do. It is up to you and your committee to see that they are informed through a news letter or bulletin. Here may I say that a well informed member will be a cooperative one.

Now that you have decided to go ahead with the reconstruction, you must pick the best time of the year to do the work. You certainly do not want to start if the rainy season is at hand. The soil will become too wet to handle, equipment gets bogged down so that the surrounding areas are damaged. Whether the topsoil is mixed at the new site of the new green or trucked in, you must have the best weather conditions. Here in the Midwest we know that early fall is the right time for rebuilding. And, this is ideal for growing bentgrass.

As early as possible a good temporary green should be started for play during reconstruction and afterwards until the grass is well established. A temporary green should be started early enough so it will have a decent surface. Where the old green must be destroyed, a temporary can be made by cutting the fairway grass short in front of the old green, then smooth the area with a heavy topdressing, extra fertilizer and some quick germinating seed, such as redbud or bent.

Any good product whether an automobile, a house or a green, must have the correct set of plans. These plans must contain all the information needed. A golf course architect is the best way to obtain such a set of plans. Quite a few golf course superintendents are qualified to do this kind of work. It does not matter where the plans come from as long as they are accurate and conform with the desired results.

It is while the plans are being formulated that all criticisms and

ideas must be thrashed out, because to change grade line on paper is not nearly as costly as it would be after the green has been completed. At this time a sketch or model should be placed in the Grill Room, or Locker Room, for the members to look at so they can see what the finished product will be like.

H. Lindlar, the noted diet expert says, "You are what you eat." By the same token, a new putting green is only as good as the materials that are put into it. The sub-grades should be made up of materials that will carry away excess water. Where this is not possible drain tile should be placed in the proper position. Then, to stop unsightly hollows from forming over the tile, fine gravel, crushed stone or some other material should be used that will not disintegrate with age. Some people favor back-filling the last six or eight inches at the top of the ditch with the same topsoil mixture that will be used for the surface. This will prevent dry areas directly over the tiles. Good contouring will permit surface run-off in two or three directions.

Topsoil or topmix is the cause for controversy since few people agree on the same mixture. Most of us have an idea on what we would like, but getting this mixture and then using the correct maintenance with relationship to the mixture is another thing.

After the topsoil has been spread and firmed, pulverized limestone if needed and a good fertilizer should be applied. Now last and very important you should use the strain of seed or stolons that has proven best in your particular area. In conclusion, if you had a good reason, the date right, the plans followed to the last detail, the materials used correctly and a great amount of help from The One Up Above, the new green will turn out to be a picture.

BUILDING AND REBUILDING GREENS

G. M. Dearie, Supt., Medinah Country Club,
Medinah, Illinois

Golf and the maintenance of golf courses has been my life's work. Over the years I have seen many changes in golf architecture and many more changes in maintenance practices and golf course equipment.

Golf Architects are not born; they are developed through the years and years of golfing knowledge and experience. To learn golf architecture you must know golf itself, its companionship, its sorrow and its battles.

The choice of site must be considered from the viewpoint of construction; therefore, site and construction go together.

One of the most important things about the site is the soil. Beyond question sandy loam soil is the best soil to build a golf course on. This type of soil is easy to handle in the development of green, tees, fairways and hazards. One of the outstanding features of this soil is that it dries more rapidly after rains, and the playing condition of such a course remains more constant than if on a heavier soil during the entire playing season.

In building a green, it is important also to know that different golf clubs and organizations have different needs depending on the type of use to which the course will be put. Fortunately, the building of a green does not have to be exact in its measurements. The slopes may vary. Even the levels may differ from your proposed plan. The danger to the playing value of the hole is to NOT provide each golfer with a reasonable route of safety to the green.

The ability to visualize a complete job before it is started is a gift. Building a green is an art. You have to analyze not only the golf hole in question, but the entire layout. Through this you can arrive at a sound decision for improvement. Changing the location of a tee sometimes will be all that is needed, or adding a trap or traps in the fairway, or at the green. It may be necessary to relocate the green in order to improve the hole. Be sure the green you are improving does just that, and does not upset the balance of the other holes.

If you are planning a long range improvement program, do not upset the layout by starting on #5 or #6 hole. Start your program at #1, #9, #10, or #18 green. I have seen where the superintendent of a golf club had rebuilt a green and the membership of that club were complaining about the green. When you had all the facts you could see why the members were complaining. For the first five holes of this course, the greens were as flat as a pancake, the 6th hole (the new one) was completely different in style and design. This membership was used to putting on flat greens and when they got to #6 green they were completely lost as to how to putt this green. The club went ahead and improved three more greens on the first nine holes, and I may add the #6 hole was the best improved hole on this course.

Rebuilding greens not only constitutes the knowledge of construction, but the knowledge of the game itself. When a golf course is heavily played and the greens start giving trouble, you have to be doubly sure that when you rebuild such a green that you don't lose the character of the layout.

When you add up the number of shots that are used on the average par 72 course, you have 36 putts, normally in the layout you have 14 tee shots, using the driver with 4 shots, demanding 1 or 4 of the irons on the short holes. You have used a total of 54 shots. You have used up only 6 of your 14 clubs. You have 18 remaining shots, to use the 9 remaining clubs. This is where variety and diversity starts. You have to analyze all of the facts before you start to improve a hole.

Drainage

Drainage is one of the most important factors, not only of the putting surface, but of the entire site, and especially on heavy soils. You must have an outlet for your drainage which may be a mile or two away from your green. You must bring a tile big enough to carry the water from ^{excess rain} or irrigation on the green, ^{approach and} fairway, traps. All this area must be drained. Water should not run off the green into a sand trap, or onto the approach, but should be diverted to the side of the green, or rough where it will enter into a tile line. Your green drainage must have surface drainage and should have a herringbone ^{type} tile. When using tile I like to have it not deeper than 18 inches from the surface, with a good fall of 5" to 100 ft.

All tile lines in the greens and traps should be covered with pea

gravel to within 2 or 3 inches of the putting surface. This soil should not be less than 10 inches deep for your finished greens, using 1/3 sand, 1/3 humus, and 1/3 soil.

When you start to plan to build a green, draw a number of greens on scrap paper. When you have what you think you want, start a clay model of the green. You need to go out and look at the site three or four times before you get what you want.

Select the strain of grass you are going to use. If it is sod, have your nurseryman cut it not higher than 1/4 inch in height for four weeks before you use it. When you are ready for it, have him cut the sod as thin as you can handle it.

Know the amount of soil to be moved, if any.

Know how much humus, sand and gravel you will need.

Know how many feet of tile to be used, and its size.

When you have gone this far you can start construction.

First with your drainage, bring your drainage to the green site.

If you start construction on Monday you should, bar rain, have the new green finished by Friday, and be playing the new green within three weeks.

BUILDING AND REBUILDING OF GREENS

Ralph Guyer, Supt. of Westborough Country Club
Webster Groves, Missouri

The majority of superintendents who are planning to build or rebuild a green have in mind a green designed to blend in with the surrounding area with large aprons to have gradual slopes and sweeping lines with sufficient area for cup settings. Besides these you must have good surface and sub-surface drainage so that a downpour, when the temperature is in the 90's, will not leave the green soaked and cause damage. Finally, you need a type of bentgrass suited for the area. We cannot be too specific about building greens. However, we can use available information and experience as a guide. Considerable information on the placing of tile for sub-surface drainage, the mixing of soils and the selecting of bentgrasses is available to the superintendent through literature reading and knowledge gained by experience, which can be exchanged in Turf Conferences such as this one.

In the St. Louis area we have four weather extremes: hot, cold, wet and dry. Westborough, like most older Clubs, was built when little emphasis was placed on design and none on sub-surface drainage. The grass on the greens is seeded with bent, with about 50% Poa annua.

Midwest Turf

NEWS AND RESEARCH

No. 19

February 1958

DEPARTMENT OF AGRONOMY
PURDUE UNIVERSITY

Midwest Turf leaflet No. 1 (revised)
lists current projects and student activities.

Membership, Grants — Again High

Industry Supports Research

Grants from industry, to support and encourage research, has continued very well in 1957. We appreciate these funds, which are used primarily for student labor, but equally as much, we appreciate the opportunity to work closely with the personnel of companies actively interested in providing materials to the turfgrass industry.

American Cyanamid Co.....	\$ 750.00
New chemical formulations of nitrogen	
The Borden Co.....	1,000.00
Nitrogen release from ureaforms	
E. I. duPont de Nemours Co.....	2,500.00
Nitrogen release from ureaforms	
Golf Course Superintendent's Association.....	400.00
Student scholarship	
Indianapolis District Golf Association.....	150.00
<i>Poa annua</i> studies	
Indiana Golf Association.....	150.00
<i>Poa annua</i> studies	
W. E. Lafkin Co.....	150.00
General studies	
Turf Research Foundation.....	4,000.00
Bluegrass disease, Ph.D. study	
U.S.G.A. Green Section (National Golf Fund).....	2,000.00
Carbohydrates on bent, M.S.A. studies	
Vineland Chemical Co.....	1,500.00
Crabgrass control	
Westwood Country Club, Rocky River, O.....	100.00
Student training activities	
Nitroform Agric. Chem. Div. of	
Woonsocket Color and Chem. Co.....	1,000.00
Nitrogen durability	

Materials Received, 1957

Although the list below may be incomplete, it indicates the range and diversity of the materials furnished to us for testing and observation. We appreciate the assistance to our turf program through these contributions. Besides this there were many who drove their cars on a tour, or assisted in their local areas towards turfgrass education.

Acme Chemical Plant—Lewis Harris
3 cs. Calcium arsenate
15 Experimental herbicides
American Cyanamid—Luke Evans
1000 lbs. Experimental materials
American Chemical Paint—John Gallagher
Experimental herbicides
American Potash Institute—W. L. Nelson
3,000 reprints—Soil Tests Highlight Turf Needs
Chipman Chemical—R. A. Brown
5 lbs. NaAs & Experimental herbicides
W. A. Cleary Corp.—Paul Sartoretto
Experimental herbicides
1 gal. Greenzit dye
Corn Products Refining—C. W. Stewart
200 lbs. Corn Gluten meal
1 gal. Steep water
Dow Chemical Co.—John Davidson
MC-2 Experimental crabgrass oil
DuPont de Nemours Co.—Del Kolterman
1000 lbs. Uramite
1 case Tersan
Gate of Heaven Cemetery—Al Bloch
1 lb. Experimental tall fescue
Geigy Chemical Co., General Chemical Division—Ed. Schneider
Experimental herbicide
General Chemical Division of Allied Chem. & Dye—
W. W. Thompson
Experimental 20% HCA Weed Killer
Grau, F. V.
4 bu. Uganda grass
½ lb. Experimental tall fescue
Henderson Mower Co.—Earl Shapland
Contour mower with thin cut reel
Indiana Farm Bureau—Walter Weber
600 lbs. CaAs mixture
International Minerals & Chemical Corp.—R. P. Thomas
3 bags Experimental fertilizer
Jacklin Seed Co.—Arden Jacklin
S-21 bluegrass seed
Jackson Manufacturing Co.—Tony Mascaro
1 Liquid spreader sprayer
Kelly-Western Seed Div., Salt Lake City—B. R. Ellison
100 lbs. Pax
Kohler Bros. Co.—George Kohler
1 quart Wilt-Pruf
O. E. Linck Co.—O. E. Linck
Spreaders and Green paint
Mallinckrodt Chem. Works—Stan Frederiksen
Kromad and MF 18 Experimental fungicides
Millburn Peat Co.—John Darrah
4 cu. yds. Peat

Milwaukee Sewerage Commission—O. J. Noer
6 bags Milorganite
Minnesota Mining & Manufacturing Co.—W. G. Rupp
1 roll Grass Mat
Allied Chem. & Dye Corp. N. Division—Dale Friday
4 gal. V.F. 85
Woonsocket Color & Chemical—Jim O'Donnell
400 lbs. Nitroform—Blue Chip
Olin Mathieson, Fungicide Division—C. K. Cloninger
Experimental fungicides
O. M. Scott & Sons Co.—Vic Renner
2 bags 20-10-5
R. M. Schery
2 lbs. Recleaned yeast
2 lbs. Uncleaned yeast
Upjohn Company—Bill Klomparsen
Acti-dione RZ
Vineland Chemical Co.—Art Schwerdle
100 lbs. Crab-E-Rad
120 lbs. Crab-E-Rad
West Point Products Corp.—Tom Mascaro
Experimental herbicides

Winterlawn Sales Corp.
Winter Lawn Green paint
Zonalite Company—Ray Rothfelder
Heavy terralite

Foundation Membership Reaches 298 in 1957

Each year, since starting in 1946, there has been a modest increase in the memberships. In 1957 the 298 members, including the 27 new members, through their fees, provide us with approximately one-third of our resources for turf research and information. Only through combined support could some of the basic things being considered in research be accomplished. As an organization we appreciate the financial support, but we covet at the same time the personal interest and the common sharing of problems and ideas that has made Midwest Regional Turf Foundation a working organization.

1957 M.R.T.F. Members by Districts

Central Illinois Golf Course Superintendent's Association

Bureau Valley Country Club, Princeton
Charleston Country Club, Charleston
Country Club of Decatur, Decatur
Country Club of Peoria, Peoria
Danville Country Club, Danville
Highland Park Municipal Golf Course, Bloomington
Illini Country Club, Springfield
Lake of the Woods Golf Course, Mahomet
Mattoon Golf & Country Club, Mattoon
Quincy Country Club, Quincy
*Scripps Park Golf Club, Rushville
Taylorville Country Club, Taylorville
Western Illinois State College, Macomb
Veterans Administration Hospital, Danville

Central Ohio Golf Course Superintendent's Association

Beacon Light Golf Course, Columbus
Columbus Country Club, Columbus
Coshocton Town & Country Club, Coshocton
Ohio State University Golf Course, Columbus
Shawnee Country Club, Lima
Willow Bend Country Club, Van Wert
York Temple Country Club, Worthington

Greater Cincinnati Golf Course Superintendent's Association

Camargo Club, Cincinnati
Cincinnati Country Club, Cincinnati
Clovernook Country Club, No. College Hill
Crest Hills Country Club, Cincinnati
Hamilton County Park District, Cincinnati

Hartwell Golf Club, Cincinnati
Highland Golf Club, Fort Thomas, Ky.
Hyde Park Golf & Country Club, Cincinnati
Kenwood Country Club, Cincinnati
Losantville Country Club, Cincinnati
Maketewah Country Club, Cincinnati
Public Recreation Comm. City of Cincinnati
Western Hills Country Club, Cincinnati
*Woodland Golf Course, Cincinnati
Wyoming Golf Club, Cincinnati

Indiana Golf Course Superintendent's Association

Anderson Country Club, Inc., Anderson
Benton County Country Club, Fowler
Blackford Golf Club, Hartford City
Bloomington Country Club, Bloomington
Broadmoor Country Club, Indianapolis
Clearcrest Country Club, Evansville
Connersville Country Club, Connersville
Delaware Country Club, Muncie
Edgewood Country Club, Anderson
Edwood Glen Golf Club, Lafayette
*Elcona Country Club, Inc., Elkhart
Elks Country Club, Fort Wayne
Evansville Country Club, Evansville
Evansville Park Department, Evansville
Fort Wayne Park Commission, Fort Wayne
Fort Wayne Country Club, Fort Wayne
Frankfort Country Club, Frankfort
Harrison Lake Country Club, Columbus
Hartley Hills Country Club, Hagerstown
Hazeldon Country Club, Brook
Highland Golf & Country Club, Indianapolis
Hillcrest Country Club, Indianapolis
Country Club of Indianapolis, Indianapolis

Indian Lake Country Club, Indianapolis
Kokomo Country Club, Kokomo
Lafayette Country Club, Inc., Lafayette
Meridian Hills Country Club, Indianapolis
Meshingomesia Country Club, Marion
Orchard Ridge Country Club, Fort Wayne
Country Club of Terre Haute, Terre Haute
*Tippecanoe Lake Country Club, Goshen
Valparaiso Country Club, Inc., Valparaiso
Wabash Country Club, Inc., Wabash
Woodland Country Club, Carmel

Kentuckiana Golf Course Superintendent's Association

Anderson Golf Course, Fort Knox
The AC Officers Open Mess, Fort Knox
Big Spring Golf Club, Louisville
*Harmony Landing Country Club, Goshen
Louisville Country Club, Louisville
Shelbyville Golf & Fishing Club, Shelbyville

Miami Valley Golf Course Superintendent's Association

*Brown's Run Country Club, Middletown, Ohio
Dayton Municipal Golf Courses, Dayton, Ohio
Dayton Power & Light Golf Club, Dayton
Miami Valley Golf Club Co., Dayton
Moraine Country Club, Dayton
National Cash Reg. Emp. Ben. Ass'n., Dayton
Piqua Country Club, Piqua
Walnut Grove Country Club, Inc., Dayton

Michiana Golf Course Superintendent's Association

Gary Country Club, Inc., Gary
Gary Board of Park Commissioners, Gary
Michigan City Mun. Golf Course,
Michigan City

Pottawattomie Country Club, Inc.,
Michigan City

*South Bend Country Club, South Bend
University of Notre Dame, Notre Dame
Woodmar Country Club, Inc., Hammond

Michigan and Border Cities Golf Course Superintendent's Association

Birmingham Country Club, Birmingham
Burroughs Corporation, Brighton
Country Club of Detroit,
Grosse Pointe Farms
Detroit Golf Club, Detroit
Flint Golf Club, Flint
Lochmoor Club, Grosse Pointe Woods
Maple Lane Golf Club, Warren
*Meadowbrook Country Club, Northville
Plum Hollow Golf Club, Detroit

Midwest Association Golf Course Superintendents

Aurora Country Club, Aurora
Bel-Mar Country Club, Belvidere
Beverly Country Club, Chicago
Bob O'Link Golf Club, Highland Park
Butterfield Country Club, Hinsdale
Calumet Country Club, Homewood
Chicago Golf Club, Wheaton
Chicago Heights Country Club,
Chicago Heights
Chicago Heights Park District,
Chicago Heights
Coal Creek Country Club, Sheffield
Cog-Hill Golf & Country Club, Lemont
Columbus Park Golf Course, Chicago
Deer Park Golf Club, LaSalle
Edgewater Golf Club, Chicago
Edgewood Valley Country Club,
LaGrange

Elks Country Club, Paris
Evanston Golf Club, Skokie
Exmoor Country Club, Highland Park
Flossmoor Country Club, Flossmoor
Forest Hills Country Club, Rockford
*Forest Park Dist. of Cook County,
River Forest
Glen View Club, Golf
Indian Hill Country Club, Winnetka
Jackson Park Golf Club, Chicago
Kankakee Country Club, Kankakee
Knollwood Club, Lake Forest
LaGrange Country Club, LaGrange
Marquette Golf Course, Chicago
Medinah Country Club, Medinah
McHenry Country Club, McHenry
Midlothian Country Club, Midlothian
Northmoor Country Club, Highland Park
North Shore Country Club, Glenview
The Oak Park Country Club, Oak Park
Old Elm Club, Highland Park
Olympia Fields Country Club,
Olympia Fields
Onwentsia Club, Lake Forest

Park Ridge Country Club, Park Ridge
Ravistoe Country Club, Homewood
Ridge Country Club, Chicago
Ridgemoor Country Club, Chicago
Riverside Golf Club, Riverside
Rockford Country Club, Rockford
Rockford Park District, Rockford
*Ruth Lake Country Club, Hinsdale
Shoreacres, Lake Bluff
Silver Lake Golf Club, Orland Park
Skokie Country Club, Glencoe
South Shore Country Club, Chicago
Sunset Ridge Country Club, Winnetka
Tam O'Shanter Enterprises, Chicago
Timber Trails Golf Course, LaGrange
Waveland Golf Course, Chicago
Wilmette Country Club, Wilmette
Woodridge Golf Club, Lisle

Mississippi Valley Golf Course Superintendent's Association

Algonquin Golf Club, Webster Groves,
Mo.
Crawford County Country Club,
Robinson, Ill.
Forest Park Mun. Golf Course,
St. Louis, Mo.
Franklin County Country Club,
W. Frankfort, Ill.
Glen Echo Country Club, Normandy, Mo.
Greenbriar Hills Country Club,
Kirkwood, Mo.
Green Hills Country Club, Inc.,
Mt. Vernon, Ill.
Lakeside Golf Club, Overland, Mo.
Lockhaven Country Club, Alton, Ill.
Meadowbrook Country Club, Overland
Municipal Golf Course, Alton, Ill.
Normandie Golf Club, St. Louis, Mo.
Norwood Hills Country Club,
Normandy, Mo.
Old Warson Country Club, Ladue, Mo.
Westborough Country Club,
Webster Groves, Mo.
Westwood Country Club, Creve Coeur,
Mo.

Northern Ohio District Golf Course Superintendent's Association

Acacia Country Club, Cleveland
Beechmont Country Club, Cleveland
Canterbury Golf Club, Cleveland
Cherry Ridge Golf Club, Elyria
The Country Club, Inc., Chagrin Falls
Edgewood Golf Club, No. Canton
Elks Country Club, Rushtown
Findlay Country Club, Findlay
Firestone Country Club, Akron
Glengarry Country Club, Toledo
Hawthorne Valley Country Club, Solon
Inverness Club, Toledo
The Kirtland Country Club Co.,
Willoughby
*Lander Haven Country Club,
Mayfield Heights
Lincoln Hills Golf Course,
Upper Sandusky
North Olmsted Golf Club, No. Olmsted
Oakwood Club, Cleveland Heights

*Pepper Pike Club, Chagrin Falls
Portage Country Club, Akron
Rosemont Country Club, Akron
Shaker Heights Country Club,
Shaker Heights
*Sleepy Hollow Golf Course, Brecksville
Tam O'Shanter Golf Course, Canton
Tippecanoe Country Club, Canfield
Trumbull Country Club, Inc., Warren
Westfield Country Club, LeRoy
Westwood Country Club Co.,
Rocky River

Wisconsin Golf Course Superintendent's Association

Brynwood Golf & Country Club,
Milwaukee
Clintonville Riverside Golf Club,
Clintonville

Golf Course Superintendent's Association

Greater Cincinnati Greenskeepers
Association
Indiana Golf Course Superintendent's
Association
Miami Valley Greenskeeper Supt. Assn.
Michiana Golf Course Supt. Ass'n.
Michigan & Border Cities G. C. Supt.
Assn.
Midwest Assn. G. C. Supts.
Mississippi Valley Golf Course Supt.
Ass'n.
Northern Ohio Dist. G.C.S.A.

Cemeteries

*Anderson Memorial Park Cemetery,
Anderson, Ind.
Mount Emblem Cemetery Association,
Inc., Elmhurst, Ill.
The Mount Greenwood Cemetery
Association, Chicago, Ill.
Resurrection Cemetery, P. O. Argo, Ill.
Cemetery of Spring Grove, Cincinnati,
Ohio
Robert Bruce Harris, Chicago, Ill.
D. A. Hoerr & Sons, Peoria, Ill.
Jacobsen Power Lawn Mower Company,
Mayfield Heights, Ohio
Jacobsen Power Lawn Mower Company,
Columbus, Ohio
Kahn Brothers Company, Chicago, Ill.
*Kelly Western Seed Division,
Salt Lake City, Utah
Kenney Machinery Corp., Indianapolis,
Ind.
*Kunz Lawn and Garden Center, Dayton,
Ohio
Kramer & Company, Inc., Wilmette, Ill.
Link's Nursery, Inc., Creve Coeur, Mo.
Bill Lyons Turfgrass Farm, Akron, Ohio
J. A. McCarty Seed Company, Evansville,
Ind.
Mallinckrodt Chemical Works, St. Louis,
Mo.
E. F. Mangelsdorf & Bro. Inc., St. Louis,
Mo.
*Mann's Zoysia Nursery, Sparta, Ill.
Lawrence J. Meisel Company, Clayton,
Mo.
Miami Nursery Co., Tipp City, Ohio

Wm. Mihelich & Son Nursery,
East Detroit, Mich.
A. J. Miller, Inc., Detroit, Mich.
Nettie's Flower Garden, St. Louis, Mo.
The Nickel Plate Elevator Co., Cleveland,
Ohio
Northrup, King & Co., Minneapolis,
Minn.
*Northwestern University, Evanston, Ill.
Ohio Toro Company, Cleveland, Ohio
Old Orchard Turf Nurseries, Madison,
Wis.
111th Street Golf Center, Oak Lawn, Ill.
J. C. Oliger Seed Company, Akron, Ohio
*Permalawn Products Co., Evanston, Ill.
Pleasant View Nurseries, Troy, Ohio
Richard A. Plent & Son, Cleveland, Ohio
*Pontiac Mills, Inc., Pontiac, Mich.
Portage Oil Corporation, South Bend,
Ind.
Procter & Gamble Company, Ivorydale,
Ohio
Vine Street Hill Cemetery, Cincinnati,
Ohio
Walnut Hills Cemetery Association,
Cincinnati, Ohio
The Catholic Cemeteries of Chicago,
Hillside, Ill.
Evergreen & Woodlawn Cemetery
Association, Chicago, Ill.
Gate of Heaven Cemetery, Montgomery,
Ohio
*Graceland Cemetery Co., Chicago, Ill.
The Greenwood Cemetery Association,
Hamilton, Ohio

Industrial and Individual

*American Agricultural Chemical Co.,
Cleveland, Ohio
Eberhard Anheuser, St. Louis, Mo.
Baker Lawn & Golf Equipment Co.,
Dayton, Ohio
Bohling's Nursery, Munster, Ind.
Branigar Organization, Inc., Chicago, Ill.
Bunton Seed Co., Louisville, Ky.
Paul E. Burdett, Lombard, Ill.
W. A. Cleary Corporation,
New Brunswick, N. J.
George A. Davis, Inc., Chicago, Ill.
Detling Bros. Seed Store, Akron, Ohio
Albert Dickinson Co., Chicago, Ill.
Dixie Lawn Supply Co., Inc., Louisville,
Ky.
Dow Chemical Co., Midland, Mich.
Sidney L. Dryfoos, Cleveland, Ohio
Duncan Electric Co., Lafayette, Ind.
E. I. duPont de Nemours & Co. Inc.,
Wilmington, Del.
Evanston Landscaping Co., Evanston, Ill.
George Fiel, Indianapolis, Ind.
*Finn Equipment Co., Cincinnati, Ohio
Frigidaire Recreation Park, Dayton, Ohio
H. F. Godwin & Son, Detroit, Mich.
C. E. Griener Co. Inc., Indianapolis, Ind.
H. & E. Sod Nursery, Inc., Tinley Park, Ill.
Rainy Sprinkler Sales, Peoria, Ill.
Riley Lawn & Golf Equipment,
Indianapolis, Ind.
Roseman Mower Corporation, Evanston,
Ill.

W. H. C. Ruthven, Alliston, Ont., Canada
*R. L. Ryerson Co., Milwaukee, Wis.
O. M. Scott & Sons Co., Marysville, Ohio
Sewerage Commission Co., Milwaukee,
Wis.
*Smith Agricultural Chemical Co.,
Columbus, Ohio
The Sod Nursery, Bartlett, Ill.
Summers Fertilizer Co., McKeesport, Pa.
Swift & Company, Plant Food Division,
Chicago, Ill.
Herb Taylor, Detroit, Mich.
*Terra-Lite Division, Zonolite Co.,
Chicago, Ill.
Toro Mfg. Company, Minneapolis, Minn.
Turf Equipment, Inc., Cincinnati, Ohio
The Upjohn Company, Kalamazoo, Mich.
Vaughan's Seed Company, Chicago, Ill.
Warren's Turf Nursery, Palos Park, Ill.
*Waslic Management Corp., Cincinnati,
Ohio
West Point Products Corp., West Point,
Pa.
J. R. Wood Supply, Cincinnati, Ohio
Woodward Governor Company,
Rockford, Ill.

* New Member in 1957

Non-Profit Org.

After 6 acres were sold to a school board and 3 acres to the Christian Church in the early 1940's, a group of members bought the Club and operated on a shoestring for a number of years. In 1953 the school and Church started to build, so we moved and rebuilt two greens.

Our first green, which was a par three, was given a gradual slope toward the tee, elevated it on three sides to give us ample area for cup settings. A herringbone system of 4 inch tile (200' with 3 laterals 14" apart) was layed in a trench 14 inches deep. Two inches of crushed stone was placed in trenches 14 inches deep under the tile, then crushed stone filled trenches to the level of the sub-surface. Our topsoil was mixed through a royer, using 50% medium grade sand and 35% river silt soil, and 15% black peat by volume. To insure even distribution we drove 10 inch stakes at 10 foot intervals over the entire green and topsoil was raked to this grade. We also allowed some of this mixture to spread over the apron.

Before planting in early October, 200 lbs. of Milorganite was raked into the soil, planted with C-1 and C-19 stolons, 8 bu./1,000 sq.ft. We spread the C-1 and C-19 stolons, 8 bu./1,000 sq.ft., and covered them by topdressing by hand. The green was rolled with a light roller and watered lightly, being careful not to flood or wash the soil from the stolon, which we found very important. Some days the green required watering several times. It has been said that experience is the best teacher and rightly so. We found that a river silt type soil would tend to compact due to the very fine particles of sand - the green had a good putting surface, but did not hold as it should. We are gradually correcting this by aerification and topdressing.

Our next green was shaped like a painter's palette, with two large traps on either side, giving us needed soil for constructing and sub-surface, with a good slope toward the tee. The same system of tile was laid in this green, with 10 inches topsoil mixture, using a clay loam soil instead of the river silt. We used a power sod cutter and moved the sod. A row of sod was laid across the center of the green first, then we placed 1 x 12 boards on this to walk on, and in this manner the whole green was sodded, moving the boards as we went. This gave us a smooth surface. Moving of the sod required two days.

After sodding, the green was fertilized with Verta-green and watered. In order to avoid walking on the green, a sprinkler was set. Two weeks later it was rolled to get a smooth surface. Six weeks after laying the sod, the green was open for play.

The membership was pleased with the two greens built, and wanted us to continue. After selecting a location, the old sod was removed and the topsoil piled to one side. We made this green with two levels, with a distinct roll across the center. When the topsoil was put back on the green, we added 10 tons of sand and two yards of black peat. This was spread evenly and roto-tilled to a depth of 8 inches until we felt the mixture was sufficient. The green was then planted with C-1, C-19. This green has no tile, but has good surface drainage and is doing real well.

Next we wanted to make a new number 18 and locate it where our practice green was. We used cinders over the tile and to a depth of 6 inches over the entire sub-surface of the green. There was ample room so this green was made larger than the first three, with 6,500 sq.ft. putting area. The green was planted in Pennlu which we raised in our nursery. We were able to carry out this program without an increase in our budget. All the

work was done with our regular crew, using our own equipment. With these changes we have been able to keep our 18 hole course. And, by making the greens more difficult, it made up for the yardage we lost in the sale of the property.

If I were to stress a point it would be - if you are building a new green, be sure to have good surface drainage.

MECHANICAL BENTGRASS MAINTENANCE

Harold W. Glissmann, Owner, Cedar Hills Golf Course
Omaha, Nebraska

When we talk about mechanical bentgrass maintenance, I suppose we are talking about, or at least should follow quite close to talking about mowing, fertilizing, aerifying or spiking. Call it what you want - putting holes in the green, spraying, brushing, dragging, or poling for dew and maybe several other mechanical operations. I would like to discuss some of these.

To maintain bentgrass by mowing we should use only well conditioned equipment that is sharp and kept that way. These should be operated by someone that realizes he has one of the most important jobs on a golf course. He should know why the clutch is on the machine and uses it at all times when he is turning around at the edge of a green. The greens should be mowed in the cool of the day.

Fertilizing is something that we often don't do correctly. Don't pay any attention to factory calibrations - do your own and know how much fertilizer you are applying - do it at the right time of the day, which I believe to be before 10 A.M. most every grass growing day. Aerifying should be done in the same manner. Plan your operation to be completed before weather and temperature can make a much needed job turn out to be a better one, if you had not attempted it at all that day.

Spraying or putting on fungicides - this too is an operation that needs considerable attention in planning as to what kind of fungicide is needed, and that it be done in the cool part of the day. (We never spray after 8 A.M. unless weather conditions make it mandatory). I am sure a lot of these so-called sick greens would recover much sooner by waiting until the next morning rather than spraying them when it is too hot or humid whatever time of the day it is.

Topdressing operations should also be well planned and completed with consideration given to how much should be applied, how long must the green lay covered with material and be unplayable, and probably more important with some moisture to help heal and seal some wounds that were caused before and during the operation.

In a quick summary. the manufacturers have made us good equipment and that is about all they can do. The next step is our own. Take care of your equipment so that when you do use it on your grass it will do the job

it should. Consider that this equipment can't tell time or temperature. Also, that it can't say no, or refuse to go if someone is abusing it and does not handle it properly. It will cause trouble and you can't blame the machine. To close, good mechanical bentgrass maintenance does not come just by starting the motion on some piece of equipment. It takes good judgment and considerable knowledge.

ST. LOUIS TURF RESEARCH

Raymond Freeborg, Student in Turf Management
Purdue University

This research work is supported by the golf and country clubs in the St. Louis area and the Mississippi Valley Golf Course Superintendent's Association. Mr. Leo Bauman, who served many years as Greens Chairman at Westwood Country Club, has been the key person in securing support and keeping the program before the golfers. He, Al Linkogel and Oscar Bowman serve as the Committee on Research in cooperation with Dr. M. Ferguson of U.S.G.A. Green Section, and Dr. W. Daniel of Midwest Turf Foundation.

Daily work reports and accurate records of this research work are maintained. Once a month at the MVGCSA these reports are reviewed and discussed with the golf course superintendents. Any suggestions, relating to the experimental use and screening of new herbicides, fertilizers and newly developed fungicides by the superintendents attending these meetings, are carried out.

The main objective of these studies is to determine which product would give the best performance in the Mid-Mississippi Valley area. Superintendents have been most cooperative in providing test sites and helping in every way possible. Chemicals are applied according to manufacturers recommendations whenever possible, as well as comparative rates. Various formulations were screened as pre-emergence and post-emergence herbicides at Westwood Country Club and at Link's Nursery. Fertility plots were maintained throughout the summer, utilizing the organic and inorganic forms of fertilizers. The new selections of bermuda and several selections of bentgrass were planted and will be observed for winter hardiness and disease resistance. The results of the majority of these experiments can be practically applied to a wide scale use on the golf courses in this area. This research work will be continued in 1958.

CARBOHYDRATE PRODUCTION AND BALANCE IN TURF

E. E. Jordan, Graduate Student, Purdue University

My studies have been directed toward helping find a solution to the annual problem of summer dormancy in cool season grasses. The cool season grasses, such as bent and bluegrass, produce and store different carbohydrate compounds than do the warm season grasses, such as Zoysia and Bermuda grass. The cool season grasses produce fructose as their simple sugar, and store this sugar in a carbon compound called fructan. The warm season grasses produce glucose as their simple sugar and store this sugar in a complex compound called starch. The amounts, or levels of concentration of these sugars in their simple and complex forms, are affected by all the environmental factors, such as nitrogen, potash, water, temperature, etc.

Of these factors we speculated temperature would exert the largest influence on sugar concentration in plant tissue. It affects the process which makes the sugars, photosynthesis; and it also affects the process which burns sugar for energy, respiration. Plant physiologists have shown that at cool temperature production of sugars exceeds the amount being used in respiration, giving the plant a net increase of sugars. But, as the temperature rises the production remains somewhat constant, while the consumption of sugar by respiration rises, giving a smaller and smaller net increase with each rise in temperature. Finally, respiration exceeds photosynthesis at still higher temperatures, causing a net loss of sugars by plant tissue rather than a gain.

In previous work under the direction of Dr. Daniel, attempts were made in feeding the plants sugars to cover this loss by respiration at higher temperatures, but the results were disappointing. Using a test developed by Dr. Teel of the Purdue Agronomy Department, we were successful in measuring the concentrations of sugars in the tissues of cool season grasses. An experiment was set up to study the effects of temperatures on these grasses.

For two months flats of bentgrass were grown under uniform controlled climate conditions of light, nutrition and moisture, but with the different temperatures of 60°, 70° and 80° F. The grass was clipped every three days at a 1" height and the clippings weighed and tested to determine the levels of sugars in the tissue.

Table 1. Growth differences in bentgrass at 3 temperatures.

Temperature	Total green clippings. gms.	Comments
60°	179	A sharp peak of growth during the second week, then falling gradually to the same constant rate as the other two temperatures.
70°	195	A broad gradual peak of production over the first six weeks, declining slowly to the same rate as the other two temperatures.
80°	139	A sharp peak of production in the first week and a rapid decline to the same daily rates as the other two temperatures.

The total production was the best on the 70° temperature turf, with 60° next and 80° lagging far behind. The peaks are an indication of the driving force behind growth. The sod in the 80° temperature was the first to enter this phase of rapid growth, but the duration of this period was very short. The 60° was next to enter this rapid growth phase, but it also was short lived. The 70° did not enter a short rapid growth period, but the rate slowly rose, remained high for a few weeks, then slowly declined. This is a strong indication that the 70° temperature is close to optimum for growth of the bentgrass, but temperatures higher and lower tend to limit optimum growth in some manner.

Was this inhibition caused by a lack of an energy source, or a sugar supply?

The results from the sugar analysis indicate it remains low during these periods of better growth at all temperatures, but the sugar level builds up as the growth rate declines. However, if sugars were the factor limiting growth, you would expect a very low concentration when growth was poorest rather than this accumulation. This indicates some other factor is lacking which converts sugars into tissue.

Table 2. - Levels of sugars in bentgrass grown at 3 temperatures.

<u>Temperature</u> <u>°F.</u>	<u>Sugar in clippings during</u>		<u>Comments</u>
	<u>rapid growth</u>	<u>slow growth</u>	
	<u>%</u>	<u>%</u>	
60	0.4	0.8	Rapidly rose as growth slowed
70	0.25	0.35	Only slight change at any time
80	0.35	0.8	Sudden fall-off in growth

The question which now awaits answer is - why are the sugars NOT being converted into tissue at the two extreme temperatures? The raw materials are present, but something is lacking to convert them into a finished product. We hope to continue on in the work and identify compounds which will help the cool season grasses grow better at the less optimum conditions.

The value of the tissue tests for carbohydrates is available as a useful tool in understanding plant life. With tissue tests we can study the effects of N, P, K, 2,4-D, moisture, clipping heights, drouth tolerance and numerous other factors. I hope it will become as commonplace as soil testing and as useful.

ROOT GROWTH AND SPECIAL NUTRITION

James B. Beard, Research Assistant,
Department of Agronomy, Purdue

A grass plant can be divided into two parts, the shoots and the roots. The shoot system is involved with the manufacture of food through photosynthesis as well as sexual reproduction. In turf it is this above ground portion of the grass that we observe, evaluate and prize so highly in terms of quality. Below ground is the root system which functions in

anchorage, absorption of water and plant nutrients, conduction, food storage, and as a means of vegetative reproduction. All parts of the plant, both shoots and roots, are obviously dependent on one another. We assume that in order to have a healthy, high quality turf, a deep, extensive root system is necessary. However, we need a broader understanding of the limiting and contributing factors that govern this. Actually root data is woefully lacking!

Most golf course superintendents have experienced the problem of a shallow root system during the hazardous summer months. A shallow root system results in a restricted area for nutrient and water uptake and increases the dangers of turf damage due to wilting. Root growth is influenced by the following factors: soil compaction, oxygen availability, deficient or excess water, nutrient availability, carbohydrate supply, temperature, diseases and insects and presence of chemical inhibitors.

Research is being conducted at Purdue to study the factors influencing root growth of bentgrass. These studies should give a better understanding of the causes of shallow root systems during the summer months, and in turn lead to the appropriate remedies. Research is also being conducted on the use of materials to stimulate the growth of roots. To date five series of tests, labeled G-1 through G-5, have been conducted.

Last summer, in test G-1, 12 materials in 25 treatments were applied to experimental putting green at weekly intervals for a period of 6 weeks. During this period no visible difference could be observed. On August 22, 4 inch plugs were taken from the treated plots. They were trimmed to the surface 1/4", placed in nutrient pots and placed in the greenhouse. Duplicate plugs were placed in controlled climate chambers at 80° F. with a 12 hour day. After 40 days growth the plugs were harvested and measurements of root number, length and health were taken. Results of this test, called G-3, indicates that both glucose and Vitamin B₁ applied in the plots gave a delayed favorable response by having more roots.

Following this, test G-4 was conducted with plugs not treated before being taken to a 65° F. greenhouse. These plugs were given 4 weekly sprays of Vitamin B₁ and glucose. Included in these tests were comparisons between cut and uncut leaves. The results of these tests at this temperature indicated no difference among the treatments except that excessive rates of nitrogen did reduce root growth. Generally we were testing under favorable conditions for grass growth, which limits the response expected.

The next series of studies, G-5, were conducted in the control climate chambers, using especially built root boxes with a glass side for viewing. The tests were conducted at four temperatures of 60°, 70°, 80° and 90° F. Two cutting treatments, cut daily at 1/2" and uncut, were maintained. Also, on separate cultures, glucose and Vitamin B₁ sprays were applied semi-weekly.

In these tests root elongation was marked daily on the glass for 8 weeks. The results indicated that desirable root growth was obtained in temperatures up to 80° F., but when the grass was subjected to 90° F. temperature, the rate of root growth and root depth were reduced by one half. Generally the rate of root growth on the uncut treatments was twice as fast as on the cut treatments. Cultures at 60° F. had the best top growth and satisfactory root growth. Cultures at 70° F. produced the most branching of roots. The 80° F. cultures had the fastest rate of root growth initially. Root growth in the 90° F. culture was very slow as compared with the other 3 temperatures. The glucose and Vitamin B₁ did not give any major increases

in root growth over the untreated plots under these conditions.

Earlier in test G-5, observation and data indicated that in raising the temperature 10° F. from 65° to 75°, the rate of root growth was reduced by one-half. Also, when a plug was clipped after growing unclipped (up to 3") for 15 days, root growth was actually stopped for a period of 11 days before slow growth was again evident at the root tips.

Further research is planned for this coming summer on the Purdue experimental green. Plans are for temperature measurements to be made at 0, $\frac{1}{2}$, 1, 4, 8, 9, and 18 inch depths in the ground for the complete summer period, using automatic recording devices. Glass viewing boxes will also be installed in the experimental green to make root growth observations during the summer period. From this research we will correlate the data from the greenhouse, controlled climate chambers, and outdoor plots for a better understanding of the causes of shallow root systems.

Actually when this study was started, it appeared simple. Yet, it has been a challenge and there remains much to be done.

HOW BLUEGRASS GROWS

W. H. Daniel, Turf Specialist, Purdue University

(Presented before Basic Turf Section)

Throughout the Midwest, bluegrass predominates as the climax turfgrass under mowed conditions. However, many may not realize the slowness and the steps necessary for its establishment.

Most bluegrass selections have over two million seeds per pound, and in general, when planted under ordinary to good conditions, you would expect approximately 40% of the seeds to make seedlings. In general we say that good lawn seed mixtures must contain at least 30% bluegrass. Obviously from the above, expect to get plenty of young bluegrass seedlings. Why then are there so many sparse lawns from six weeks to two years following plantings?

The bluegrass seed has enough carbohydrates, or energy, stored in it to get the seedling up to approximately 3/4" when the nutrition provided by the seed is exhausted. At this point, unless the seedling gets light enough to make its own carbohydrates, it quickly dies. For this reason, when ryegrass is incorporated in seed mixture and allowed to grow dense and tall before the initial cutting, it may completely smother the bluegrass planted. For this simple reason, bluegrass produces the quickest turf when planted alone, particularly in fall conditions.

Let's picture a young plant. It will develop three true leaves, then from a side bud at the crown of the plant it will develop three additional leaves, then at the opposite side another three. This cluster of small leaves, with the plant not yet hardly up to mowing height, has required approximately two months of growing weather. Under ideal conditions, shortly after this time, the seedling plant becomes a 'young man' in that

it begins to put out rhizome buds. When these are initiated the plant can have extreme adversity, yet regrow and continue to spread and establish itself.

How far do rhizomes grow? We selected samples at the Chicago Golf Club. Their records indicated extensive renovation in 1936, 20 years previous to the selections. We found two selections, one spreading 16 ft. across. It was aggressive enough that it completely masked all other grasses that may have been remaining or surviving. Another spot was 13 ft. across, showing that these vigorous, uniform areas originated from a single seedling. In general, bluegrass rhizomes will spread from 2 to 10" per year, depending upon the competition, soil fertility and moisture available. In bluegrass it is not the number of seeds planted that determines the turf two years hence, it is the number of seedlings surviving and able to put out rhizomes that distinguishes good turf from failures.

WHY SOAK GRASS SEED?

W. H. Daniel, Turfgrass Specialist, Purdue University

There have been several technical advances in seed application. For example, the use of manufactured mulch sheetings, some of which even include seed and fiber as one roll. We do have special demands for quick performance, particularly on slopes and important areas for which a quick cover is desired. And, with some of the newer selections, wherein the seed cost is higher per pound, added encouragement for maximum germination and survival becomes more economical.

Our research can be summarized as follows:

1. Bluegrass is as much favored as any by soaking. This has been observed by many turf men. Particularly in the fall it is easier to keep seed damp within a loose cloth sack in the shade than when spread over sun-baked soil. Obviously the seed must be planted before the seed coat is broken and the primordia emerge, which would be approximately four days under warm temperatures. In contrast, for lespedeza this may be only two days at most. Tall fescue and ryegrass, both of which germinate more quickly, would be less favorably affected than bluegrass.

2. Seed and fertilizer in the same solution was very precarious. To our surprise, potassium salts were much less toxic than ammonia salts. With many of the components, the saturation conditions for that salt, seed damage was obvious. Also, if damage did occur it was within three days. If there is any question it would be recommended that seed not be soaked in any except very dilute fertilizer solution.

There are several machines on the market which seed areas by mixing water, fertilizer and seed, then spraying this over the area. In this case the solution and the soil surfaces immediately begin to cause dilution so that the initial mixing should have no damage and be beneficial for germination survival. If equipment breakdown or weather changes occur, then the safest possible procedure would be to dilute the solution as much and as

soon as possible and retain it for minimum time. And, if in doubt, use the hold-over material at light rates over a large area, then come back with a lighter application of newly prepared solution to avoid extreme risk.

In summary, soaking of seed is best only for ideal cases and/or desperate conditions.

Germinating percentages of soaked grass seed.

Fertilizer	Sol. Conc. Percent by wt.					
	1	2	3	1	2	3
	Tall Fescue			Ky. bluegrass		
KCl	51	36	13	54	12	2
NH ₄ NO ₃	42	20	10	13	4	0
N & P	0	0	0	10	1	1
Superphos.	0	0	0	2	0	0
Urea	0	0	0	0	0	0
Check or no fert.		66			40	

IMPROVING BLUEGRASSES

R. C. Pickett, Associate Professor
Dept. of Agronomy, Purdue University

There are over 400 species of *Poa* in the world and in Hitchcock's Manual of the Grasses of the United States there are 69 species of *Poa* listed in 8 sub-genera. This is an important part of the 1400 grasses in the U.S. To show the variety, these include annuals and perennials, bunch grasses and rhizomatous species, tall and short plants, male and female in the same flower and on different plants, narrow and very broad leaves, adaptations from arctic areas to desert areas to sub-tropical areas and introduced and native U.S. species. Most species are adapted to cooler northern and high altitude areas and grow primarily in the cool season elsewhere.

The chromosomes (fiber-like carriers of genes or hereditary material in each cell) range in number from 14 in some shade bluegrass (*Poa trivialis*), 28 in annual bluegrass (*Poa annua*), 70 in *Poa glauca*, 42 in Canada bluegrass (*Poa compressa*) and Texas bluegrass (*Poa arachnifera*), and several species with a range of chromosome numbers such as 28 to 123 in Kentucky bluegrass (*Poa pratensis*) and 63 to 103 in Plains bluegrass (*Poa arida*).

Kentucky bluegrass is an introduced species that has become extremely well naturalized and is very widely occurring in pastures, fields and road-

sides throughout the midwest and eastern United States in both former prairie and former forested areas. Under the severe drouth stress of some years, Kentucky bluegrass may go completely dormant in wide areas except where protected from excessive moisture loss. As a major species in turf-grass mixtures, Kentucky bluegrass enjoys wide adaptation, but is subjected to the same cessation of growth during dry, hot spells and to rather severe disease epidemics.

The work of Dr. Jens Clausen, William Hiesey, and co-workers, of the Carnegie Institution has been concerned in part with the responses of various bluegrass species and some of their hybrids to contrasting environments. One location for these plots has been here at Purdue. Some lines or clones have very narrow ranges of adaptation and some exhibit useful characteristics over a remarkably wide range of environment.

An ecotype or collection from the coast of Oregon named "Newport" has shown "unique tolerance for highly contrasting environments." In Norway at 1500 ft. it out-produces the best Norwegian strains. At 10,000 ft. in California, it is the most vigorous of the wild strains of *Poa pratensis*. Here at Purdue it is in a class with the best adapted strains.

Some bluegrasses head out well in some locations and not at all in others. It would be very helpful if turfgrass varieties could be developed that would not produce seed heads in the area where grown for turf, but would produce them in a good area for seed production. This might be possible to have a good seed producer in the seed production areas of the West that had relatively few heads and accompanying management problems in the Midwest.

Studies at Wisconsin and Purdue have shown that genetic differences in several grasses can be masked by severe management. Frequent defoliation and low fertility will serve to eliminate differential performance among different lines. Thus, the breeding material must be well managed and kept as separate plants as long as needed.

The present stage of work on the bluegrass breeding program is the selection of parents for crosses among species of bluegrass. Stem rust resistant parentage is available among lines of Kentucky bluegrass, Canada bluegrass and Plains bluegrass.

Itaru Shiotani has counted the chromosome number on over 40 prospective parental plants in 6 species. Different plants of Newport Kentucky bluegrass varied in number from 41 to 79 in chromosome number. It will be of interest to see how, or if these plants differ in self and cross-fertility and in degree of apomixis before and after crossing. Fortunately, many of the plants that normally reproduce apomictically are able to cross sexually, given opportunity. The typical pattern in apomictic seed production is for the stimulation of pollination to take place, but the seed development takes place without fertilization. Frequently interspecific hybrids have been reported to be non-apomictic and to segregate like sexually reproducing hybrids. Clausen, Hiesey, et. al. have incorporated genomes of three or more distinct lines into self-perpetuating apomictic combinations. There are obvious advantages in selecting apomictic lines in that a superior type may be immediately perpetuated, but it is also possible that sexually reproducing types may have an advantage of diversity of germplasm for maintenance of disease resistance. Such diseases as rust that can produce new races, may be better controlled if tremendous acreage of identical germplasm are not available.

The following characteristics include some of the things that need recombining from diverse sources in order to get truly improved new types of bluegrass: density, naturally short growth of leaves with few flowering stems, desired color, hardiness combined with continuity of growth in temperature and moisture extremes, desired degree of fineness, fast rate of spread, seedling vigor, and resistance to Helminthosporium, Curvularia, stem rust, leaf rust, Scolecotrichum and other leaf spots.

VARIATION IN MERION KENTUCKY BLUEGRASS

J. M. Duich, Ass't. Professor
Penn. State University, University Park, Pa.

The genetic purity and ability of an improved type of economic plant to reproduce true-to-type progeny are factors of theoretical and practical importance in a breeding program. Numerous investigations on biotypes of Kentucky bluegrass have demonstrated that the species contain both sexual and facultatively apomictic strains. Apomixis (or sexuality) in this species is seed formation characterized by embryo development from maternal tissue. Therefore, the off-spring resemble the mother plant in morphological and physiological characters since they possess the identical germ plasm. A facultatively apomictic bluegrass plant can reproduce both mother-like plants apomictically (sexually) and aberrants (off-types) sexually by the union of male and female germ plasm.

Merion Kentucky bluegrass, a naturally occurring selection of Kentucky bluegrass, has proved to be a superior type of turfgrass in certain areas of the United States. A large demand for seed has resulted in its sale at a premium price several times in excess of common Kentucky bluegrass. Approximately five million pounds of seed have been produced since 1952.

Prior to the first commercial production in 1952, research was limited to turf quality and seed production tests. For several years seed was produced without a pedigree source of growers seed and regulatory control. In addition, the lack of basic information on the nature of its reproduction has resulted in numerous problems for seed growers, analysts, and state and federal control agencies. Consequently, it has been impossible to determine whether the off-types occurring in growers fields, and in commercial seed lots, have been produced by Merion, or whether they are the results of pollution or mechanical mixture.

Since Merion was originally selected in Pennsylvania, and the Pennsylvania Agricultural Experiment Station was delegated to produce and maintain pure and adequate supplies of breeders seed by the Green Section, U.S.G.A., it appeared appropriate that this Station study its reproductive behavior. This investigation was concerned with the above problems as they relate to Merion Kentucky bluegrass. The study was designed to secure information on the:

- (a) extent of apomixis and aberrancy.
- (b) nature of aberrant forms produced
- (c) advance generation performance, and
- (d) possible selection of improved types.

The technique used in the study was the progeny test. For each of the 100 parent plants of Merion selected from our Breeders Nursery, 100 first generation progeny plants were germinated on blotting paper (to allow weak types an equal chance) grown for 5 months in the greenhouse, then transplanted to the field in 1953. Individual plant records were kept until the plants first reached maturity in 1954 at which time they were classified on the basis of collective records.

The results of the first generation test in 1954 showed:

Merion + type progeny	93.7%
Aberrant type progeny	3.2%
Questionable type classification	3.1%

In 1954, 120 plants of the three classification types were selected for a second generation test. This test was designed to (1) serve as a check on first generation classification, and (2) to provide information on advance generation performance. Using the previously explained technique, these plants were set in the field in May 1955. Each plot contained eight second generation plants, and a clone (vegetative division) of both the immediate parent and the grand parent. These plots were replicated 6 times.

The 1956 results of this test showed that the Merion and aberrant type plants were classified correctly in 1955. However, of the questionable type plants, 68% were found to be Merion type and 32% aberrants. On this basis the 1955 first generation classification was corrected to show Merion to reproduce as follows:

Merion type progeny	95.8%
Aberrant type progeny	4.2%

In order to determine the nature of the aberrant forms produced, all aberrant plants fell into three classes based on relative growth, vigor and seed production, when compared with the Merion type

Classes within the 4.1% aberrant plants in 1954 first generation test.

%	
5	PLUS aberrants for plants stronger than Merion
14	EQUAL aberrants for plants equal to Merion, and
81	MINUS aberrants for plants weaker than Merion

One-third of the PLUS and EQUAL aberrants tested in the second generation reverted to apomictic reproduction. This shows that selection of aberrant types as possible improved types has merit in a breeding program. Since Merion only produces a maximum of 4.1% aberrants and only 18% of these are PLUS or EQUAL, the strain faces little danger, less than 1%, of significantly decreasing its purity in future generations.

SEEDING AND ESTABLISHING ROADSIDE TURF

J. M. Duich, Ass't. Prof., Penn State University

One of the major phases of roadside development operations performed by State Departments of Highways is the establishment and maintenance of

adequate protective cover on slopes and other roadside areas to check erosion and reduce maintenance costs. In the large majority of cases, grasses and legumes or mixtures of these are recognized as being the least expensive to establish and the most effective in providing the needed protection quickly and permanently.

Beginning in 1947, the Pennsylvania Agricultural Experiment Station, in cooperation with the Pennsylvania Department of Highways, undertook studies under actual roadside conditions in an attempt to evaluate species of grasses and legumes for slope control. These studies have extended over an eleven year period and include 3 separate series of trials covering comparisons of various grasses and legumes and mixtures of these, different techniques of establishment, various seeding rates, effects of different slope exposures, time of seeding, and similar items that affect the development and persistence of a protective cover.

The species of grasses and legumes studies were limited to those types which are generally recognized as having a wide range of tolerance to the low moisture and fertility of raw soils that are characteristic of highway cuts and fills. The tests included orchard, ryegrass, red fescue, tall fescue, tall catgrass and povertygrass. Trials of legumes were limited to crown vetch and birdsfoot trefoil, both slow starting, low growing plants.

Results of the first series of trials clearly demonstrated that the best performing grasses consistently produced quicker cover and slope protection than the slower growing legumes. In contrast, the legumes, and particularly crown vetch, when once established, provided a better permanent cover than any of the grasses. This raised the immediate question of whether mixtures of grasses and legumes could be used that would supply sufficient early slope protection by the grasses, and at the same time permit development of the legumes at a rate that would provide adequate protection when the grasses began to deteriorate.

This led to the establishment of a series of replicated plots in 1952 in which the 3 best performing grasses were seeded at rates of 25, 40, and 60 pounds of seed per acre in all possible combinations with 20 and 30 pounds of crown vetch and 15 and 25 pounds of birdsfoot trefoil. The grasses used for the study included red fescue, tall fescue (Ky. 31) and domestic ryegrass. The plots were located on a cut section of Pennsylvania Highway Route .047 approximately 7 miles from State College. The slope was from 20 to 30 feet in height, with an average gradient of $1\frac{1}{2}$ on 1. The soil was a very sandy phase of Morrison sandy subsoil, very poor in moisture holding capacity, low in fertility, and high in acidity. Approximately 2 tons of limestone and 1200 pounds of a 5-10-5 fertilizer per/A were applied prior to seeding.

Continuous records of cover development condition, and persistence have been kept on each plot throughout the 6 year period, 1952 to 1957. They include initial stand, rate of development, percent of cover contributed by each species, changes in population and persistence. The results show that:

1. All 3 grasses provided adequate slope protection at all seeding rates during the first 2 years.
2. Crown vetch competed successfully with the grasses grown in association with it at all seeding rates and was contributing the major part of the slope cover by the end of the second season.

3. Birdsfoot trefoil was not able to compete with the grasses and did not produce a satisfactory permanent cover.
4. The total cover produced with the lower seeding rates provided as good slope protection as at the heavier rates.
5. At the end of the sixth season (1957) crown vetch is still providing complete slope protection without additional fertilization, or other maintenance treatments.

Since 1948 the Pennsylvania Department of Highways has made over 150 plantings of crown vetch along our highways. The results of these plantings brought forth this statement from the Chief Highway Forester, "All Roadside Development Engineers of the Department who have made seedings of crown vetch are enthusiastic about the quality of cover obtained on the majority of the treated slope areas. They share the opinion that its potential value as a highway erosion control medium appears to be equal to the best of any type of vegetation which has been used in Pennsylvania."

The experimental work and practical plantings in the state have resulted in the following set of new seed mixtures in our highway specifications:

Flat Area Mixture

50% Kentucky 31 Fescue
 20% Pennlawn Creeping Red Fescue
 20% Common Kentucky Bluegrass
 10% Merion Kentucky bluegrass

Slope Area Mixture

75% Kentucky-31 Fescue
 25% Domestic Ryegrass

Slope Mixture with Crown Vetch

25% Penngift Crown Vetch
 75% Domestic Ryegrass

These mixtures were formulated to provide the best vegetative slope protection at the lowest possible maintenance cost under our present system of management.

GROWING SOD -- HOW FAST?

W.H.C. Ruthven, Merion Sod Co.
 Alliston, Ont., Canada

(Presented before Sod Nurserymen Section).

This is the sixth year that I have enjoyed the fellowship and splendid meetings of your Midwest Regional Turf Conference at Purdue.

This field now showing on the film contains seventy acres of sod, and a creek runs the full length of the property through the wooded area in the background. Sixty acres of this field was seeded to Merion bluegrass at eighteen lbs. per acre, and ten acres seeded with a mixture of 50% Merion and 50% Kentucky blue at 26 lbs. per acre. Excellent stands were obtained with each seeding. The rear seed boxes on the 8 ft. Brillion seeder for seeding coarser grass seeds were discarded and were replaced by an 8 ft. grass seed box manufactured by John Deere which did more efficient seeding of the smaller grass seeds.

Merion bluegrass is our highest grade sod, but some landscapers, and more especially building contractors, frequently prefer the 50% mixture sod as we can sell it for 5¢ a yard less, and this. mixed Merion and Kentucky bluegrass also produces a beautiful sod. We have never dampened nor treated grass seed to hasten germination. The Merion bluegrass seeded on September 1, 1956 was ready for lifting the last week of June, 1957. The mixture of 50% Kentucky blue and Merion seeded at the same time was ready for lifting on July 12.

Regarding the tractor roller shown here in action, the rear dual rubber-tired wheels and rims were removed from a Ford tractor and two steel rollers each 30" wide replaced them. The front wheels were replaced with a water-filled roller 4 ft. long. Hydraulic steering connected to the front roller makes for easy and safe operation. Additional weight may be required for the back rollers and if so, build a carrier on rear to hold 6 to 10 concrete blocks. Two men can make the change-over in less than two hours. The cost of this roller equipment in Canada last year was \$ 405.00.

Our portable irrigation equipment is powered by a 125 h.p. six cylinder gas engine. Twenty foot aluminum pipes as 6" mainline and 4" laterals supply sprinklers spaced 40 ft. apart. Splendid fertilizing results were achieved by applying a 45% nitrogen, as Urea, water-soluble fertilizer, through a barrel and suction on the intake, on the irrigation lines at the rate of 160 lbs. per/A, which is equivalent to 72 lbs. actual nitrogen.

For spraying we use a 21 ft. boom rotary pump connected to power take-off and a 100 gal. tank mounted on rear of tractor. This equipment is permanently attached to an older model Fordson tractor and is always ready for immediate use.

A mower with seven units operated at a moderate speed will cut 7 acres of grass per hour. During June, the fast-growing season, Merion should be clipped every four or five days.

In transporting sod, long-distance hauling requires longer and larger trucks and invariably they are high and more difficult to load by hand. The mechanical conveyor shown on this film was designed and built in a local machine shop. It is powered by a 2 h.p. gas engine and with two men on the truck and three on the ground placing sod on the conveyor, 1000 to 1200 yds. of sod can be loaded per hour on all trucks, including the high semi-trailers.

Successful turf production requires that seeding, rolling, fertilizing, spraying, irrigation, cutting of grass, etc., be done at the right time and season. Since weather conditions are an important factor, observing daily forecasts and five-day probabilities will help in planning

daily work and general operations. To produce a top-quality sod fast, seed to Merion bluegrass, fertilize well, clip the grass often, and, if there is not sufficient rain, irrigate.

SOD REGULATIONS FOR HIGHWAY -- A REPORT

Ben Warren, Warren's Turf Nursery, Palos Park, Illinois
(Presented before Sod Nurseryman Section)

The construction of highways involves the use of a considerable amount of sod in most of the midwestern states. A survey we conducted several years ago showed 30 of the 48 states using sod in their construction programs. Sod, of course, serves two purposes: (1) To control erosion, and (2) Improve appearance. The latter is, and should be, a secondary but important accomplishment. Covering bare soil quickly and permanently with a healthy stand of tough grass is the finest sort of insurance protecting the large investment involved in engineering features of modern highway construction. As our business is growing sod, we have concerned ourselves with the various specifications and practices connected with the highway sodding operations, although in the past we have supplied very little material for this purpose.

In the survey mentioned earlier of the various states, there are several things worthy of notice in the different specifications. The sections describing grass species acceptable as sod in all cases are rather indefinite phrases. For example, one state says, "Kentucky bluegrass, June grass, or other grasses specified;" Another says, "Sod shall be vigorous, well-rooted bluegrass, or other approved sod." And from another state, "Sod shall consist of a dense, well-rooted growth of permanent and desirable grasses indigenous of the general locality." These rather indefinite specifications are in sharp contrast with very explicit qualifications set for seed mixtures. It is understandable that in the past it was necessary to have these broad specifications. However, I believe that with the development of sod growing as a sizable industry, the states can benefit by being more particular in the varieties of grasses used for sod. This lack of being specific is not so apparent in the regulations regarding the thickness of cutting sod. While there is a wide range in the thickness required, varying from 3/4" to 4", all states have set a fixed minimum.

The following phrases are quoted from various state specifications. Ohio asks for "depth equal to fibrous roots" with a 2" minimum; Pennsylvania says, "Depth equal to growth of roots" thickness 2"; in Minnesota we find "the thickness shall be such as to contain practically all of the dense root system" and here a 1-1/2" minimum; North Carolina asks that sod "shall be cut below the root line -- to a depth that will retain all the dense root system" and says that a 2" cut will do; Wisconsin says, "so that practically all of the dense root system of the grasses will be retained, but exposed" 3/4" is their minimum. Briefly, the minimum thickness required in some other states are: Illinois 2 to 3", Michigan 2", Iowa 1-1/2", Kentucky 1-1/2", New York 1-1/2", Indiana 1-1/2", Kansas 1", Missouri 1 to 1-1/4".

The thinking which arrived at some of these specifications seems to be explainable by one of two ways; either there is a gross misconception of the actual depth of grass roots, or the writers have erred in terminology, using the word roots to refer to rhizomes. There also seems to be a misunderstanding of the location of rhizomes and their function in sod transplanting. Only in the Wisconsin regulations do we find specifications which correspond with scientific investigation, such as Tom Hodges is conducting here at Purdue and with opinions expressed by leading turf workers throughout the country.

During the past year we solicited opinions regarding the proper thickness for cutting sod, and I would like to quote briefly from some of the replies we received.

Dr. Fred Grau stated, "Sod cut as thin as practicable - not to exceed 1". 3/4" preferred."

Dr. H. B. Musser said, "We believe that sod always should be cut as thin as practicable for handling without tearing. Actually the thinner the better," and also, "Frankly, I cannot think of a single sound reason for using excessively thick sod."

Dr. W. H. Daniel commented, "With an understanding of the valuable nodes on the rhizomes and the necessity of their initiating new roots and regrowth, the cutting of sod less than 1" thick so that it rolls and lays without tearing, is desired for sodding of roadsides and exposed turf areas."

Dr. J. A. DeFrance observed, "We have found that established sod cut to a thickness of 3/4 to 1" roots more quickly in a prepared sodbed than sod cut thicker."

And finally, quoting C. G. Wilson, "Contrary to some popular opinion on the subject, thin cut turf knits more rapidly and is better able to stand adversity."

Apparently a very wide difference of opinion between the engineers writing specifications and the scientific thinking. Because of this, and because it is not uncommon to encounter a degree of skepticism in the public mind regarding scientific observation and practical application, we made further inquiries among commercial people handling sod. This group included the three largest highway sod contractors in Illinois, who, as a group, lay millions of yards of sod each year. Also included were three sod nurserymen, Carl Habenicht and Al Schaper from Chicago, and Bill Ruthven from Canada. I will not take time to quote from the letters we received from each of these gentlemen. They were unanimous in supporting the thinner cut sod. Their years of experience seems to have shown them that sod cut in the neighborhood of 3/4" thickness handles much more satisfactorily than thicker cutting.

These examples of vagueness in varietal specifications and outmoded thickness regulations seem to indicate a need for overhauling of specifications relating to sod laying. Consideration of some of the handling requirements also leads to the same indications.

Fertilizer specifications show a very wide range of variation in the different state literature. This variance goes from no required fertilizing at all, to what seems to be very adequate application. The specifications of the midwestern states approach adequacy, but I believe in most

cases the rates should be revised upward. It also might be wise to consider requiring that at least a part of the nitrogen be derived from the urea formaldehyde formulations.

Watering is recognized universally as an essential requirement in successfully transplanting sod. I believe it is impossible to specifically say a certain amount of water applied to a given area of sod is right for all conditions, although in one instance this is the type of specification found under water requirements. Perhaps the most relastic wording in this regard was found in New Hampshire specifications, which I quote, "All sods shall be watered sufficiently to insure growth." In only one instance was provision made for what to me is a very important requirement in successful sod transplanting. That is the importance, especially in unfavorable weather, of applying the first watering immediately after laying sod. One state requires the first application to be made within one hour after laying; perhaps the ultimate in absurdity is the provision by one state that during intense heat all watering be done between the hours of dusk and 2 hours before sunrise. This seems to indicate that "old wives tales" are influencing our sodding specifications.

Our original interest in this investigation arose from the very obvious discrepancy between state specifications and general practice regarding thickness of sod cutting. In the course of pursuing this investigation, it became apparent that there were other specifics in this field that were open to study and revision. I believe the most fundamental change that should and could be made is that of grass varieties specified. This, of course, is closely keyed to thickness of cut, for with a more relastic spec. here it should be economically feasible for the rapidly expanding sod nursery industry to supply a superior product, in utility and appearance, to the material now used from neglected and worn out cow pastures.

CUTTING SOD FOR RHIZOME VALUES

T. K. Hodges, Senior in Turf Management, Purdue University

How deep should sod be cut? This question has been raised many times. However, for the most part, these answers were based upon observations and practically none were based upon proven data.

Many of the state highway specifications in the Midwest are requiring that sod should be cut between 2 and 3" to be laid along roadsides. Naturally sod growers are reluctant to sell that much topsoil with every crop of sod. Besides, soil moving is expensive and labor consuming so the contractor must protect himself through higher bids. Also, this extra work requires a longer period for sod laying.

A series of three experiments were devised to determine just how deep to cut sod. They were: (1) counting the number of rhizomes within four depths in the soil; (2) planting rhizomes to see where new root growth initiated, and (3) re-laying various depths of cut sod and observing the extent of new root and rhizome development.

In the first experiment, counting the rhizomes was accomplished by taking a 4" plug, 3" deep, and cutting it into 3/4" increments. Plugs were taken of good, medium and poor quality sod, depending on the density of turf, the maintenance it had and location. Most samples were taken where sod was being cut and sold for turf purposes. Three locations of each quality were obtained with 3 samples in each locality, or a total of 9 plugs for each the good, medium and poor quality sod.

Table 1. Percent of Rhizomes in Each 3/4 Inch Layer.

<u>Quality of Sod</u>	0 to 0.75"	.75 to 1.5"	1.5 to 2.2"	2.2 to 3.0"
	%	%	%	%
High	88	11	1	0
Medium	72	20	6	2
Poor	64	25	9	2

As an average, 75% of the rhizomes were in the upper 3/4" of sod and over 90% were in the upper 1-1/2". Keep this in mind as we proceed on to the next experiment.

The second experiment, that of planting the rhizomes and observing the new root growth, was accomplished by separating individual rhizomes from the sod, and planting them in the greenhouse. The roots on the rhizomes were pruned to 0.5", 1.0" and 1.5 inches. These rhizomes also had the shoots detached from them. Then, one additional group of rhizomes had the terminal shoot left on, but had all the roots cut off. All the groups were replicated 5 times and planted in a mixture of soil, sand and vermiculite. After growing one month, until new shoots were emerging, the rhizomes were washed free of soil.

To our surprise, all the new root growth initiated at the nodes on the rhizomes. That is, none of the new roots formed anywhere on the cut ends, or sides of the old roots. Also, the length of roots left on the rhizomes appeared to have little effect upon the new growth. The rhizome that had the shoot left on it had longer roots, which could be explained as a benefit of having attached leaves. From these results and from the fact that over 90% of the rhizomes are in the upper 1.5 inches, it appears useless and wasteful to cut sod any deeper than this. The deeper sod is cut, the farther these new roots have to grow before entering the prepared soil below; thus, a slower knitting of the sod to the soil.

To verify these results, the third experiment, that of re-laying sod cut at various depths, was carried out by getting 8" plugs of good and poor quality sod, cut to 0.75, 1.5, 2.25 and 3 inches. The various depths were replicated three times and placed in the greenhouse and let grow for 2.5 weeks.

The plugs were then washed out and data taken on the number of new roots emerging below the plug, the length of the roots, and the new rhizomes formed. In every case, the sod cut at 3/4 inch showed the most new roots, with the 1-1/2" next, the 2-1/4" next and the 3" last.

In summarizing the results of these experiments, it seems evident that sod cut either at 1.5" or less would be superior to that cut at deeper depths. I will admit that the water holding capacity of thicker cut sod is greater than in thin cut sod. However, about 90% of the rhizomes are in the upper 1-1/2 inch of soil, and when roots are cut off they die and new roots are initiated from the rhizome. Therefore, the thinner the sod, the faster it will knit itself to the soil below. Only to the extent that poor sod is used, or poor care is given during adverse drouth, or drying periods, could there be reason for additional sod depth.

USING BERMUDA AND ZOYSIA

Ernie Schneider, Supt., Evansville Country Club,
Evansville, Indiana
(Presented before Southern Golf Course Section)

For modern golf, more and more has to be said for Bermuda and Zoysia in the Midwest, as it is no longer enough just to have good greens. Close cut tees and fairways are just as important. The only grasses in the Evansville area which can take this close cutting are the Bermudas and Zoysias.

I have in plots and use, more than ten improved types of Bermuda, besides the seeded types. The commons are very coarse to a medium texture, most of these in play. Of the improved types the U-3, Sunturf, Uganda, Gene Tift, T-35A and Tifgreen have been the outstanding Bermudas in the fairways. The U-3 and Gene Tift have more of a tendency to build up a mat than the others. The Sunturf is very tight, close growing turf, although the growth is slower. I just obtained the Tifgreen last spring -- it is the fastest growing of the Bermudas, good color, fine texture. I do hope it is winter-hardy. These Bermudas which I have mentioned by name do green-up about two weeks earlier than the U-3. What I am looking for, is turf which is as winter-hardy as U-3, but also that gives a green turf earlier in the spring.

Around the collars and aprons of my greens I have mostly U-3 and common Bermuda. On the collars, I prefer the common as the runners will grow on top of the bent, instead of under the sod which makes for easier maintenance -- the runners from the common have never given me much trouble. When the runners grow on top of the green, if I do not get them pulled back, they usually freeze back. The U-3 is harder to control as it wants to grow under the sod, as well as on top of the sod. I guess we should not worry too much about this as I would much rather have a little Bermuda on the edge of my greens than to have crabgrass and naked collars and approaches. In two or three years, you can always take the sod cutter and rip out several cuts around the edge of your green and sod it with bent again.

My tees are Common Bermuda, U-3 and Meyer zoysia. Due to the late greening-up of the Bermudas, as I rebuild my tees, I am putting them in Meyer zoysia. Meyer zoysia has done very well for me on the tees. At the present I have five tees of it in play, and plan two more this spring. I grow the sod in a nursery and then transfer it. Zoysia has stood the play

very well. The turf is already green by the time the earliest of the Bermudas are beginning to green-up. It is maintained at one-half inch cut. Clippings are removed with grass catcher on the mower. It requires less mowings than the Bermuda. The thatch is removed once each year with a Parthatch. They play these tees all winter and so far there has been no injury to the Zoysia. The Zoysia tees are all wood shot tees, and I will continue to use the Bermuda on the iron shot tees, because the Bermuda recovers from injury faster than the Zoysia. We use less fertilizer on the Zoysia - Bermuda is fertilized five times and Zoysia four times during the season. Therefore, I feel I save the club money on fertilizer and labor. I have had far more compliments from the golfers on the Zoysia tees than I have had on the Bermuda.

I have one green with Zoysia on the apron, the runners are hard to detect as they hide themselves as well in the turf of the bent, except for close observation, they are more noticeable when the turf is dormant. At the present, there are straight runners into the green, as much as 30" long. These runners never seem to fill out around themselves, just get longer each year. This could be due to the close cut on the greens. As soon as the weather permits, I hope to remove them before they green-up this spring. In 1952 we plugged some Zoysia into some of our Bermuda tees, slowly but surely it is crowding out the Bermuda. I have one tee in Uganda, been in play since August. It is still too soon to tell how it will hold up.

I intend to continue to experiment with these strains of Bermuda and some of my native Bermudas.

(Note of Editor, W.H. Daniel - The Sunturf Bermuda has looked very good in all observations - see article of DeHays. It is Certified in 1958 in South Carolina, Oklahoma, Mississippi and Arkansas. Trials at Purdue, Southern Indiana Forage Farm and St. Louis are underway).

USING WARM SEASON GRASSES IN CINCINNATI

Donald E. Likes, Supt., Hyde Park Golf Club,
Cincinnati, Ohio

Cincinnati, being in the transition zone, is a difficult area for maintaining the cool season grasses. Consequently, we have sought the use of the warm season grasses for better and easier turf maintenance. In discussing the use of Bermuda or Zoysia, the question arises - will it survive our winters this far north? Several clubs in Cincinnati have U-3 Bermuda tees that have performed well for several years. Other clubs have lost U-3 on their tees during the winter.

Three years ago the topic of discussion at our local Association meeting was "the loss of U-3" during the previous winter. On Bermuda tees, with any amount of player traffic during the dormant season, 80 to 90% of the turf was lost. Where the golfers were kept off the tees, U-3 survived 100%. The loss of Bermuda that winter can be attributed to several factors. It is our opinion that it doesn't exactly "winter kill." True, it is lost by the next spring, but U-3 has survived freeze tests as

low as 28° below zero. Actually the grass dies from lack of moisture in the early spring months. O. J. Noer calls this "wind burn" and it not only happens to Bermuda, but also to bent and bluegrass if it has been subjected to a lot of winter heaving. If the grass is heaved up it can very easily become too dry during the month of March which is often warmer and drier than April in Cincinnati. This condition can be aggravated by heavy winter traffic and perhaps over-feeding in the fall with nitrogen. In some cases, superintendents have watered U-3 in the early spring while it is still dormant to prevent "wind burn." Winter survival of U-3 in most cases will be acute only the first winter.

On the newly established areas of U-3, the first summer it makes considerable lateral growth above ground, but has not had sufficient time to develop its root system which will go as deep as 6 feet. For tees we like to mulch with straw, or similar material, this first winter. This not only prevents heaving and drying out, but the turf does not die back as far. The mulched U-3 is about 2 or 3 weeks ahead of the unmulched Bermuda in the spring.

In maintaining U-3 for tees, we have found that it must be cut very close (3/8") to prevent any undesirable fluffiness. The clippings must be removed or they turn brown and are unsightly. Regular applications of N are necessary to keep the grass tender enough for the mowers to do a good job of cutting. With its deep root system, Bermuda can go for long periods without water in most soils. We like to water only when tees become so dry and hard that it becomes difficult to tee up. In one particular case our #5 tee of U-3 was not watered for an entire season. This tee is about 150 feet from the nearest water valve; consequently, it is often neglected when it comes to watering.

Another bad experience we have had with Bermuda tees is earth-worm damage. In Cincinnati we have the "nightcrawler," the granddaddy of them all, and if the soil is soft and moist they can do a good job of fall plowing. We think it is advisable to apply an insecticide as it is needed to discourage earthworm action. This is especially needed in the late fall after the U-3 becomes dormant. The earthworm can leave Bermuda turf in bad condition for going through the winter.

At the present time little has been done on planting U-3 into fairways. Some superintendents are convinced it is the thing to do. However, it may be sometime before club members will buy the idea in our area.

Very little Zoysia has been used on any golf courses in Cincinnati. For some time Meyer zoysia was in the shadow of U-3. However, in the last 3 or 4 years it has proven a superior turfgrass in several ways. It is our opinion that Meyer zoysia would make a fairway turf superior to U-3 or any of the cool season grasses. Meyer greens up about 3 or 4 weeks ahead of Bermuda in the spring. It makes a much better winter turf than Bermuda because it does not die back as far. It merely turns brown on the tip of the grass blade. In our area, properly maintained dormant Meyer lawns are as uniform and beautiful as any bluegrass-crabgrass lawn during the winter season. At the present time, Meyer has been used only on a few lawns, fewer tees and in some cases on aprons where bent is difficult to hold in the summer. On one course in Cincinnati, Zoysia will be started in the fairways this year. The disadvantage of Zoysia is its tendency to build up thatch. We think this can be controlled by manipulating fertilizer applications and by mowing properly - even spring burning if necessary.

There is some question as to the use of Emerald zoysia in Cincinnati. This strain, although much finer textured than Meyer, is more difficult to mow. When maintained at fairway height, it becomes very difficult to mow without causing discoloration. This is particularly true in the late summer. When maintained at putting green height in the test green at Camargo, this was not a problem. All indications are that Emerald has limited possibilities for a putting green grass on low budget courses. Vertical growth of Emerald is very slow, but runner extension is faster than Meyer.

To summarize the warm season grasses for Cincinnati, U-3 is definitely the best grass for tees except where shade is a problem. It must be mowed close, fertilized often and where earthworms are a problem an insecticide should be applied. Water only when soil becomes so hard that playing conditions become difficult. U-3 tees should not be used during the dormant season. For winter play tee markers should be placed elsewhere. It is our opinion that Meyer zoysia would make a fairway turf superior to Bermuda, or any of the cool season grasses. Thatch may become a problem. This can be controlled by proper fertilizer and mowing practices.

PRINCIPLES ON BASIC WEED CONTROL

James F. Morré, Dept. of Botany and Plant Pathology, Purdue
(Assisted by E.B. Hollingsworth)
(Presented before Basic Turfgrass Section)

The correct use of chemical weed killers depends upon a thorough understanding of their values and limitations. Each material on the market is specific for a certain weed, or group of weeds. The kind of weeds and the conditions under which they are growing determine to a large extent the most feasible method of control. As we seek to maintain turfs, industrial grounds and recreational areas, both the economic importance and unattractiveness of weeds become more apparent. You attempt to have a well-managed golf course, a beautiful lawn or a profitable nursery.

What is a weed? By popular definition a weed is any plant growing where it is not wanted. A tendency to vigorous growth and a high capacity for reproduction under various climatic conditions are among the factors which are important in classifying a particular plant as a weed. Whether or not a plant is a weed will vary with the locality, its association with other plants and the individual's point of view.

Weed control, prevention and eradication. Prevention, in practice, prohibits the establishment of weedy species on an area not previously infested. The prime means of infestation are the presence of weed seed in crop seed and the transportation of weed seed by wind, water, birds, animals, etc., from adjacent infested areas. More often the problem is one of control and eradication of established weeds. An individual will often be content with control methods because they keep the weed below the nuisance level. Eradication is unlikely without previous control measures. By this I mean a weed cannot be forever eliminated by one cultivation, one mowing, or even one application of a chemical.

Cultural methods. Mechanical control is probably the oldest method developed by man. Hoeing, mowing and various means of cultivation will undoubtedly be practical as long as there are weeds to combat. Competition is one of our better methods of weed control, especially in a grass sod. "Discourage weeds by encouraging grass" has been repeated often enough to become an axiom of weed control. Given an advantageous start by proper management, many crop plants can successfully suppress weeds by depriving them of moisture, light and nutrients. You are familiar with mulching as a form of weed control.

Biological control. The use of herbicides is increasing at a rapid pace. Chemicals have been used in a crude manner for centuries to control weeds, but only in the past 40 years has scientific research with herbicides developed techniques as sound in their basis as those used in combating diseases and insects. The use of chemical compounds as herbicides is divided into two broad classifications, selective and non-selective.

Selectivity in an herbicide implies that the material will kill weeds in a germinating or growing crop without harming the crop beyond the point of recovery. Selectivity is governed, to a large extent, by specific characteristics of the plant and by the time and method application. Physiological selectivity occurs within the plant. The cells of some plants tolerate the toxic action of an herbicide better than do those of other plants. Chemicals themselves vary in their activity. An herbicide may kill a plant on contact, or, like 2,4-D, may enter the plant, be translocated to susceptible tissue, where it alters the metabolism, causing death. Whether or not a leaf has a hairy surface, or is smooth and waxy, will influence the retention and subsequent absorption of herbicidal sprays. Structural features of a plant are very important in its response to an herbicide. The leaves of cereals and grasses are usually upright and narrow so that the spray tends to slide off. Broadleaved plants have wider leaves which grow more horizontal and are easier to wet. The location of the growing point of cereals and grasses is located in the plant crown, near or below the soil surface, where it is protected from the toxic spray by surrounding leaves. Broadleaf plants, however, have their growing point exposed at the tip of shoots and in the leaf axils where they are easily killed by the spray. Annual plants may be killed by a chemical in a crop with a perennial root system.

The operator can greatly enhance selectivity by proper application of the herbicide. Pre-planting treatments are satisfactory for killing old sod or perennial weeds prior to seeding. Fumigation is a very satisfactory pre-planting treatment for keeping seedbeds and other small areas free of weeds.

Chickweed - Chickweed seed normally germinates in the fall during damp, wet periods and will establish wherever the turfgrasses become weakened. Chickweeds are moderately resistant to 2,4-D and can be controlled only when the plants are small. 2,4-D, or 2,4,5-T applied in mid-October will usually give good results. Neburon, when available on the market, provides excellent kill at any stage of growth. Repeat applications of DSMA, or AMA, crabgrass killers, may reduce competition of chickweed in the spring.

Knotweed - Knotweed germinates in very early spring in bare areas, often where the soil has become compacted. It is easily killed by early post-emergence applications of standard 2,4-D and arsenate treatments. As the plants advance beyond the seedling stage, they become more difficult to

kill until satisfactory control is impossible. These early 2,4-D treatments may also delay crabgrass.

Other Broadleaved Weeds - 2,4-D has been very successful in controlling many of the broadleaved weeds, such as dandelion, buckhorn and common plantain, but gives only partial control of chickweed and mature knotweed. Most turfgrasses and weedy species are not killed by 2,4-D at normal rates, although some strains of creeping bent are severely injured.

Esters and amines are the most common forms of 2,4-D available on the market. Esters are made by combining in alcohol with the 2,4-D and give off killing, volatile fumes. Since 2,4-D vapors can injure trees, shrubbery, flowers and nearby crops, high volatile forms should be avoided or used with extreme caution. Heavy alcohols attached to the 2,4-D reduce vapors and are sold as low volatile esters. The amine form is non-volatile and can be used near susceptible plants. Spray drift must be avoided even with amines. Coarse sprays are least likely to drift.

2,4-D is a synthetic growth regulator which upsets the plant's normal growth pattern. Twisting or bending of leaves, thickening of leaves and stems, and change in color are common symptoms of 2,4-D injury. Since 2,4-D is moved throughout the plant or translocated, it is not necessary to spray all the leaves as in contact killers.

Even with susceptible weeds, a given rate of 2,4-D will not always give the same amount of weed control. The size and age of the weeds sprayed is very important, as well as weather conditions. For example, chickweed must be treated early to get good control. Dandelion and buckhorn are also more easily controlled when young and rapidly growing. During hot weather, weed growth is slowed down and the 2,4-D will not give satisfactory kill.

All Vegetation - There are materials available on the market that will kill all growing plants. These chemicals are termed soil sterilants, or non-selective weed killers, and may find limited use in special turf weed problems, such as cleaning out fence rows, driveways, and/or around buildings.

When it is desirable to rid the soil of weed seeds, soil fumigants may be employed. These chemicals are applied as gases under airtight covers, or as a soil drench. The soil should be cultivated to good tilth and contain sufficient moisture to induce seed germination at the time of treatment. Satisfactory fumigants include methyl bromide, vapam and allyl alcohol.

Aquatic Weeds - Aquatic weeds are classified as floating, submersed and emergent. Scum or algae, is removed by treatment with copper sulphate, or phygon. Sodium arsenite will kill most submersed aquatic weeds and cattails are controlled with amino triazole. Consult Indiana ID-1 for rates and special precautions. At present, no one chemical will control all 3 types without some harmful effects to fish or humans.

Brush (Woody Plant) Control - Woody plants sensitive to either 2,4-D, or 2,4,5-T can be treated with setting the foliage with a spray containing one gallon of 4 lb. material per 100 gallons of water, or water-oil emulsion. Ammate is recommended as a foliage spray for the control of woody plants where adjacent sensitive plants would prevent the use of 2,4-D or 2,4,5-T. Use 1 pound in 1 gallons of water.

Control of brush and small trees during the winter months is accomplished by spraying the bark with a solution containing 4 gallons of 2,4,5-T (4 lb. material) in 100 gallons of fuel oil or kerosene. The lower 12 inches at the base of the trees should be sprayed until thoroughly wet. Woody plants may also be killed by applying the above mixture of 2,4,5-T to freshly cut surfaces of stumps or stubs. This type of treatment may be applied at any time of the year and will usually give the most complete kill.

Poison Ivy - Where susceptible plants may be injured from 2,4-D fumes, ammate (1 pound per gallon of water) will give some control of poison ivy. A mixture of 2,4-D and 2,4,5-T (1 gallon in 100 gallons of water) or amino triazole (5 pounds of 50% material in 100 gallons) are usually most effective.

The selective action of all weed-killing chemicals is relative. Many chemicals are satisfactory selective herbicides at low concentrations, but become less selective as the rate of application is increased. Extremely high concentrations will result in soil sterilization. For more efficient and satisfactory chemical weed control, it is important to know the limitations and capabilities of the herbicide, the susceptibility of the crop and weed, and the optimum time and method of application.

CRABGRASS CONTROL BY FOLIAGE TREATMENTS

N. R. Goetze, Dept. of Agronomy, Purdue University

Hairy crabgrass and smooth crabgrass are summer annuals which produce ^{many} seeds in the fall. They may appear throughout the summer when conditions are favorable, but germination is largely restricted to a 6-8 week period during late spring and early summer. Within the last ten years tremendous progress has been made in research on crabgrass control, but it has been more than matched by constantly expanding consumer interest as a part of the homeowner's constant effort towards outdoor living. We recognize crabgrass in the Midwest as the plant that germinates when a warm spell arrives in mid-spring, that it continues to grow wherever there is room and opportunity for infestation and survival until frost kills it in the fall.

Crabgrass is fast becoming a relatively unimportant weed on most modern golf courses. Considerable progress has been made in improved management practices which have reduced its severity. Tees have been enlarged to allow for greater alternate areas to cut down the intense mechanical wear in mid-summer. Fairways and roughs have been better fertilized and managed for the prevention of crabgrass.

Before chemicals the homeowner's mainstay for control was either good management, or mechanically digging it out. Sometimes mistakes, which overlook crabgrass habits, may actually encourage infestation. For example, severely raking a lawn in late spring. There has been considerable progress in mechanical control - the Flexicomb, the Verti-cut, the Contour Thin-cut. Several of these machines are designed to either thin

crabgrass, or to remove much of the competition as the cool season approaches.

The first step in reducing crabgrass on turf areas is to alter management procedures which may indirectly cause it. Remember that crabgrass germination requires high light intensity, high temperature and ample moisture. Crabgrass seeds seldom germinate nor survive in the shade of other species. Any practice, such as higher mower height or increased fertility during the earlier part of the season prior to the warmer weather, will promote a better turf growth and reduce the infestation of crabgrass. Use of fungicides, or disease resistant species, will also reduce the weakening of turf and cut down the encroachment of crabgrass into disease weakened areas.

Chemicals that Kill Growing Plants

Earlier work with potassium cyanate proves its good qualities and the fact that it can selectively, because of some plants ability to escape damage, control crabgrass. Normally it takes two sprays and there is considerable discoloration to bluegrass. It has largely been supplanted by the organic arsenicals.

Another material widely tested and widely used has been the organic mercuries, including PMA, or phenyl mercury acetate. It has not received widespread homeowner acceptance, but has been a godsend to golf courses and turf specialists who can use it with care, moderation and understanding. Its combined fungicide-herbicide action gives it added value. The organic arsenicals have proven superior in research at Purdue University.

With the di-sodium methyl arsonate the kill is comparatively slow and quite selective with adequate soil moisture and growing crabgrass. Obviously with unregulated dosage, with dry soil conditions, or with poor distribution, damage can occur to several grasses. Two applications 5 to 7 days apart, applied in late afternoon as sprays have been standard. It has been used on bentgrass, bluegrass, Zoysia and of course Bermudas. The di-sodium methyl arsonate can control both smooth and hairy crabgrass, witchgrass, barnyard grass, sedge, dallasgrass, chickweed, foxtail, the top of nutgrass; in fact, many annual weeds which may come into turf areas. When combined with 2,4-D and 2,4,5-T it is possible to almost completely clean up weeds and weedy grasses on very poor turf.

In 1956-57 we have continued additional screening in an attempt to find chemicals that would serve as a one application crabgrass control which would greatly modify its application limitations. Of the arsenicals tested, we ranked them according to selectivity, 9 out of 12 were superior to di-sodium methyl arsonate, the current chemical used. Of those superior a selection, V-59, was formulated as A-2, with different pH of solutions, different mole concentrations; yet whenever the same amount of arsenic was applied, controls were equal. When equal total organic arsenic was applied in either 1, 2, 3, 4 sprays, the control was almost identical. The two applications could be made anywhere from the third to the seventh day with little observed difference in the rapidity of kill, or toxicity to the weedy material. In reviewing our experiments I find we have used almost 2,000 plots in greenhouse and field studies to evaluate and ascertain this information.

Based on these results and others, one manufacturer in 1958 is providing an improved organic arsenical, Octyl Ammonium Methyl Arsonate, abbreviated AMA. Most formulators may carry it as an improved, or superior formulation. Some formulators will carry it mixed with DSMA. Others will continue to use DSMA alone. The AMA should give a faster initial yellowing - a faster kill. In some ideal situations, one application may be sufficient to kill young crabgrass. Under most conditions two applications will be required. Somewhat lighter rates will be used, approximately three-fourths as much actual arsenic as is used in DSMA. Much of the new material will be available in liquid forms. Nationally there is a tremendous acceptance of the vermiculite carrying forms of crabgrass killers for repeat spreader application to turf when leaves are damp. (See Arsenic Toxicity article, page 51.

POA ANNUA RESEARCH CONTINUES

N. R. Goetze, Dept. of Agronomy, Purdue University

Extensive field and laboratory tests during the last two growing seasons have indicated that annual bluegrass may be selectively removed from turf. Results of these tests have been variable due to localized environmental conditions and species composition of the turf.

Of the more than 30 herbicides used in various trials, none have exhibited selectivity between the annual bluegrass and desirable turf when applied to the foliage. This would be expected since true selectivity between grasses by foliar acting herbicides is rather rare, except in the case of crabgrass control by organic arsenicals. Pre-emergent applications to the soil have been very encouraging, but the results have not yet been consistent enough to warrant recommendations.

Surprisingly enough, the degree of selectivity between Poa annua and bluegrass is wider than with any other cool season turfgrass. Bentgrass and the fine leafed fescues have not been very resistant to damage by the compounds which are most effective on the annual bluegrass. Bermuda has been shown to be quite resistant to some of the materials and our experience with Zoysia is quite limited.

Neburon, a substituted urea herbicide, has been the most effective new compound under test. It has never damaged bluegrass turf when properly applied and has usually been effective on the germinating Poa annua. It is most effective on germinating grass seeds and has only slow acting effects on mature grass. Results with the material have been erratic and inconsistent. Bentgrass putting green plots have been completely destroyed in the St. Louis area, whereas no damage to the bentgrass has been experienced in more Northern locations. Trials currently under way are designed to explain the differences in degree of damage to the bentgrass, and to improve the methods of application by reducing exposure of the bentgrass to toxic concentrations of the material.

Other experimental herbicides that have shown some promise include vegedex, SD 1369, and EPTC. They are being included in present field trials

to gain more information on factors affecting their selectivity.

Until more information can be gained on the new experimental organic herbicides, calcium arsenate and lead arsenate will continue to be the recommended treatments for control of Poa annua. Calcium arsenate was shown to be the most effective material in the St. Louis area, and lead arsenate has been equally effective in other experimental sites. The action of these materials is reduced on soils containing high amounts of phosphorus so it is difficult to specify a particular rate.

On soils containing only low amounts of phosphorus, 24 lbs. of lead arsenate, or 12-16 lbs. of calcium arsenate, should prevent the establishment of new seedlings of annual bluegrass. (See next article also). Additional quantities of arsenic may be required to build up toxic concentrations on some older turf soils which may be high in phosphates. Arsenates are not readily lost from soils and the first applications will not be wasted if they are not heavy enough to be toxic. Since these materials are active only on germinating or very young seedlings, their effect may not be noticeable until the season after application after the older plants have weakened and died and the new germination begins to germinate. Arsenics most affect Poa annua in the cool spring and fall, when otherwise Poa is growing most rapidly.

ARSENIC TOXICITY TO WEEDY GRASSES

W. H. Daniel, Dept. of Agronomy, Purdue University

Gentlemen, the subject of arsenic use as a herbicide is comparatively old. Before summarizing the compilation available, may I explain four basic actions of arsenic. These are: foliar burn, foliar absorption, root absorption, sterilization. There may be more or combinations of these.

Foliar Burn

First, you perhaps best know the foliar burn of arsenics. This is so well exemplified by sodium arsenite sprays on fairways. Very soluble forms of inorganic arsenic acids give grass burn within minutes - with a fast peak of action - within 2 to 3 days. Since you depend on the initial burn to assure plant kill, 2 - 3 applications are used in 5 - 7 day sequence. And how well you know that hot, dry winds at noon day give maximum burn, while cool, cloudy weather reduces foliage damage! Thus, spring applications are uncertain at best. To the contrary, timely, early fall applications as a part of renovation, may be economical, fast and certain. Even at high rates the desired bluegrass survives due to their rhizomes, and bentgrass survives because of dormant buds. As more selective chemicals are offered, less interest is evidenced in sodium arsenite, or arsenic acid.

One pound of grey powder sodium arsenite, or one pint of 75% arsenic acid per acre would be standard rates, while 3 up to 30 lbs./acre have been used. And while using these do a good publicity job about the browning ex-

pected, the reason being used, and the fact it takes time to re-establish new turf with seeding and regrowth of new leaves.

Foliar Absorption

Let's move from the first type, called foliar burn, to the second - foliar absorption. Here we jump up to 1954 for commercial activity. Actually there may be 10,000 ^{organic} arsenic compounds possible. Now for your interest, perhaps 20 - 40 organic arsenics have been tested with positive crabgrass kill. However, there are only two marketed di-sodium methyl arsonate and a new one for 1958, Octyl-ammonium methyl arsonate.

How does foliar absorption work? A large organic molecule aids the arsenic to enter the leaves. In the leaves it causes an interference in metabolism, or growth processes. Those cells in fast growing areas turn yellow, the plant stops growth, the yellowing spreads and browning occurs throughout susceptible plants. When used at inadequate rates, instead of getting kill, the plant's response is to very gradually yellow, to stop growth, to be so inactive that it will not respond to added materials. This is to be avoided. If it does occur, then one must wait 3 - 4 weeks, until regrowth starts, before starting a new spray program. In general, the organic arsenics have been very acceptable when used on growing crabgrasses as two applications 5 days apart.

Root (and Seed) Toxicity

From foliar burn to foliar absorption to No. 3 - Rootzone toxicity.

May we begin by pointing out these relationships -

1. Plants require phosphorus - not much - but a constant supply in each cell.
2. The arsenic ion is almost same size and chemical activity as the phosphorus ion, and can replace some of it in plant absorption by the roots.
3. When arsenic infiltrates, plant growth stops. Why? Because growth requires a complex transferrable phosphorus compound to new growth area, and arsenic is NOT transferred.
4. When growth stops, susceptible plants are weak and non-competitive. Any adversity should give their kill.
5. A seed contains enough phosphorus to get weedy grass seedlings up to the 3 leaf stage before toxic arsenic in rootzone is effective.
6. Smooth and hairy crabgrass, witchgrass, barnyard, and to a lesser extent goosegrass, are affected selectively when toxic arsenic is present as seedlings start.
7. Poa annua, during periods of rapid growth, during cool weather of spring and fall, may be affected regardless of its age or size.
8. Bentgrasses, bluegrasses and ryegrasses are more tolerant to arsenic toxicity than weedy species above.
9. The more cations present - Ca, Fe, Mg, or the higher the soil alkalinity, or the higher the phosphorus availability, the more arsenic will be required to get toxicity.

10. If excess arsenic restricts turf growth, apply 400# superphosphate, or equivalent, per acre to override arsenic by supplying phosphorus.

And yet, these facts are unimportant unless transferred into action. Let's understand one difficult point. Arsenic toxicity in rootzone must be understood, or leave it alone. It isn't for those who are faint-hearted, guess rates, guess dates, or make poor application with poor equipment. Half enough is useless - three-fourths enough is useless, but costly. So, let's apply the 10 points above to situations.

Let's suppose you have crabgrass problems! What program? Treat the left half of two fairways, or a section of two, even a 1,000 sq.ft. area of two this spring before the earliest possible crabgrass germination. You decide the area, but it is equally important to decide rates. It is "available" arsenicⁱⁿ the soil solution that counts. Based on our observations with the current materials available, you could use the following chart as a guide:

Weed and Condition	Calcium arsenate	Lead arsenate	Timing & Comments
crabgrass on	lbs./1,000 sq.ft.		Apply any time before crabgrass germinates (will not kill old plants)
low fertility or sandy soils	8 - 12	12 - 24	
fertilized or clay soils	12 - 16	20 - 32	
<u>Poa annua</u> on			
low fertility or sandy soils	10 - 16	16 - 24	May affect old plants, but only during ^{spring} and fall
fertilized or clay soils	16 - 24	24 - 32	
On putting green - 2 appl.ea. of	8 - 16	12 - 24	As split repeated application, or
On putting green - 1 appl. of	16 - 24	24 - 32	As one application rinsed off leaves

What Others Have Said

Work as reported by Crafts shows that 8 lbs. per 1,000 of sodium arsenite should give sterilization for two seasons along ditches, but he records a four fold increase in rates between light and heavy textured soils for sterilization purposes.

In New Jersey, Frantz reports that arsenic tri-oxide from 100 to 4,000 lbs. per acre was applied in tests. Soil cores were taken from 1 to 30 months afterwards. The higher the rate the longer toxicity so that at 30 months only the highest rate prevented normal oat plant growth.

Excellent research was reported in September 1933, U.S.D.A. Bulletin by Monteith. He reported that insoluble arsenic at rates of 40 lbs. per 1,000 may cause some retardation of Kentucky bluegrass, but gave selective control of several weedy grasses.

Extensive research by Welton in Ohio, was reported in Turf Culture in 1937. Their experiments showed that crabgrass seed, when mixed and dampened with lead arsenate for two weeks, would initiate seed growth. This was confirmed in research at Purdue in 1957 where even two weeks under greenhouse conditions seemed adequate to inhibit seedling growth of crabgrass when arsenic was present in soil surfaces in toxic quantities. Further, that when seed and arsenic are applied together, weedy grass seedlings will germinate, but then be restricted in vigor as arsenic is picked up by the young roots.

Welton also reported in 1935 that 15 lbs. calcium arsenate did as good a job as 25 lbs. lead arsenate.

In his book on Weed Control, Ahlgren reports that arsenic inhibits a large number of enzyme systems, but that in extremely dilute concentrations it may stimulate growth, which is true of most other inhibitors.

Back in 1926 Leach reporting in U.S.G.A. Bulletin, Vol. 6, reported that Kentucky bluegrass did well, but that Poa trivialis did not grow satisfactorily under arsenic treatments.

One of the best references summarizing arsenic materials is that of Grau in Vol. 13 of U.S.G.A. Bulletin. In this he points out the arsenic control of weeds is best adapted to those that are shallow rooting, that the absorption into the plant causes it to prevent the formation and utilization of products of photosynthesis.

Summary of Toxicity

Again it should be stressed that arsenic toxicity will not work unless adequate quantities are applied to the soil, that it will work only on seeds and seedlings for most weedy grasses, that adequate applications should be toxic for two to three years, that contamination of the surface would allow re-infestation because seedlings would not get the arsenic at the early stage.

Several companies are working on granular, or pelleted forms for 1959 use. There is a tremendous potential for sales of any formulation of arsenic that would be a crabgrass preventer, but to achieve this sale potential, the material should meet these specifications:

1. Low toxicity to existing foliage so that it does not have to be rinsed off leaves.
2. That it be pelleted or granular for easy distribution with various applicators, even by hand when necessary.
3. That it be dust-free to minimize contamination of dothing, breathing and exposure to arsenic.
4. That the toxicity last one season or longer.
5. That it be a unit package designed to cover a limited area, for example 1,000 sq.ft.
6. That it be well labeled, including follow-up directions.

SOIL STERILIZATION METHODS

J. C. Harper, Senior Agronomist, Toro Mfg. Corp.
Minneapolis, Minn.

In the establishment of turfgrass or ornamental areas, weeds are always a serious hindrance to the rapid development of quality turfgrass

and ornamentals. The first real interest in seedbed weed control was by the tobacco growers, and much credit must be given to them for our present knowledge of seedbed weed control. One of the earliest methods consisted of the piling and burning of large quantities of brush on the prepared seedbed in hopes of sterilizing the soil by heat and, at the same time, supplying potash through the oxidation residues. They also used steam sterilization method whereby live steam was released on the seedbed under some type of hood or confining device. Although effective, both were cumbersome, slow, expensive, and often resulted in damage to the physical properties of the soil.

"Soil Sterilization" infers permanent sterilization, but temporary sterilization is really the objective. The ideal soil sterilant would kill all plant life in a very short time, move out of the soil quickly with little danger to humans, and be reasonable in cost and labor.

Chemical sterilants vary in killing power, residual effect, and mode of action. We must, therefore, consider these factors when choosing one -

1. The inherent toxicity.
2. The manner or type of reaction that takes place between the chemical and the soil. If a chemical adheres to the surface of colloids, it is going to require relatively high rates to be effective. And, clay soil may require four times as much as sandy soils.
3. The rate of decomposition; also, whether the toxicity occurs as applied, or is a result of the breakdown products. The rate of breakdown caused by bacteria or chemical reaction within the soil is highly dependent on temperature and moisture. These determine not only the active period of toxicity, but also the waiting period between treatment and planting.
4. The species tolerance of weeds to a given chemical. For example, established knotweed is highly resistant to arsenicals. The killing ability of a material will be dependent on its inherent toxicity, the weed species present and the environmental conditions.
5. On the more practical side, consider the ease of application, the cost of the material and the labor required - these are strong contributing factors. Any type of temporary soil sterilization is expensive and careful consideration must be given to justify it.
6. The care and precautions required in using.

Research workers and practical men have tested chemicals ranging alphabetically from acrylon to zinc sulfate. One of the first soil sterilants used was sodium chlorate. It may sterilize the soil for periods up to several years, depending on the amount used, the soil type and the amount of rainfall. It has the added disadvantage of being highly inflammable. Many other materials, including arsenicals, oils, chloropicrin, carbon bisulfide, carbolic acid, sulfuric acid, oxyacetic acid, IPC, borax, CMU, ethylene oxide, etc., have been tried. In practically every instance these materials failed because they did not give effective control, remained toxic in the soil too long, were impractical to use, or were extremely expensive. You can, for example, get excellent seedbed weed control if you mix 100 lbs. urea, ammonium nitrate or sodium nitrate, or 1,235 lbs. Milorganite per 1,000 sq.ft. However, such high nitrogen would be toxic to seedlings later.

Of all the chemicals available today, only three are of current importance. These are calcium cyanamid, methyl bromide and sodium methyldithiocarbamate, commonly known as Vapam, or VPM.

CALCIUM CYANAMID

Calcium cyanamid is a fertilizer containing 20% nitrogen and 70% hydrated lime equivalent. Under proper soil and climatic conditions, calcium cyanamid will perform well against some types of weeds. In the South, calcium cyanamid has limited value because it does not kill all bermudagrass runners, or nutgrass corns. At low soil temperatures, or inadequate moisture, calcium cyanamid is broken down very slowly and does not supply the toxic concentration required. Calcium cyanamid is most effective on those weeds germinating when it is breaking down and toxic. Applications of calcium cyanamid made in early spring give excellent control of early spring weeds, but are only partially effective on crabgrass and purslane, both of which germinate later in the spring.

The rate of application varies from 50 pounds per 1,000 sq.ft. on light sandy soils, to 100 lbs. per 1,000 sq.ft. on heavy clay soils. One-half should be mixed thoroughly into the top three inches of soil, followed by a surface application of the remaining one-half material. Mixing peat or organic material in with calcium cyanamid may improve soil and tie-up released N. Rolling, mulching, cultipacking, after mixing, favors better contact and kill. Seed planted 7 - 14 days later, in warm weather, will germinate, but may pick up toxic nitrogen in young roots. In the Midwest early fall is best time of use.

METHYL BROMIDE

Soil treatment with methyl bromide is the most positive method for controlling weeds in seedbed, but the application problems, hazards to the users and the cost, have greatly limited its use. It is used as a fumigant for grain and plant material prior to shipment to other localities. Methyl bromide is a highly toxic, quick acting gas that is tasteless, colorless and odorless. It may cause serious burns or respiratory damage if not handled properly. For safety sake, some producers add chloropicrin (tear gas) as a warning agent.

When using methyl bromide the following materials will be needed:

1. Methyl bromide. It comes in 1 lb. cans at a cost of 80¢ each, or for large areas it may be purchased in cylinders at a slightly lower cost. Normal application rate is one pound per 100 sq.ft., although under difficult conditions, use 2 lbs.
2. A gas-proof cover. Specially treated paper, or cloth, or plastic material may be used. These materials cost about \$ 12.00 to \$ 18.00 per 1,000 sq.ft., and may be reused several times if handled carefully.
3. Methyl bromide applicators. These applicators cost about \$ 4.00 and may be used indefinitely. One applicator is all that is required, but several will speed up any job.
4. Gas tubes. Gas tubes may be copper or saran plastic and cost about \$ 2.00 each.
5. Gas pans. Shallow pan, a rain gutter, or plastic sheet.

6. Safety goggles for the operators when releasing the gas.

(Example: 2 covers, each 20' wide and 50' long, with 6 applicators or tubes, would be possible golf course unit).

In placing the gas-proof cover, boxes, large cans, or nailing a 2" strip of wood to the top of the stakes may be used to provide open space for gas diffusion. Rough edges should be avoided, or padded, to prevent tearing of the cover.

The gas pans or troughs should be placed along the center of the area to be treated, and the gas tubes anchored securely in these pans or troughs so that the liquid methyl bromide does not empty directly on the soil. The gas tubes must be long enough to extend beyond the area to be covered by the cover. The cover is now placed in position and the edges sealed by placing soil on the edges. The soil on the edges should be tamped to insure a good seal. If the soil is dry, water with a light sprinkling prior to tamping will be beneficial.

After the cover is securely in place, check the gas tubes by blowing through them and connect them to the applicators. The cans are then placed in the applicators and the proper number of cans emptied. The last can should be allowed to remain in the applicator to act as a seal until the cover or gas tube is removed. After 24 hours the cover can be removed. Within 24 to 72 hours, seed or plants may be safely set out in the treated area.

Methyl bromide will be more effective on a well-prepared seedbed having good aeration, good soil moisture and at soil temperatures above 70° F. At soil temperatures of 50 to 70° F, exposure and aeration time should be doubled, and not be used below 50° F. Effectiveness may be increased by heating the escaping gas through coiled copper tubes in a boiling, or hot water bath.

The following precautions should be observed:

1. Store in outbuilding away from dwellings and in a cool place.
2. Do not breathe vapor. If can is spilled, move upwind immediately.
3. Keep animals and children away from areas under treatment and for at least 30 minutes after cover is removed.
4. Do not spill. Do not wear gloves. Remove any clothing immediately if methyl bromide is spilled on them.
5. Do wear goggles.

VPM

At the present time, the methyldithiocarbamates are available under the trade names of Vapam (Stauffer Chemical Co.) and VPM (DuPont). They are liquids which vaporizes rapidly upon contact with moist soil, are poisonous if inhaled or swallowed, are irritating to the eyes, nose, throat and skin, has a highly offensive odor, and can be absorbed through the skin by contact. Goggles, protective clothing, rubber gloves, boots and a respirator should be worn when using this material. The manufacturers suggest the following application methods:

1. Sprinkling can. Add one pint of Vapam and water, stir and sprinkle uniformly over 50 sq.ft. Immediately continue sprinkling with can

or hose nozzle to assure Vapam and water penetration to a depth of 4".

2. Hose Proportioner. Add 1 qt. Vapam to 3 qts. water, stir and apply uniformly to 100 sq.ft. with a hose proportioner having a ratio of about 1:15. Immediately continue sprinkling to insure water penetration to a depth of 4".
3. Sprinkler. Run sprinkler until soil surface is moist. Gradually inject into the system the total amount of Vapam needed for the area covered by the sprinkler. Continue sprinkling 15 to 30 minutes to seal the surface.
4. Sprayer. Apply Vapam as a coarse spray, as dilute as possible, at the desired rate per acre. Immediately follow with a tiller, or other equipment that will thoroughly mix the soil. A water seal following mixing will increase effectiveness.
5. Flood irrigation. Meter Vapam at a steady rate continuously into water during irrigation.

For small areas, a layer of plastic or paper may encourage a better kill than water seal. Lay plastic flat on soil, hold down with hose, boards, or any weights.

Regardless of the method of application used, the area should be lightly cultivated 5 to 7 days after application to promote escape of vapors. On light to medium soils, allow an additional 7 to 9 days between this cultivation and planting (12 days total). On heavy soils, or soils high in organic matter, allow 14 days between cultivation and planting (19 days total).

Do not apply to dry or cold soils. For weed control, the soil should be continuously moist 5 to 10 days prior to application to start weed seeds germinating. Vapam should not be used within 3 ft. of any desirable plant, nor should it be applied within the drip line of overhanging trees or shrubs.

Vapam itself will vary in cost from \$5.60 per single gallon to \$3.20 a gallon in 30 gal. drums and 500 gal. lots.

NEMATODES - A REVIEW AND QUESTIONS

James L. Holmes, Mid-Western Agronomist, USGA Green Section

Nematology is the newest science, as such, in the agricultural field. It follows then, that research workers are faced with the problems of obtaining necessary basic information before broad, inclusive allegations can be made. However, there is sufficient research and field data available to prove in some instances and indicate in others, that nematodes are, in fact, virulent plant parasites.

Nematodes have basically two body shapes. In certain species, such as the common root knot, the adult females are rounded or saclike and remain immobile at maturity. Eggs are extruded from the female's body in a resistant matrix and can remain unhatched, yet viable, in the soil for many years. The cyst forming nematodes are also saclike. However, when females die, the body forms a leathery, resistant covering for the contained eggs. Eggs contained in such cysts are extremely difficult to kill.

The other nematode body shape is similar to that of an eel; thus, the common name "eelworms." When adult, these plant pests are 0.3 to 2 m.m. in length. They have a digestive tract and nervous, excretory, reproductive and muscular systems. Adult nematodes tolerate adverse conditions as they can be found in rotting fruit on the upper limbs of fruit trees, in arctic ice and in arid deserts and on every plant investigated.

Research data on damage to turf, caused by nematodes, is limited. Nematode damage to grass is similar to that on other types of plants. Nematodes are a factor in the overall maladies which affect plant growth. For example, through tearing and weakening root systems, nematodes make excellent points of entry for other organisms such as fungi and bacteria, which are detrimental to healthy plant growth. A plant attacked by nematodes is also more subject to wilt and will show nutrient deficiencies readily because of a reduced feeder root system.

The following examples indicate plant damage:

Around 1900 celery was a big crop around Sanford, Florida, producing 1000 crates per acre. Within 10 years yields began to drop and within 20 years a decline was evident. Soil scientists determined that certain minor elements were lacking in the soil and yields were temporarily increased by their addition. However, the overall celery yield continued to decline.

The work of plant pathologists and entomologists once again gave a temporary increase in production.

By 1950 yields were 300 crates per acre and some fields were total failures. Fertilizer recommendations were 2 tons per acre of a high nitrogen and potassium fertilizer, plus all minor elements known to be necessary to celery growth.

In 1950 it was determined that sting nematodes and other kinds, known to be parasitic on plants, were present in large numbers. Five acres of a 100 acre field treated with a nematocide at 20 gal. per/A yielded 900 crates per/A, while the other 95 acres were a total failure. In 1951 the entire field was fumigated for nematode control and yield was over 800 crates per/A.

Another good example of the insidious type damage that nematodes cause is cotton. Plant breeders developed Dixiebright 101 with resistance to Fusarium, and it was planted on a large scale. In certain areas Fusarium was reported, but it was established that nematodes play a prominent role in this cotton-wilt complex. The nematodes cause minor damage themselves; however, when the two are present -- wilt.

Very little research work has been done on nematode damage to fine turf. Dr. Gene Nutter, Florida, is currently working on the problem. Mr. Vernon Perry, Wisconsin, will publish his doctorate thesis this year of research on nematode damage to Kentucky bluegrass and on bent, which will

add to what is known about nematode damage to turf, especially in the northern part of the country.

In 1951 Tarjan and Ferguson reported that nematodes were associated with yellow turf. In 1955 Tarjan and Hart verified the former report that nematodes were indeed present and probably a major factor in yellow tuft.

In 1954 Tarjan and Troll found 10 known parasitic species of nematodes present in varying numbers on 41 samples from 17 golf courses in Rhode Island. The nematodes were associated with "definite symptoms of chlorosis and/or dieback of grass blades. Turf exhibiting chlorotic patches of varying size and intensity occasionally would contain bare areas where individual plants had died out completely. (*Poa annua* gave a natural yellow case in some of the test areas and may have confused the issue somewhat.)"

In 1957 Perry and Holmes screened soil samples from nine different golf courses in Minnesota, Michigan, Illinois, Indiana and Nebraska. Samples were taken from greens which were considered by the superintendent to be problem greens. The turf in these areas invariably had a shallow-sickly root system, was difficult to water properly (usually remained over wet), was readily attacked by fungi, was subject to severe wilt and iron chlorosis, would not stand up under heavy traffic and was easily burned by fertilizer applications. In every sample screened, large populations of parasitic nematodes were detected. One species (*Tylenchorhynchus* sp.) was present in every sample. Four other parasitic species were found, but not in every sample.

Infested areas on four golf courses, two in Illinois, one in Minnesota and one in Michigan were treated with nematocides. Results from these tests will be available by July or August of this year. We expect to continue screening samples from golf courses in the area to determine which parasitic species are present and try to determine the extent of damage.

It is logical that nematode damage to turf does not kill turf outright, but rather it is responsible for a slow, gradual decline. Things are wrong and the superintendent cannot "put his finger on it." Response to fertilizer is poor and iron chlorosis is such that iron salts must be added weekly, roots are practically non-existent, watering is a tricky and difficult job, and foremost, diseases are extremely difficult to control.

At this time no absolute remedy can be reported; however, there are a number of practices which will help:

1. Two nematocidal chemicals, which can be safely used on growing turf, are available. Trade names for these are VC-13 and Nemagon, or Fumazone. Turf research, with these chemicals, is not complete. Some superintendents have tried these chemicals. Mr. Emil Picha treated one-half of No. 18 green at Oak Ridge with VC-13 in 1955. In 1957 when Dr. Ferguson observed this green for the first time, he was able to detect the half which had been treated. Carl Bretzlaff applied a nematocide in one-half a green at Meridian Hills Country Club last fall.

Mr. Vernon Perry treated a plot in a Kentucky bluegrass lawn at Madison, Wisconsin, with VC-13. All other cultural practices were identical. I have never seen more favorable growth resulting from the use of any agricultural chemical.

2. It is strongly recommended, in order to reduce or eliminate parasitic nematodes, (and weed seeds, etc.) that all greens and teeing areas before being planted, be sterilized (see article on sterilization). You are referred to Dr. Gene C. Nutter's article, "Soil Sterilization Practices in Turf", which appeared in the June 1957 issue of the USGA Journal: pages 25 - 30. If a green or teeing area has been sterilized, it would be foolhardy to topdress with non-sterilized topdressing, or bring in soil on stolons.
3. Superintendents have learned how to handle problem areas by "babying" the area, or following such practices as light, frequent application of fertilizer (foliage feeding in many cases), daily syringing, frequent aerification or spiking, use of limestone or hydrated lime, frequent applications of fungicides and other practices. In order to be able to live with nematodes, it will be necessary to continue such practices, especially during weather periods which are adverse to turf culture.

SUMMARY

1. Every plant thus far investigated has its nematode parasites.
2. Insufficient research work has been done, yet parasitic nematodes are present in many turf areas.
3. Perry at Wisconsin, has obtained some outstanding results with nematocide treatments on Kentucky bluegrass and associated parasitic nematodes with turf decline.
4. Nematode damage is loss of turf vigor rather than killing the turf outright.
5. Nematocides, currently on the market, show promise.
6. Sterilize all new green and teeing areas and all topdressing used on these areas.

DEVELOPING IDEAS FOR EQUIPMENT MODIFICATION

Carl Habenicht, H. & E. Sod Nursery, Inc.
Tinley Park, Illinois
(Presented before Sod Nurseryman Section)

Ideas are important factors in business survival today. In any organization, creativity must come from all sides, but it is the top and middle management executives, who must set the example.

Ideas depend largely on personal mental habits. - Remember first that it is a quantity of ideas that you are after. Second, don't mix value with your idea gathering. Get ideas first, worry about whether they are good later on.

Don't be surprised if you find that you already have used one or

more of these. The value of having them gives you confidence to know these tools exist - that they have a purpose and you have a need for them. Devices are also helpful.

Making notes is an important factor - it is a big help in idea producing. Perhaps you have had the experience of seeing a good idea. In fact, it was so good you thought you wanted to use it, but when that time came, the idea was gone and the problem still there.

Jot down your opinion on problems. Go after lots of ideas. Form the habit of noticing anything that may be a possibility in the future for you. Include clippings from newspapers, magazines, etc. Store them in a box, or use whatever system appeals to you - follow through with it.

Evaluate your idea. They are of no importance until something is done with them. Often impossible ideas are used to good advantage. It is a fine policy to listen to fellow employees' suggestions - these often times lead to different facts and thoughts.

You cannot expect to design a machine, or remodel one, with a single idea. Should one idea solve a problem, well and good, but if it fails, you are right back where you started. If you have ten or twenty ideas, your chances of solving the problem are much greater.

Finally, when all facts, thoughts and ideas have been gathered, you are ready to draw your equipment modifications. If you are not qualified to do so, consult a draftsman who is familiar with machinery designing.

In conclusion:

1. Look for a better way - faster or economical.
2. Get many ideas. Read literature - save clippings.
3. Make notes of dates, ideas.
4. Evaluate them.
5. Put them on the drawing board.
6. Be willing to try new ways.

An Example of Modification

At the H. & E. Sod Nursery, we have about 25 engine driven pieces of equipment which is a great expense to operate and keep in good working order and ready for use when needed.

1. Our first step was to find a better and more economical way to do this. Our aim was to reduce our expense on machinery operation and maintenance costs.

2. We wrote down our problems - thus keeping our goal constantly in front of us.

3. We gathered ideas by discussing them with our mechanic and other people. I'd like to illustrate:

Diesel fuel, being cheaper than gas, came to our mind first. Propane was a relatively new fuel at this time. We knew little about it, but heard that it cut down maintenance costs.

4. We evaluated our ideas. Advantages. Diesel fuel, cheaper, less maintenance than gasoline, more power and cleaner burning. Propane fuel cost less than diesel and gasoline. Clean burning, requires less maintenance and longer hours of operation between oil changes. Disadvantages. Diesel fuel, more expensive, somewhat dirtier than propane, costlier to repair and overhaul.

After carefully evaluating our ideas, we decided on propane.

Reason: It was close to diesel fuel in operating costs, but much less on maintenance and repairs.

5. We put our idea to work: Converted all our late model heavy equipment, such as big trucks, tractors and irrigation equipment to propane. All old equipment not in constant use did not warrant the conversion expense and was left on gasoline. All new tractors or trucks which we now purchase are immediately converted to propane.

This is just one example of developing an idea for equipment modification to fit our operation. This idea itself may be of no importance to you, but the method of collecting ideas has done much to help us.

I, like many of you, need to discover short cuts, ways and means of cutting expenses. Since using this idea program, I have found it helps a great deal in our business of raising sod. I know this idea of using propane has worked out to a great advantage to us.

WHAT HAPPENED ON A REDUCED BUDGET

Bud De Hays, Supervisor, Frigidaire Recreation Park
Dayton, Ohio

I accepted Dr. Daniel's invitation to speak on this subject since many of you are concerned about it in these times of readjustment. Further, this is a normal function going on in all fields. What we are talking about is "BUDGET CONTROL:" all we are doing is bringing it to the foreground. First, may I give you some idea of our Park and its responsibilities. We have 340 acres, 200 of which we have in operation as Frigidaire Recreation Park. We have three traps for trap shooting; volley ball; four soft ball diamonds, one lighted and all have grass infields; archery range of eight bucks; driving range with twenty positions, plus a new grass tee we are now constructing; a miniature golf course, covering over an acre and handling over thirty-five thousand players per season; eight shuffleboard courts; four playgrounds, pony track, miniature car track; outside movie area; a half acre ice rink for winter months only; tennis courts; seventeen clay horseshoe courts; eleven buildings; forty-seven toilets; fourteen parking lots; band stand; rose garden and fourteen croquet courts, all planted in SUNTURF Bermuda. We are also ready to plant a practice green, or 4,200 sq.ft. in Uganda as soon as the weather permits. As far as we are concerned, Bermuda fits our reduced budget perfectly for croquet and game areas in our particular park.

May I term my remarks as "MEETING TODAY'S CHALLENGE." All of us today are faced with certain curtailments, must trim expenditures; yet do a

good job. We shouldn't feel too badly, nor complain too loudly for we are not alone, and, to prove that we are capable supervisors,^{we} must face adversity - even though it hurts. The governing bodies realize that the large investment must be protected, and they do not wish to reduce any budget to the point of degradation. This was clearly explained to me when I met with my board of directors. When I realized the huge investment entrusted to me, I felt like a V.I.P. Yet, it was now in my lap and it was up to me to accomplish the assignment.

Perhaps you would like to know my first reaction when I left the board meeting - it was the same as yours. I had an empty feeling in my belly - and a slight headache - and as I drove back to our Park, my head was buzzing. I realized that the first thing that usually accompanies a reduced budget is a reduction in labor. None of us like this, but since labor represents 60% of most budgets in our type of work, it becomes necessary. In my case where many items are fixed, such as, light, heat, taxes, insurance, etc., the largest remaining item to reduce was labor. We at Frigidaire Recreation Park are no different than you. This was the first time in my life that I had to let someone go for no reason of their own.

I slept on that one, to give myself time to plan my move, for this was my challenge. After trying to sleep, it looked to me that either I ran the show, or someone else will get the opportunity to try. What next? I deducted that with reduced labor, but with the same work to be done, we would have to improve our methods. Let me give a few examples. Each spring we would move 250 heavy picnic tables from storage to locations scattered over a thirty acre picnic grove. To do this job we would use one tractor, one wagon and four men, hauling two tables to the load. Then in the fall they were returned in the same manner. Today we do this same job with one tractor and one man by using a carrier which we made to fit the power draw bar. We, too, wonder why we had not done this before. It's the same old story - we had always done it the other way.

Another example: Each spring when we cleaned up our river front area, we would get into quite a mess. You can all imagine how a grove along a river looks after high water in the spring. Fence posts, logs and debris of all sorts get wedged in the trees, then the corn fodder, bottles, old tires, and you name it, collect and make quite a jam. In the past, we cleaned this up by hand, but, no more. This time we devised a large metal hook which we fasten to the logs and a chain that binds the jam together as we pull it out with a tractor. This saves time and also requires less men.

Another challenge was to realign men to pick up slack, and place one man of leadership, who was transferred to our downtown office. Naturally I wanted to use one of my older men, and again I knew I had to make the right decision. I analyzed the job requirements, and in behalf of these men I could not ask for better workers, or cleaner fellows. After telling my boss what requirements I had, all he said was: "You want egg in your beer?" Gentlemen, it pays to take your time in hiring. I was most fortunate in hiring the man I wanted.

But, employee morale became challenge number three. There was a certain amount of resentment in the air, so I talked to the men, one at a time, and explained the decision and pointed out his good qualities, as well as his bad.

Now: What Happened on Reduced Budget? So far as I am concerned, we

are actually better off than before due to: 1. Better methods; 2 Better management; and 3. Better understanding or morale. And our Board of Directors has openly expressed their satisfaction.

PROBLEM SOLVING IN TURF MANAGEMENT

Argel L. Pion, Pion Landscape Company,
Ft. Wayne, Indiana

It has been suggested that some effort be made to set down a few constructive ideas relative to Problem Solving. As a commercial operator, it becomes a "must" that I try to acquire as much "know how" as possible.

Planning and Scheduling Work

Of all the functions in industry, planning and scheduling of maintenance management is the most neglected. With poor controls and procedures, maintenance effectiveness varies from 20 to 40%. Good procedures and controls bring effectiveness up to 40 to 60%. By adding sound job methods, possible effectiveness goes up to 70 to 80%. Planned maintenance, according to Factory magazine, is "discharging the plant engineering and maintenance function so that only necessary work is done and that work is done efficiently."

Planning - there ought to be an easier and better way, and we're going to find it. Based on past experiences and observations, the aim in planning is to set up equipment and jobs in order to cut time.

Scheduling - when to carry out the work outlined by the planning function, based on anticipated labor and work load.

The aim to scheduling is to reduce delays between jobs. Planning calls for a lot of know-how and ingenuity. Scheduling is a mechanical aftermath of planning. You can do good planning without scheduling, but not good scheduling without planning. What do you achieve by sound planning and scheduling?

- Pre-plan jobs and preparatory work, coordinate equipment and information relative to the most efficient way of doing the job.

Supply job priorities to all crews in advance.

Coordinate activities during the job process and its interruptions.

Follow up on completion dates and meet time schedule.

Anybody who has adopted sound planning techniques will tell you he "never had it so good." Not only management, but employees feel the same way. The big job in sound planning and scheduling is to have someone think out the job in detail ahead of time. Don't leave it entirely to a gang foreman.

This is not a speedup. The objective is to have your employees work smarter, not harder. One of the commonest grips today is, "I can't get a

fair day's work out of my man." You're pretty well convinced they could produce better. You don't have to guess. Study important work samples to find out. Identify working time, traveling time, personal time, delays and any other minor categories special to your needs.

Are You Due For a Surprise?

If the pattern of your operations holds true to other industries you're due for some surprises. Don't be shocked if your men show only 30 to 50% labor effectiveness, as many companies discovered when first digging into the problem. Look into the nature of the 50 to 70% unproductive time. Much of it is due to poor maintenance management and not to lazy and incompetent workers. Often they can't work efficiently, because they lack information, proper tools, or proper materials as the case may be.

Now turn to maintenance management. How good is your planning? You can take an overall sampling of your entire maintenance function, or a sampling of a single operating division, or even of a single crew job. The aim is to uncover non-productive time as revealed by all sorts of delays. Label the delays as to cause; you can then pin-point areas needing improvement. Reasons for delays are noted in order to show the effectiveness of the planning. Sampling won't score the job performance - only work measurement standards will do that. And it won't necessarily tell whether the men are using the best methods. This takes a methods study.

For example: A work sampling of a man moving a pile of lumber might show 95% effectiveness if he carries one plank at a time with no rest in-between. If he carries three planks at a time he might show only 50% effectiveness, because he rested between trips. Yet, insofar as work performance is concerned, he does the job in two-thirds of the time. By applying methods study, you might cut his time in half again, or you might eliminate the job altogether by putting the pile in the right place at the start.

Look over your reports of breakdowns, or other troubles. If you don't have such reports you should insist on them. Are there repetitions that are costing you considerable sums in lower labor output? You might be able to eliminate or reduce them, or the operation might be changed around. In growing container plants it may eliminate costly weeding between the containers by setting them on inexpensive black polyethylene, or even a paved surface. Which is more expensive, over-head watering or irrigation, and for which plants? Can six men in a crew do four or five times as much work as two men in a crew? Or is the smaller crew more efficient? Such things can be measured by trying them out.

Check on Follow-through of Planning

In the average nursery, 80 to 90% of all work should be scheduled in advance, and each operation should be thought out fully ahead of time so that both work methods and tools are as efficient as possible. Why have a crew get out in the field, for example, and then find there isn't enough insecticide to spray it all? Does lack of a 25¢ washer, or similar part sometimes hold up spraying for hours? Perhaps that's exaggerated, but there's no reason for delays to become common occurrences.

Even if the nursery had a rough form made up to show the work completed, the delays and reasons for them, it would help because the sheets could be studied for improvement. But the better way, of course, is to work sampling, performance and methods study. Sound planning is not easy and it's not a job

for the inexperienced, but there are a great many ways in which the work load can be better managed. The trick, of course, is to discover the better ways.

Some nurserymen make it a habit of visiting other successful nurserymen, and attending meetings to pick up pointers on improving various growing and other operations. Good planning comes from sound thinking about the various ways for improvement. Get into the habit of searching for better methods, better planning. For example, landscape nurserymen often complain that they can't make any money planting on the customer's property. Good planning and scheduling, in combination with a sound study ^{methods} might result in faster, better and more profitable landscaping.

The secret of a successful planning and scheduling program is to have employees say, "That's the best way we ever did it." They'll say it if the work is efficient and they feel they are accomplishing something by the improvement.

WHAT'S YOUR BASIS FOR COST ESTIMATION?

Argel Pion, Pion Landscape Company,
Ft. Wayne, Indiana
(Presented before General Turf Section)

Before it is possible to figure the contract bid of any job of landscaping or turf building, many things should be taken into consideration. It is through good planning and budgeting cost that we learn to bid accurately. The idea of cost finding in the landscape and turf business has not been explored and studied as it has been in other businesses.

When a manufacturer produces an item, he is reasonably sure of his cost of production. This is necessary for the wholesale and retail pricing of the manufactured article. When we figure to sell a turf or landscape job, we, too, are thinking in terms of cost. What is our basic cost of production, what must be our selling price in order to receive a fair profit? Whether we are large or small contractors, costs are a fundamental part of our business. Costs are all the expenses that are incurred in producing a piece of work, or in the execution of an order. Cost findings expose all the weak points in every operation and bring about more efficiency in the field.

We are not in business to sell materials or labor, but rather to make profits. The selling of materials or labor is only the means to an end. Profit is the vital part of business. Making sales without a profit is just wasted time and energy. Anyone can sell below cost, but it takes a wise and clever man to sell his product at a fair, profitable rate in face of all kinds of competition.

An extensive list of items could be compiled on cost estimating. Several factors that I try to keep in mind when bidding a job may be of interest to you.

1. Weather - The weather conditions should be anticipated. If a 5 or 30 day outlook forecast is available in your area, try to use it with your planning.
2. Topography - Analyze the lay of the land where work is to be done. Is it a flat area, rolling, or with severe slopes? General soil conditions might be considered as part of the topography. Is it impervious, hard clay, sand, silt, or good friable loam soil? Can equipment, trucks and supplies get to the location?
3. Equipment - Having the right tools, especially power equipment, is all important for the successful performance of any lawn job. Observe the time saving and efficiency of your equipment; discard the tools that have become obsolete.
4. Material - What is the source of topsoil, its quality and cost? Are seed and fertilizer being purchased from a reliable firm or manufacturer?
5. Labor - Do you have qualified and competent supervision for and on the job? Are you paying fair wages for good employees? What fringe benefits are provided?
6. Overhead - Are all the hidden costs, such as taxes, insurance, depreciation on buildings and equipment, being taken into account? Is a contingency percentage being figured on all jobs to take care of these hidden costs? It might be argued that overhead charges should not be added in computing the bid estimate. This is not true. Overhead is just as much a cost as direct labor. Each item must bear its proportionate cost of overhead. If you contend that certain items should not be charged with overhead cost, then other items will have to bear an additional proportion to cover them.
7. Unanticipated work failures - What kind of a guarantee is made for producing a good lawn? What position do you take if you have a complete washout, or a partial washing? Is lost time figured for mechanical failures? How can it be figured?

When a man fails in business, he never blames himself. He most often blames his competitors for cutting prices. This is about the poorest excuse that could be offered. Your business is your own. You alone are responsible for its success. If a competitor sells his material or services at a lower price than yours, you can certainly feel there is no sense in cutting your price to meet his competition. If that competition is below cost, that is the result of poor management. There is little reason for anyone to follow an incompetent competitor and lose money.

Custom Service on Industrial Lawns

Industry is rapidly becoming very conscious of good public relations. One way it has found to further good relations is to keep the exterior appearance of their plants in A-1 condition at all times. Hence, we have noticed in recent years a complete transformation in many industrial plants, particularly in the landscape treatment and lawn care.

We, as commercial operators, are called in for counsel and advice on their particular landscape and lawn problems. Always, the question is asked, "How much will it cost?" It isn't here and then that our accumulation of knowledge in estimating becomes very important. Just where do we

start? Our back log of experience and records can give us a clear picture of the work at hand and what our cost to the client should be. If the job is priced out of limits, we probably won't get the work because of the high cost. If the same job is priced too low, we would lose money. Therefore, if we know our costs and can price the job right, make a fair profit, and do good work, that is as it should be. Each job should be analyzed for the kind and amount of work to be done. Is it just lawn mowing, or is it a complete lawn management job! If it is a complete job, we should have a comprehensive knowledge of labor and material costs, how much lawn area can be properly cut by one man per hour, or per 8 hour day, what kind and how much fertilizer will we be using? These and many similar questions we will ask ourselves and answer.

The question is sometimes asked, "What is minimum maintenance?" To me it means, doing the best possible job for a given amount of money. Minimum maintenance should include all the operations necessary to keep a good turf at its best as a result of good and efficient management. It requires a terrific amount of study and application of many of the principles mentioned in this paper.

Let us resolve to keep informed as to the most efficient methods of operating our businesses. In conclusion, let us continue to be happy in our chosen profession. No profession is more rewarding than ours when we see the results of well-executed jobs. Finally, let's appreciate the fact that by good, careful management we can remove the guesswork in cost estimations and conduct our businesses in a profitable way.

Editor's note: The material below may be of value to others, so is included through courtesy of Argel Pion, who prepared form and report.

A SURVEY OF LANDSCAPE COSTS

(Average of 42 Chicago area firms participated in this survey)

What kind of operation do you have:

Landscape contracting	<u>37</u>	Lawn construction	<u>31</u>
Garden Shop	<u>8</u>	Nursery	<u>16</u>
		Retail	<u>23</u>
		Wholesale	<u>3</u>

Do you do yard maintenance work? 15 of 42 said yes

How many people are employed full time? 4.6 Part time? 9.33

Do you develop landscape plans and specifications? 36 yes

What is your charge per square foot for lawn construction, including seed, fertilizer and labor (no topsoil) per sq.ft. .05, or per sq.yd. .45

What is your charge per cubic yard for good topsoil? \$ 3.35
For spreading 1.25

What is your charge per hour for - Common labor \$ 3.21 Skilled labor \$4.05

What is your charge per hour for tractor with operator? \$ 7.90

WORK SIMPLIFICATION IN TURF OPERATIONS

Charles E. French, Dept. of Agricultural Economics, Purdue

To apply your Conference theme, "Increasing our Understanding", to work simplification, suggests that we take into account a few facts about our changing economy. Engineers tell us that a man as a source of energy is worth about a 75-watt light bulb. They are a bit more generous when they say we match a one-tenth horsepower motor as a source of power. Certainly the dignity of man suggests that he should use his time for something more useful than this!

Man has not been ignorant of this fact. For instance, estimates say that in 1850, machines contributed 30% of our productive power, animals 50%; and man 20%. In 1950 machines contributed 96%; animals 2% and man only 2%. Of course, productivity is increased not only through machines and capital expenditures, but man's own work methods may also improve. Certainly, all cannot industrialize equally, but each must be fully cognizant of what it can do to increase productivity.

The old idea, "if it was alright for grandpa, it is alright for me" is a natural tendency to resist change. But, a broader look shows change is one of the inevitables; here, it ranks with life and death.

Work simplification is a philosophy. It emphasizes the importance of labor, an open mind, the offensive, the dynamic and a system. But, the system is one which should lead to the one best way of doing a job. However, I must admit that we are often temporarily satisfied with merely an improved method. We merely want to be sure that we are going in the right direction.

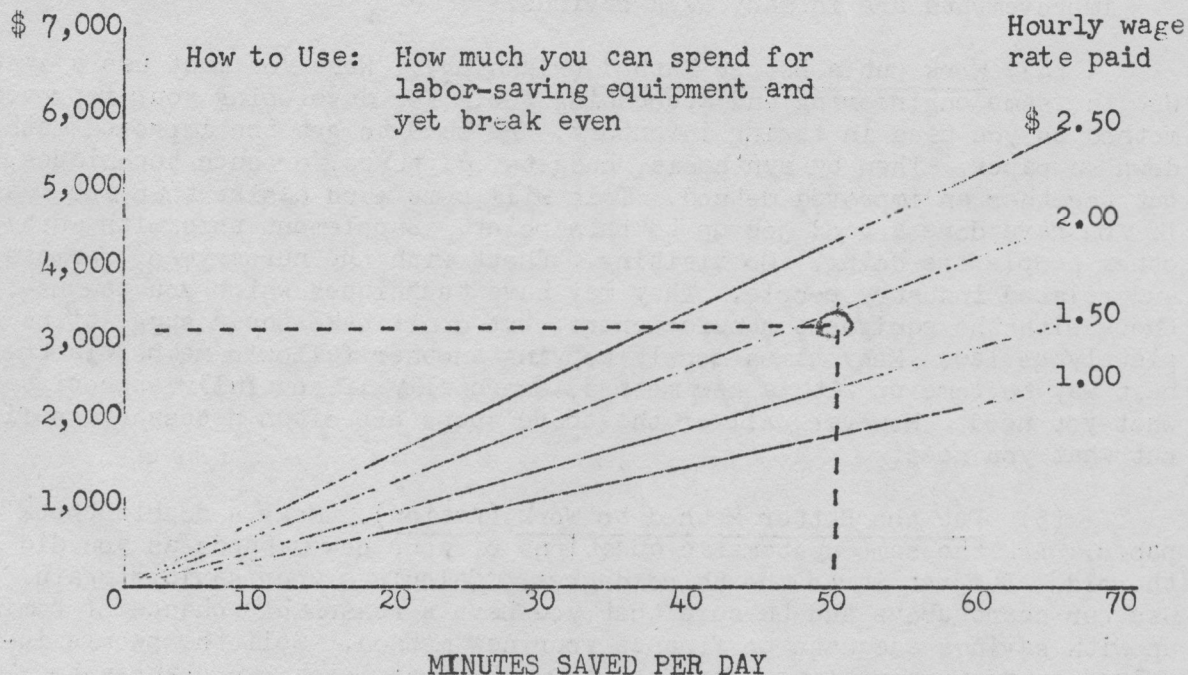
The System

Basically, work simplification is a five-step system.

(1) Pick the Right Job for Improvement (Selection). Many jobs can be improved. However, we can't work on them all, so we must pick the most important. One guide is to select those offering the best chance for greatest net over-all savings. You must know the relationships among your costs, and for you labor is a big cost. If you don't, a few simple checks will often give this information. In selecting the important jobs among your many, a few simple calculations may be helpful. For instance, a one man job for two-hours-a-day will limit your feasible expenditures on equipment, even if you can save the whole two hours. However, a three-man crew usually gives opportunity for considerable investment in equipment; in fact, you can usually spend more here than you realize. Observe the following chart concerning possible investment with varying labor savings and wage rates. (Chart 1).

You should not only know the right job for improvement, but you should know your basic objective in making this improvement. For instance, your objective may be better quality or material savings and not labor savings at all. Generally we emphasize labor, but this is not the only objective work simplification can handle.

Initial investment
possible (10 yr.
equipment life)



(2) Write Down Each Step (Inventory) This inventory process is most important; yet, many times it can be quite simple. Break down the time used by each employe so that you know, in a general way, what each is doing. You can have them put down each day on a small card the time they spend on each job. After you have done this for a week, you will probably have a fair idea of where your payroll is going. You should be familiar with man and machine charts, flow diagrams, process charts, which can be quite useful. The accountants also can lend a hand here. Describe your equipment and work methods. Get it down on paper and you will see things you have never seen before.

(3) Challenge Every Detail (Analysis). Ask certain basic questions of each part of each job. "Why is it done at all?" You are surprised at how often this eliminates the whole job. "Where it is done?" "Why is it done, when it is done?" "Why is it done by the person now doing it?" "Why is it done by the present method?" Simple questions, etc; but you will be surprised what such questions will do.

After you have asked ^{these} questions, make three basic comparisons -

1. Compare your method against recognized principles. General work principles are available, and your industry has more specific principles.
2. Compare your method against known standards, or averages of reasonable performance under your conditions. Know your expected yields, time requirements, fuel consumption and similar factors.
3. Compare your method against recommended practices. You attend Conferences such as this, read research work and develop your recommended practices. The main job is in keeping up-to-date. After you have

subjected each part of your work to these three basic comparisons, your improvements are in many ways obvious.

(4) Work Out a Better Method (Planning). Here you must use a system. Use the same engineering and accounting tools for developing your improved method as you used in taking inventory. Be sure to get the improved method down on paper. Then by synthesis, budgets, pictures, or such techniques, put together an improved method. This will come much easier than you realize, if you have done a good job up to this point. Supplement this with what other people are doing. Go visiting. Check with the nurseryman, farmers, and related industry people. They may have techniques which you can use. Check with the equipment manufacturers, but don't take their suggestions completely as law. Many times merely copying another fellow's method is the best way to come up with a new method, especially if you fully appreciate what you need. However, all of the above steps are often necessary to find out what you need.

(5) Put the Better Method to Work (Action). Make a double check on paper. Ask the same systematic questions of your new methods as you did of the old. Subject it to the third degree. Calculate your savings again. Use our chart above and be sure that you have a reasonable chance of coming up with savings adequate to finance your new method. Sell the people involved on your operation. Give the new method at least two chances to succeed. It will have some things wrong with it; they must be worked out. After it is in operation, be sure to set up periodic checks. This is necessary otherwise you tend to get back into the old routine.

In summary, this is a tried and proved system. Use it all; don't shortcut it seriously or it will disappoint you. It is possible only through organized common sense. That's where it gets its power. Be careful of being a slave to instinct, habit, custom, tradition, precedent, past experience and standard practice.

SALES AND SERVICE TO HOME LAWN OWNERS

Al Linkogel, Link's Nursery,
R. R. 3, Creve Coeur, Missouri

Being asked to talk on Sales and Service to Home Lawn Owners is a definite challenge; first, because I've never considered myself an authority on this subject; and second, because through most of my life I've been coaxing grass to grow, rather than selling and serving home lawn owners. However, I've always felt that 30 years experience as a golf course superintendent was the best possible preparation for service to that marvelous multitude - who spend hours each week pursuing a mower, sprinkling the petunias, and trimming the hedges - the proud owners of home lawns. And the fact that we've been able to put to constructive use this background of golf course experience is, we are sure, the reason for the modest success our turf and nursery business has enjoyed during the seven years of its existence.

Your might think that sales and service are two separate and distinct things so far as the home owner is concerned. However, we've found that the two complement each other so closely as to mean much the same thing. You

can't sell without serving! And if you are promoting products, whether for the lawn owner or others, you can't render solid customer service without such service resulting in substantial sales. Of course, the business aspects of selling - the planning, the advertising, the record keeping, the financial items - all these are important. But, the real basis for happy and satisfied customers is the SERVICE you extend to them.

Service to home lawn owners can take many forms. Here are a few of the services we can suggest you offer your home lawn owner customers:

1. EXPERIENCE - The average home lawn owner is a highly intelligent person, with a deep pride in his home and its surroundings. He wishes he knew the answers to all the problems in maintaining a home lawn, but by the very nature of things he can't know all the answers - his chief interest and occupation lie in other fields - his lawn is usually his hobby rather than his prime interest. And so, he needs help from someone with experience. We've found that we've made many friends - and many customers - by sharing our years of experience with the home owners who have sought our help.

2. CONSULTING SERVICE - Free consulting service is the next step beyond sharing experience. It includes the affirmative suggestions and recommendations you offer those who seek your advice. In our area lawn owners are going to the warm season grasses. We keep up-to-date on all new grasses so when a customer calls us about it we have the answer. Our sales of warm season grasses are very high, but we tell our customers the bad parts as well as the good. Inducing others to rely on your judgment, by acting as you suggest, places a major responsibility in your hands. You've got to be RIGHT. If you aren't, you'll likely cost the home lawn owner valuable time and money, and you'll lose his business. More important, you'll lose his respect. It is through experience that you gain the sound judgment so necessary for offering sound advice.

3. THE "PERSONAL TOUCH" - Seek to develop and keep that "Personal Touch" with your lawn owner friends. In every successful business one person has more "know-how" than the others. Often that person builds the business on the foundation of his own background and experience, only to step aside and leave others to handle it when it gets to be a going concern. This is a grave mistake. That "Personal Touch" - being a personal friend and available to the lawn owner when he needs you - is as important in maintaining a business as in starting it. When you refer him to someone else for the answers to his problems, you are, in a real sense, "letting him down."

4. EMPHASIZE QUALITY - Your place of business must reflect quality - and so must the products and services you offer the home lawn owner. Each product must do the job it's intended to do, and do it well. When you sell it to the home lawn owner, you must "keep it sold" - follow up to see that he's satisfied, make amends quickly and without question if the performance isn't all he expected. You must represent only companies and products whose reputation is beyond question, and make sure your customer enjoys complete satisfaction. For instance, know the turf in the area where you do business. Know what type of grass does best so you can advise your customer of the best mixture to use. Most of the large reliable seed companies have good seeds in their mixtures, but they cannot mix seeds for special local areas. Their mixtures are for the overall areas. In our case we make up our own mixture, which, from our tests and experience, is doing the best job.

5. EDUCATE YOUR CUSTOMERS - Each product you represent has a definite use, definite requirements and definite limitations. A power lawn mower is nothing more than a pile of metal unless you've taught the home lawn owner how to start it, run it and maintain it. A crabgrass spray can do more damage than good, unless you educate your customers on its exact use, concentration, area to be covered, frequency of application, and so forth. There are a lot of crabgrass sprays on the market, but in our area with the hot, humid weather, the majority of them will do as much harm to their permanent grass as the crabgrass. Know if a product will give them results if used properly. The directions on the container are not enough. For example, customers will see our crabgrass plots and decide to use the material giving the best results. Then they will say, "I have a 3 gal. spray. How much material will I put into the tank?" We, or nobody, can answer that. We explain to them to stake off an area and see how much a gallon or 3 gal. sprayer will cover at a given rate, so they will not have to guess. Educating your customers goes right along with sharing your own knowledge and experiences with him.

6. EDUCATE YOURSELF - If you aren't up-to-date with the latest information on home lawn planning, maintenance and operation, you are behind the times. It behooves you to read the Journals covering home lawns, pay attention to the advice and experience of the leading authorities in the turf field, and above all, continue your attendance at the National and Regional Turf Conferences. Keep abreast of products advertised in the papers and magazines. If you don't know what they are, find out as soon as possible. There was a widely advertised grass, Mondo Grass, which I knew because I knew our customers would call to find out if the claims in this ad were correct (which we found out were not). They depend on us for a correct answer.

7. KNOW YOUR PRODUCTS - In addition to the quality built into the products you represent, there's a definite use and function that is also built in. Know the significant features of those products - how they work, how they should be serviced, in what ways they are better than other products, and what their limitations are. With such a solid knowledge, you're in a prime position to offer real service to the home lawn owner.

8. DEMONSTRATE - A picture is worth a thousand words, and a real life demonstration is worth a thousand pictures. Whenever possible, sponsor demonstrations of the products you represent - let your home lawn and golf superintendent customers see for themselves the equipment, the service, the chemicals you are offering - see them in actual operation. Our firm assists each year, to the extent of our ability, in sponsoring the Annual St. Louis Fall Field Day. Mowing equipment, root cutters, stolon sprigging equipment and spray equipment are demonstrated, often under the direct stewardship of a representative of the manufacturer. Turf plots are maintained and tests conducted with fungicides, soil sterilants, insecticides, herbicides and fertilizers. Various grass species and strains are shown, with full information given out concerning maintenance practices for each. To the home lawn owner and other potential customers, this is a real service. With them, seeing is believing.

9. GIVE GOOD VALUE - If you are in business to serve the home lawn owner, you are striving for a profit and rightly so. But, your customers will recognize a value when they see it, and they'll recognize gouging when they encounter it. A fair return to you will almost always represent fair value to your customers. In your business repeat orders are mighty significant. Your customers will seek your products and services again and again if you make sure they get their money's worth every time.

10. SET A GOOD EXAMPLE - Try to make your own place of business and your ^{own} home landscaping show places in your neighborhood. Nothing will prove to your friends how well you know your business as will the example you set with your own lawns. Show off, if you can, the grass strains you recommend, the heights of cut, fertilization practices, spray programs, watering schedules, and so on. The home lawn owners will seek your advice, your products and your services because they want lawn areas just like yours.

These, then are some of the principles which have shown us in our business that selling to home lawn owners depends, to a high degree, on the kind of real service you can extend to them. If you give the service, the sales will take care of themselves.

WHO KNOWS WHAT GRASS IS?

L. C. Grove, Garden Dept., Better Homes & Gardens,
Des Moines, Iowa
(Presented before General Turf Section)

Some of the most frequent questions asked about lawns are these: "What causes brown spots in the lawn? What is the best kind of plant food for the lawn? What is the best kind of grass to use? Should we water the lawn in the morning or afternoon? How can we get rid of crabgrass?" Now, we've covered these points and others in our lawn stories time and time again. Yet, some of these queries come from people who claim to have been faithful readers for a number of years.

Many people have misconceptions about lawn care. Some believe grass seedlings should grow very tall before the first mowing. Some believe in allowing an established lawn to go to seed in the spring to build up strength. Even though the majority of homeowners know little about what grass actually is, how it grows, and the importance of timing of maintenance operations, he does want an attractive lawn.

What can you do to help these people who know so little about grass? It's a big problem to reach all of them with timely and accurate lawn information. I'd like to give you some pointers - pointers based on 10 years experience as an Extension Horticulturist and 9 years as a Garden Editor.

First, I'd like to say something about the hazards that can occur when people attempt to communicate. We don't always say exactly what we mean. When writing is ambiguous or vague, you can be sure people don't get the intended message. Let us not assume that the homeowner reads us, but let us be sure he does. Asking a few questions should reveal if he gets the message you've given him. Once a word is spoken or published, it can never be retrieved. We should strive to say exactly what we mean in both oral or printed communication. Talking over the garden fence has the advantage over communicating with the gardener via the printed page. You are on the front line and have an advantage in helping people face to face with their lawn problems.

Perhaps none of you are guilty of gobbledygook, but why should ten

words be used when one will do the job? Squandering words is confusing to the listener. Let's not underestimate the power of the simple, direct statement on the listener. You can inform gardeners much more effectively, as a rule, by using the positive approach. Listing the wrong ways of managing a lawn, followed by the right ways might confuse your listener. We should avoid the word "don't" as much as possible in giving directions on lawn care. Starting sentences with active verbs when you give people how-to lawn information is a good point to remember and to use. Common folksy words should be used when helping the homeowner. We shouldn't expect him to understand the nomenclature of a specialized profession. He isn't likely to know what we're talking about if we tell him to verticut his thatch, or lower his pH.

Whenever we talk with homeowners, we should strive to put ourselves in their place. We should develop a degree of sensitivity towards them and speak in a language they understand. Editors speak of plant food and feeding to homeowners rather than fertilizer and fertilizing. Even though "plant food" used in this way is not technically correct, we know the layman gets the message.

You can share your knowledge of lawn management by giving talks to garden clubs, adult classes and civic groups in your community. Take lawn care pictures - you'll find illustrating your talk helps you and your audience.

Radio and TV are excellent ways in which to quickly disseminate lawn information to people in your area. Even if you're unable to use these media yourself, you may be able to encourage and assist another qualified person to appear on public service programs. Studio program directors are glad to have people with know-how appear on their public service programs when timely information can be of real service to the people of the area. Visual demonstration of lawn techniques is always effective. Last but not least is the local newspaper. It is one of your most effective instruments in reaching homeowners with sound and timely lawn information. If no timely lawn items appear in the local paper, perhaps you could sell the editor on the importance of lawn care as a high interest subject. People are more likely to act if you give the why as well as the how.

Some nurserymen have printed leaflets in which are listed briefly essential how-to points. Some progressive companies provide educational leaflets for customers. Having such information on hand ready to give to an interested customer is good service, good business, and it can save you time. Your Land Grant College is always a source of information. Also, industry has excellent publications. For example, The Better Lawn and Turf Institute and its able Director, Dr. Robert W. Schery, provide extensive material.

My magazine, Better Homes & Gardens, is read by both men and women. We publish more information on lawn care during the season than on any other garden subject. One must take nothing for granted in our how-to stories. The editor may spend several hours in heat or cold to get how-to pictures. Sometimes considerable work is done to write just a few short lines of legend, but it can mean a tremendous saving of time and money to our readers.

In story preparation, we use our library, garden files and contact authoritative sources on the subject. Where plant materials are concerned, we must think in terms of 48 states -- not the Midwest alone. We have many long time readers, yet a constant addition of new readers, so our audiences might be likened to a passing parade. For that reason, we'll continue to print lawn stories_year after year.

STEM RUST ON MERION BLUEGRASS

M. P. Britton, Dept. of Plant Pathology, Purdue University

Stem rust, (*Puccinia graminis*) was observed to survive the winter of 1956-1957 as mycelium within the live leaves of Merion bluegrass at the Purdue University Agronomy Farm turf plots. During the winter of 1957-58, however, evidence of rust overwintering was found in December and January, but not in subsequent months. Thus, it appears that stem rust is capable of overwintering at Lafayette, Indiana during some years, probably those in which good snow cover is present during the coldest part of the winter.

In the early spring stem rust pustules occur sparsely even in plots where it had been shown to overwinter. This is due to the fact that the removal of the rapidly growing leaf blades by mowing also removes the new rust infections on these leaves. Since the fungus dies as soon as the removed leaf tissue dies, no spores are formed by the fungus. Some infections survive on older, basal leaves which are below the height of mowing. These infections develop into pustules in about 10 days, and the spores from them form the inoculum for the secondary spread of the disease during hot weather when the growth rate of the bluegrass plants is retarded.

Since it takes 10 days for pustules to form, stem rust on Merion bluegrass can be kept at a low level during the entire growing season in older, well established lawns simply by watering and by adequate fertilization with nitrogen during the summer. These practices are applicable only in areas with relatively cool summer seasons where *Curvularia* "melting out" is not a serious problem. It may not be possible to do this on new seedings of Merion bluegrass as the many small areas of open turf, which are common in new seedings of Merion, provide space for the lateral growth of the bluegrass leaves below the mower height. All of these leaves, which lop-out into the open areas, rust severely as do the basal leaves on the plants surrounding the open area for two or three inches. If the bare areas are very numerous, the rusted areas surrounding them may come together, and, of course, then the whole appearance of the lawn is spoiled. The situation at this time is quite explosive, all that is needed to have the entire lawn turn red with stem rust is for the growth rate of the grass plants to slow down so that infections on the upright leaves develop into pustules.

If fungicides are used to control rust, the first application should be made when the first small spots of rust appear. Use either Acti-dione (ferrated or the RZ formulation), maneb, zineb, or dichlone at the rates recommended by the manufacturers. Repeat the application at 7 to 10 day intervals (two or three applications should be sufficient). If the lawn has not been fertilized recently, it is suggested that about 1 pound of nitrogen per 1,000 sq.ft. of turf be applied on the same day that the first fungicide treatment is made so that new uninfected leaves mask over the old rusted leaves.

IRRIGATION FOR TURF

Abstract items from three extensive talks by
C. E. Stewart, Irrigation Engineer
18357 Homewood Avenue, Homewood, Illinois

On this planet the yearly average rainfall is 44", but it varies from less than 3 to almost 500. In the Midwest the average is 35", but much of it falls in spring and fall. Now, 90% of vegetation is water, and agronomists report that to produce one pound of dry bentgrass it takes 500 lbs. of water; also, that a large oak tree will give off two barrels of water per day. Records for twenty years in the Chicago area show that there are 100 days per year when water would be used in irrigation on turf areas.

Water Supply

Water may be obtained from rivers, streams, ponds, lakes, wells, or a city water supply. Often it is advisable and more economical to drain, or pump as needed into a lake for storage, then irrigate directly from the lake. A one acre lake averaging 5' deep is the minimum size for a 100 acre cemetery, or 50 acres of irrigated turf in an 18 hole golf course. The lake should receive careful planning, so that the water level will not be lowered more than 12" during any irrigation period. This avoids unattractive edges and reduces bank slumping and erosion, which increases maintenance cost. A number of chemicals can be used to control plankton, algae and weeds. These are not harmful to fish life, nor toxic to turf when irrigated, when used as directed.

Irrigation System Design

Poor sprinkler performance, due to a lack of water and pressure, can be avoided by design. The first thing to determine is the maximum water requirements without any rainfall. The average 18 hole golf course has 45 acres of fairways, 2 acres of tees and 3 acres of greens. For 1" of water per acre, this would be 50 acres x 27,000 gal. per acre inch, or 1,350,000 gallons which amounts to 500 gpm for 48 hours watering per week. For a 100 acre cemetery it would require 700 gpm for 48 hours per week, which is equal to 27 sprinklers, each delivering 25 gpm.

In the Midwest we should limit irrigation applications to 1/4" per hour to avoid runoff and accumulation in the depression areas. This requires two hour settings twice per week to apply 1" water. With bent fairways some superintendents may wish to provide more water and sprinkle oftener. In order to water golf course fairways, which average 150 ft. in width, it is necessary to have sprinklers cover a diameter of 180 ft., because they provide even watering for only the first 80% of coverage. It is wise to locate sprinkler valves at 85 ft. intervals, which includes 4 lengths of 21" pipe, plus fittings. In any golf course system, 3" pipe represents about one-third of the total footage needed. The friction loss is greater in small pipe and increases the power bill for pumping water. A 3" pipe will deliver more water than both a 2-1/2" pipe and a 2" pipe; yet, costs only 20% more than the 2-1/2" pipe alone. Well-designed systems may be either looped or dead-end. In my own work, designing over 300 golf course systems, I have found it advantageous to use a loop design in only about 10% of the projects.

In cemeteries we must locate pipes and sprinkler items on road shoulders, paths or on the outer edges of sections. The path spacing determines the sprinkler spacing. If paths are 22 ft. apart then every fourth path, where the sprinklers are in an equalateral location, this would place them 102 ft. apart.

All too often the initial cost determines the purchase of inadequate pipe and this is false economy. The figures opposite the inter-section of any two pipe sizes in table below, is the number of the smaller pipes required to equal one of the larger pipes; thus, one 4" pipe equals over 5 two inch pipes in delivery of water.

Actual diameter needed	Number of "too small" pipes required to equal size on left				
	<u>3/4"</u>	<u>1"</u>	<u>2"</u>	<u>3"</u>	<u>4"</u>
2"	11	5	1	-	-
3"	32	15	2	1	-
4"	65	32	(5)	2	1
5"	-	55	9	3	1
6"	-	88	15	5	2

Table below shows 3" pipe most economical under this set of conditions:

Size of pipe	Cost of pipe installed Chgo. area	10% of pipe cost is: 5% interest 4% depreciation 1% maintenance	Pipe friction in h/ft.	Cost of power per year @ 4¢ per KWH	Total cost per year
2"	\$ 1150	\$ 115	358	\$ 231	\$ 346
2½"	1310	131	120	77	208
3"	1630	163	49	32	(195)
4"	2550	255	12	8	262

To find the most suitable size of pipe to use, when the flow is known, is to limit the velocity of water to 5 feet per second.

$$\frac{\text{Gallons per minute} \times 0.404}{D \text{ (squared)}} = \frac{100 \times 0.404}{3 \times 3} = \frac{40.40}{9} = 4.5 \text{ ft. per second}$$

To find the precipitation from 1 sprinkler discharging 25 gpm, and covering a diameter of 125 ft:

$$\frac{122 \times \text{G.P.M.}}{\text{Diam. squared}} = \frac{122 \times 25}{120 \times 120} = 0.21 \text{ inches per hour}$$

To find the precipitation in inches per hour of the water falling within the triangle of 3 sprinklers spaced 96' apart and each discharging 25 gpm -

$$\frac{111 \times \text{g.p.m.}}{D \text{ in ft.squared}} = \frac{111 \times 25}{96 \times 96} = 0.30 \text{ inches per hour}$$

To determine the exact precipitation in inches per hour from any sprinkler, the following method is suggested:

1. Place the sprinkler in its desired position.
2. Use as many No. 2 cans (with diameter of 3-1/4") as are required to extend them in a straight line, and at 3 ft. intervals apart, from the sprinkler to the outer edge of coverage.
3. Set the sprinkler in operation and RUN IT FOR EXACTLY 44 MINUTES.
4. Shut-off the sprinkler and pour the contents of each can separately into a cc tube, a reading in cubic centimeters will be obtained, but each cubic centimeter will equal exactly 0.01 inches (1/100 inches) of sprinkler precipitation PER HOUR.

Irrigation System Construction

The major cost for almost every irrigation system is the pipe which, for an 18 hole golf course, approximates 23,000 ft. in sizes ranging from 8" to 1-1/4". Pipe material is, as you know, available in cast-iron, steel, copper, cement-asbestos and plastic. Thermal expansion in cast-iron, steel, copper and cement-asbestos pipe is about the same, 6" for 400 yards, but is much higher, 57" for the plastic pipe. To overcome this large contraction effect, plastic pipe should be "snaked", but the best precaution is to bury it below the frost line. To prevent flaking and weakening of the asbestos pipe, it should also be below frost line. Temperature changes seem to have little effect on cast iron pipe due mainly to the fact that the bell and spigot joint permits a slight movement at each joint.

Trenching and Backfilling

One method of trenching which seems to work out quite well is to first remove the turf to a width 4" wider than the trench width; this permits a 2" shoulder on either side of the trench which eliminates much damage to the turf during pipe laying operations and later provides a grade for the relaying of the turf. When the pipe has been properly layed a six inch layer of backfill should be tamped under, around and over the pipe, the trench should then be half filled and again tamped, then brought up and tamped to the original grade, less turf thickness. The present day mechanical tamper is ideal for this type of work. Water can be used to flush the soil in also. When the turf is layed and rolled or tamped, it should go back to original grade.

Park Irrigation

The design of park irrigation is somewhat similar. Again a schedule and routing of sprinklers must be established in order to arrive at the correct size of pipe lines. Where quick-coupling sprinkler valves are used,

it is usually necessary to use a type with a locking device on the valve cover which prevents tampering by irresponsible persons.

Home Lawn Irrigation

Irrigation for home lawns usually consists of the concealed pop-up type of sprinkler controlled in batteries by a manual valve or hydraulic valve electrically operated with a time clock. Many of these systems also have moisture control valves which is a device buried in the ground in series with an electrically controlled valve and which only permits the sprinklers to operate when there is a deficiency of moisture in the soil.

Athletic Field Watering

Many athletic field irrigation systems are based on using a traveling type of sprinkler which is either guided by the hose, or pulled with a wire which the action of the sprinkler winds onto a drum, when the sprinkler reaches the end of its travel, a trip lever shuts off the water. This requires 2 pieces of 1" hose each 200' long, and two 1" or larger snap-on valves located off each side of field. A 2" pipe to one, plus a 1-1/2" across to the other is adequate. At each side also have a drinking fountain, or regular 3/4" hose valve.

The watering of athletic fields may also consist of a number of quick-coupling valves with protective rubber tops located in the field, or long range pop-up sprinklers with protective rubber tops controlled from a gate valve at the side of the field.

Some superintendents may design an adequate irrigation system for their golf course. Few of them have the time to devote to this specialized form of hydraulic engineering owing to the numerous other duties they have in maintaining the course. In the event that an engineer familiar with this type of work is retained so that the club can obtain competitive bids from responsible contractors for the work, he should furnish the following service.

1. Consult with the superintendent on the maximum water requirements.
2. Prepare a complete plane survey of the course showing fairways, tees, greens, traps, roads, buildings and all other items. On this the proposed irrigation system is drawn to scale. (A common scale is 1 inch to equal 100 lineal feet). A meeting should then be arranged with the superintendent, the greens chairman or greens committee and the engineer. This design should be thoroughly examined by the superintendent, greens committee and engineer. Any additions or deductions are noted by the engineer who then proceeds to prepare the final plans and specifications covering every phase of the work.
3. Stake out on the fairways, tees and greens the exact locations of all sprinkler valves, drain valves, control valves and routes of piping.
4. In addition to the specifications giving the complete list of pipe footage, pipe fittings, type of pipe, method of trenching, laying pipe and backfilling of trenches, the engineer must prepare the necessary proposal and contract forms in order to obtain bids; he must also make sure that the club is protected in every way by seeing to it that the successful contractor carries workmen's compensation insurance, and also fire, tornado and theft insurance on his equipment and material

going into the construction. Further, the contractor should furnish the club a performance bond, which remains in force one year, guaranteeing the performance of the irrigation system. A performance bond for 100% of the value of the contract usually costs 1-1/4% of the contract amount.

5. The engineer, in his specifications, should inform the contractor of the time and the basis of payments. Monthly payments allows the engineer to appraise the value of the work done. The contractor's bid gives a lump sum price and also breaks this into unit costs. From the unit price submitted by the contractor, the engineer can arrive at the exact cost of any addition. Thus, the cost of the work completed, may be paid less the 15% retained until the entire project is completed.
6. When the irrigation system is completed, tested and accepted, the engineer should prepare a final drawing, showing all deviations, additions or deductions, and submit to the club at least 3 blueprints of this corrected drawing with instructions that one print be forwarded to the superintendent and the other two retained in the club files.