PROCEEDINGS

of

1960 TURF CONFERENCE

Sponsored by the

and

PURDUE UNIVERSITY

LAFAYETTE, INDIANA

March 7-9

PROCEEDINGS OF THE
1960
MIDWEST REGIONAL TURF CONFERENCE

The 29 articles included in these Proceedings are condensations of talks by speakers before sections and divisions of the 1960 M.R.T.F. 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 1959 Proceedings are available at price below.

A copy of these Proceedings were mailed to:

1. The 601 attending the 1960 Midwest Regional Turf Conference.
2. One person of each Member Organization 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, Exec.-Secy.,
Midwest Regional Turf Foundation
Department of Agronomy, Purdue University
Lafayette, Indiana

Attendance divided by interest as judged by registration card	
Golf Courses	308
Turf materials & supplies	147
Sod Nurseries	42
Landscape	20
Parks (most have golf courses)	20
Industrial Grounds	11
School Grounds	9
Cemeteries	7
Non-profit & Educational	47
Total	601

Distribution by States	
Illinois	174
Ohio	125
Indiana	110
Michigan	53
Wisconsin	40
Kentucky	24
Missouri	16
Outside Midwest	32
Purdue	27
Total	601

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PRESIDENT'S REPORT

John S. McCoy, Supt. , Cincinnati C. C.
Cincinnati, Ohio

The purpose of the Fifteenth Annual Membership Meeting of the Midwest Regional Turf Foundation is to receive the annual reports of the officers, elect new directors to replace those whose terms expire at this time, and conduct any business relating to the membership of the Foundation.

The Midwest Regional Turf Conference held each spring, and the Turf Field Days held each fall, are sponsored jointly by Purdue University and the M.R.T.F. This Conference has grown in stature over the years from a small beginning in the 30's under the direction of Dr. Clevett, with an attendance of less than thirty persons, to its present commanding position as one of the leading Conferences in the nation. Growth of the Conference was gradual until the forming of the Midwest Regional Turf Foundation in the fall of 1945. To show its growth, in 1948 the attendance was 235, in 1958 it was 537.

Initially after the Foundation was organized, golf courses were the principal members. Today the membership is divided -

62% Golf Courses
4% Cemeteries
3% Associations
31% Industrial and individual

There were 27 new members added in 1959, approximately one-third golf clubs and two-thirds industrial and individual members.

Today funds to carry on the Turf Research program here are derived from three sources: one-third from memberships in the Foundation; one-third from grants by various corporations and organizations for research on certain problems, and materials and equipment donated for this purpose; and one-third from funds and services provided by the University, which in turn is supported by the State of Indiana.

After the Midwest Regional Turf Foundation was organized in 1945,Dr. G. O. Mott was largely responsible for its program in its formative years. He and others assisting him deserve much credit for their efforts. In 1950 Dr. Daniel came to Purdue on the Agronomy staff, and as Executive Secretary of the MRTF. He is about to complete ten years of service to the University and this organization. Success of any program depends largely on the continuity of its leaders. He deserves all the credit and support we can give him for his loyalty and leadership. He is responsible for the well-rounded turf research program under study, the training of many young persons in turf work, and assisting many in their turf problems. Our deepest gratitude goes to you, Dr. Daniel, for your interest and sincerity in this work, and to those assisting you.

To continue this fine program with its many benefits, we need the support of all clubs, organizations and individuals interested in turf. If you are not a member of this Foundation, I urge you to join and help continue this so vital a part of our growing and maintaining good turf.

It has been a privilege and an honor to serve this organization as President. I wish to thank the other Directors, the Advisory Council, and all others for their devotion and untiring efforts.

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DEVELOPING A TURF FOUNDATION

Carl Bretzlaff, Supt., Meridian Hills C. C.
Indianapolis, Indiana
First President MRTF

Bill Daniel asked me to make a report on the Midwest Regional Turf Foundation as to how it came about.

Back in the late twenties and early thirties I attended some of the short courses at Madison, Wisconsin; State College-Pennsylvania; Ohio State, Columbus, Ohio; Minneapolis-St.Paul, Minnesota, and the U.S.G.A. Green Section at Arlington, Virginia, well before it moved to Beltsville, Maryland. After traveling around over the states, the thought came, "why not try Purdue for it is centrally located." Then came the question - "Who can we see?" After talking to a few people, we came up to see so and so. After making a few more trips, we figured we were not in the right department.

Late that summer I received a note from Dr. John Montieth, who was in charge of the U.S.G.A. Green Section Experimental Station at Arlington, Virginia, that Professor Mal Clevett at Purdue was interested in seeing us, so back to Purdue we came. After looking for some time, we ended up in the Field House. At last we were started. Then we tried to find out if anyone else was looking for more information in regard to a Golf Course Clinic. Finally, details were arranged for the first meeting by Prof. Mel Clevett in the Field House. The room was set up for 30, but we had a few empty chairs. Would any of you who were here for that first meeting stand up? (About 10 stood up). There weren't many speakers except the one guy that doesn't miss - O.J.Noer.

The meetings then were all called Greenkeepers, as they used to think the only thing was the greens area to maintain. Today this has grown with supervision and responsibility, so we are Superintendents. Do not believe Webster has found out about this even yet as it would take another page in the dictionary to describe our variable work.

Professor Clevett later laid out 3 greens just a short distance from the football stadium in about a 10 acre field. From then on golf studies started to click. After that, about 1934, they got the first 18 hole golf course laid out (The South Course). Most of the work was done with W.P.A. workers. Now they have two 18 hole courses. Soon after this Dr. Mott had two areas of experimental plots all set up near the junction of State Roads 52 and 26 on one of Purdue's farms. Everything was going along nicely, when we woke up to find we didn't have any dollars to maintain these large areas. Then came the problem of where to go from here for revenue.

In 1945 Midwest Regional Turf Foundation, a non-profit organization for research, education and training was set up. Also By-laws were set up that would fit in with Purdue. The early Directors were:

President:	A.L. Brandon, Greenskeeping Supt. Ass'n., St. Charles, Illinois
Treasurer:	Joe Graffis, Golfdom, Chicago, Illinois
Exec.-Secy.:	Dr. G.O. Mott, Agronomy Dept., Purdue University
Directors:	Carl Bretzlaff, Greenskeeper, Meridian Hills C.C., Indianapolis, Indiana
	Neil Ransick, Charles A. Hirsch Co., Cincinnati, O.
	C.R. Runyon, Supt., Spring Grove Cemetery, " "
	W.E. Lyons, Garden Supervisor, Firestone Tire & Rubber, Akron, Ohio
	George T. Donoghue, General Superintendent, Chicago Park District, Chicago, Ill.
	Fred V. Grau, U.S.G.A., Plant Industry Station, Beltsville, Maryland

This is the twenty-fifth meeting in 26 years. The war year 1942 was skipped. From less than 30 in 1937 to 538 in 1959 is quite a step.

Think we owe Dr. Daniel and his staff a vote of thanks for the never ending job they are doing. Here's hoping that the Board of Directors and members can keep up their good work and keep new feeding new ideas for projects working for better turf.

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FINANCING TURF RESEARCH

W. H. Daniel, Executive-Secretary, M.R.T.F.
Purdue University

Your needs in getting answers to problems has done much in getting turf research accomplished. It takes four things - interest, organization, personnel and facilities to accomplish any research.

Through Midwest Regional Turf Foundation memberships your interest and support could be channeled. The total membership fees averaged $4,000 for the first three years, 1946-49. Through gradual growth from 120 to 334 members, support has increased until the year 1958-59 averaged $10,000 per year.

Equally important, grants from industry increased - because there were facilities and organization - so that a broad program could be conducted. It is amazing how fast grant sources change, for new problems arise as some are resolved. We are pleased that fifty companies provided materials to us without charge which assist in our turf program.

The fine facilities and administration of Purdue make the funds received go much farther. Also, through the Experiment Station and extension service, funds are provided toward travel, and personal service.

The training of students will require more time and money now and in the future. However, these pay dividends in added technology and capability in turf work in years ahead.

Our current program of publications, travel, research, all phases of turf is near $ 40,000. Your membership provides one-fourth of this, but most important your interest gives us the motivation, encouragement and counsel so desired.

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RESEARCH AND EDUCATION

Dr. N. K. Ellis, Associate Director, Agric. Expt. Station,
Purdue University

I count it a privilege to extend a Purdue welcome to you as you meet for this Midwest Regional Turf Conference. We are proud of our facilities for research and teaching; here I include regular students and our adult groups in this category of teaching. We are proud of our staff for we think they are tops. The best buildings and facilities will not yield new truths without top-flight staff. Only motivated scientists can do this. We are proud of our heritage. It is inconceivable that you would be here today if it had not been for the greatest educational program conceived by man. I welcome you to the campus of a Land-Grant University where teaching and research are so interdependent on each other and so complimentary to each other that I suspect that not only our public, but many of our staff do not recognize any boundaries between the areas.

Let me refresh your memory on how we in this nation are so fortunate as to have the highest living standards of any nation on earth. It dates back at least to the early 1800's. I do not know when legal action actually began to take form. Sometime in the late 1850's a bill was introduced to the Congress to provide a type of institution for agricultural teaching. Senator Clemson of South Carolina was one of the supporters of this bill. The bill was passed by both houses of Congress, and in 1859 President Buchanan vetoed the first agricultural college law. I suppose that many of the things that we oppose today will seem as unfortunate in years to come.

The law was rewritten and passed again in 1862. President Abraham Lincoln signed this, the Morrill Act, July 2, 1862. This Act provided a means for setting up colleges of agriculture and mechanic arts. Blocks of public land were awarded to state institutions which accepted the conditions of the Act. While research was started in these schools, the need for support of organized research was soon seen.

The Hatch Act of 1887 provided for direct payment of federal funds to those land-grant institutions which would establish an Agricultural Experiment Station in connection with the college or university. Of course, these laws have been amended, added to and joined by new laws under which we operate at the present time. I am told that Purdue's public land grant,

which was in a western state, was sold, the money invested, and now brings in $ 6,000 to $ 7,000 annually. This is not much in the budget of an institution like this University, but it was a catalyst for education and research under the most classless system known to modern man. Its effects cannot be measured except in the abundant food and fiber supply which is ours.

While we enjoy the most advanced standard of living in the world, we complain about our success of producing an abundance, and one group of lawmakers after another make ground rules for increasing surpluses which are turned into political ammunition fired back at agriculture. Never was the old addage about "biting the hand that feeds you" more true than in this situation. But wouldn't Mr. Kruschev like to know how to feed his millions at the same level, or Mr. Nehru have some of this production capacity to keep many of his people from starving. This program has been so successful that few Americans today can remember when they were hungry except in between meals.

I certainly don't want to leave out the educational effect of extension service people, for since the Smith-Lever Act of 1914 they have been carrying the teaching program to the farmers. This service is now being patterned all over the world.

I'm going to take a few liberties and dream about the role of education and research in agriculture in the near future. The comments here do not necessarily reflect the opinions of this institution. It's been a year and a half since I regularly lectured to a class. This makes me an old-timer, and perhaps not up to date, but I think you will be interested to know that contrary to the national trend, Purdue's entering class of freshmen in agriculture increased both in 1958 and 1959. Not only agriculture, but engineering enrollment decreased in most institutions.

In addition to a good job of encouraging students to come to Purdue by alumni, school counselors and Purdue staff, another reason in my estimation is the liberalizing of the course offerings. This has been going on quietly for about ten years. I suspect that this trend toward balanced liberal education with scientific agricultural training will continue. I feel that it would have been of some real value had those who were formulating our agricultural programs in the last 30 years recognized that almost every farm program that has been tried recently had also been tried in the past by other civilizations. For example, under the Romans, acreage controls were tried and failed. Then low prices resulting from slave labor drove small farmers from the land, which then went into large estates, and the word "latafundium" resulted from this practice in what is now Italy. These lands were often held by absentee owners who turned to animal agriculture to reduce the labor costs.

Our educated Agriculturists should know that the ever normal granary has been tried by several other civilizations. In what is now India at one time debts for farmers were forgiven (crop insurance) due to drouth or other crop failures. In earlier civilizations in the Near East, perhaps 2 to 4000 years before Christ, government crop production loans were made, and it seems to have been a practice in all civilizations for both government and religious groups to laud the farmers as having a most noble occupation, but seldom was he given much for his efforts. Deep down I resent seeing agriculture "taken in" or manipulated for the benefit of government, or anyone else. In addition to knowing genetics and plant physiology, I hope our future graduates will have some of this liberal background.

And what about research which is blamed for aiding with the production of surpluses? Research, during the past 80 years, has capitalized on a bank of basic knowledge which we inherited. The type of educational institution common before the Land-grant Act had no ground rules for getting research information to the people. Production has been further promoted through the use of a new mechanical power source (petroleum). The utilization of the principle of hybrid-vigor and general increase in knowledge about crop production have been exploited. Our fund of basic information has now been somewhat depleted, and more and more your Experiment Stations must devote a higher proportion of their resources to basic research. What is this mystic word "basic research?" I simply consider it a deeper understanding of the problem involved. For example, it has been known that some bacteria capture nitrogen from the air, but the Wall Street Journal reported last Friday that a group of DuPont researchers have isolated the enzymes from the nitrofying bacteria and have produced nitrogen outside of the living bacteria. This stage in the research for new information is certainly basic research.

This demand for more basic research calls for better education of our agricultural scientists. It calls for funds and facilities for supporting these people, and it calls for education of the public to no longer expect miracles overnight. Legislatures can provide funds, but the mind cannot be legislated. An atmosphere must exist so that brilliant scientists can be motivated to research on our agricultural problems.

So again I say to you that I am pleased that you are on our campus, some for the first time, others have been here before, but you are always welcome to Purdue. May you find here a high level of teaching and research applicable to your interests.

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INTRODUCTION TO WEED KILLERS

It takes equipment, labor, chemicals and planning to use chemicals on turf wisely. The following talks attempt to provide facts and ideas, improving the reader's understanding of the increasingly important role chemicals have in modern turf care. The general heading is, "Understanding Weed Killers."

UNDERSTANDING WEEDKILLERS
THEIR PROPERTIES AND ACTION

A. C. Leopold, Dept. of Horticulture
Purdue University

As a convenience in talking about herbicides, let us consider that they may kill plants in a three step process: they must enter, they must be moved about in the plant, and then they must have a toxic response inside. The selectivity of herbicides may be due to properties of entry, or of movement, or of the toxic action.

A comparison of various types of herbicides affords some interesting examples of differences in these three properties. I would like to describe the three properties of 2,4-D as a good common herbicide, and then to compare this one with two other classes: the substituted ureas (including monuron and diuron) and the triazines (including simazin or dacthal).

Entry

When 2,4-D is applied as a foliar spray, it enters directly into the cells of the leaf, doing so by following water surfaces in the structure of the cells. Its entry is extremely rapid for the first 20 minutes after wetting of the surface, and then there follows a period of steady though slower entry. This steady rate may continue for only a couple of hours,or it can go on for four days, depending on the formulation applied and the extent of moisture on the leaf surface. You recall that the chemical enters along a water surface, and so when the droplet dries on the leaf, entry stops. 2,4-D enters grass leaves about as fast and as readily as it enters broadleaf plants.

An interesting difference is found in the ureas, which enter moderately well, and the triazines which do not enter the leaf at all, as far as can be detected. If these herbicides were limited to foliar entry, they would be worthless in weed control.

Another pathway of entry for herbicides is through the root. 2,4-D which has been applied to the soil can enter the root by being swept up with the water in the transpiration stream. The ureas and triazines enter this way readily too. One can picture the root as having a very coarse filtering stem, and all sorts of chemical compounds can enter through it; in contrast,the leaves have a very fine filter system and are much more selective in letting materials enter.

The entry of chemicals affords a real measure of selectivity. If an herbicide is applied to the soil and remains localized at a certain level, it will kill those plants which are rooted into that zone, and not harm plants which are rooted either deeper or shallower. This is a considerable part of the selectivity of the pre-emergence herbicides used today.

Movement

After it has entered through the water pathways of the leaf surface, 2,4-D can move readily through the plant. It moves both up and down the plant at a rate varying from 3 inches to 3 feet per hour, depending upon the conditions inside the plant. The movement occurs only with the sugar stream, so as sugars are transported out of the leaf at the end of a days photosynthesis, the 2,4-D is swept right along with it. For this reason, 2,4-D is more effective when applied on a sunny day -- when there has been abundant sugar synthesis. Also, it moves more effectively in vigorously growing plants in a good state of fertility, as they have more generous sugar movement. Resistant species, or plants in a resistant state of development, are markedly less effective in moving the herbicide around through the plant. This movement is obviously crucial to the kill of deep rooted perennials, and the requirement for sugar movement is an important factor in the effectiveness of the herbicide in getting down to the deepest roots and killing them. In stark contrast, the ureas do not move even after they have entered the foliage. We do not understand why this limitation occurs.

Any of the herbicides which enter through the root system are rapidly distributed throughout the plant -- to any parts to which the water moves. The plant has a magnificent plumbing system which transports water to all of the leaves, and soil herbicides move readily through these pipes. If herbicides are injected into a plant's water system, they will move quickly up into the foliage but not downwards, as the water is moving only up towards the leaves.

So 2,4-D can move up or down, whichever way the sugars are going, and the herbicides which enter through the roots move only upwards with the flow of water. Some selectivity of herbicides occurs as a result of movement characteristics. For example, several instances of species of plants resistant to 2,4-D have been shown to permit markedly less movement of 2,4-D out of their leaves than do susceptible species. The herbicide seems to be adsorbed onto surfaces inside the leaf.

Summary

There is a remarkable difference in the screening of chemicals by leaves as compared with roots. Many diverse chemicals can enter roots, but only special ones can enter through leaves in water formulations. Once an herbicide has successfully entered, some can only move up, while others move either up or down. The difference appears to be releated to the medium with which the chemicals move: water in the former case, and sugars in the latter. Selectivity of herbicides may be related to entry through the foliage, or to entry through the roots (depending on the rooting zone of the plants), and some selective function may be associated with the movement of the herbicide through the plant.

Certainly, the differences in toxicity of herbicides in various species is not yet understood, which illustrates much is yet to be learned.

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HERBICIDES - THEIR EXPERIMENTAL TESTING

Oliver C. Lee, Dept. Botany & Plant Pathology
Purdue University

Weeds are a problem of everyone, not just to those who own or occupy land. To the farmer, weed control is essential to economical crop production. To the homeowner and those in charge of maintenance of recreational areas, they are unsightly and objectionable. On industrial areas, they interfere with efficient maintenance operations. They may also affect human efficiency as weeds often affect human health.

Chemicals, known as herbicides, play an ever increasingly important role in weed control. Many herbicides are on the market and new ones are found every year. We can expect many of the chemicals now in use to be replaced by more efficient and effective herbicides. Hundreds of scientists are at work, including those of chemical companies, Universities, United States Department of Agriculture, and private research agencies, checking, testing, and studying the herbicidal value of thousands of compounds. On the average from 300 to 2000 different compounds must be tested for every

new pesticide chemical which is found. Three to five years in work, and thousands of dollars have gone into the development of a single pesticide chemical.

There are many steps to be taken before an herbicidal chemical can be put on the market. Essentially, herbicides must be evaluated for: effectiveness of weed control, tolerance of crop or desired plants, residual properties, toxicity and danger to operator or user, and residue retention in crop when applied to edible plants, as well as economical return from investment by their use.

Many research agencies, primarily those of industrial organizations engaged in the production of chemicals, screen numerous chemicals for herbicidal value. They may be obtained from their own stock of chemicals, or obtained from other sources. Any that are found to show herbicidal action in preliminary biological tests are retained for further testing,and primary screening is usually done in a greenhouse. Test plants, including weeds and crop plants, are used in those tests. Weeds usually consist of crabgrass, pigweed, mustard and foxtail, while such crops as corn, beans, cotton and annual ryegrass are used. Chemicals are applied both as soil treatments and as foliage applications. Various rates are used and applied at different stages of growth. The response of the plants to the treatments are studied and recorded.

Generally only one in every 2,000 of these compounds will prove sufficiently promising to warrant further testing. Promising compounds are then tested in the field under varying conditions. Several chemical firms maintain farms where field testing is done. Promising herbicides are often tested by state Experiment Stations and the United States Department of Agriculture.

Test compounds are checked for toxicity to animals and man. When used on crop plants, the plant material is checked for chemical residue. If residue is found, feeding tests are conducted to determine effects on test animals.

Before an herbicide can be placed on the market, it must have label approval. This approval is issued by the United States Department of Agriculture. The Federal Food and Drug Administration is responsible for setting tolerances for chemical residue on various crops. The company or manufacturer has to prove to the United States Department of Agriculture that the product is useful and safe to use. It further has to prove to the Federal Food and Drug Administration scientists that there is no hazard to consumers if it is used on food crops.

Each year the steps toward getting label approval become more expensive. The requirements of the Miller bill and DeLaney bill passed by Congress drastically affect many products. Chemicals for turf are somewhat free of these regulations as yet. Therefore, you should attempt, by meetings such as this, to become thoroughly familiar with chemicals you might use.

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UNDERSTANDING WEEDKILLERS - THEIR PRODUCTION

Lewis P. Harris, Research Development,
Acme Quality Paints, Inc., Detroit, Michigan

The chemistry of the manufacture of the new weedkillers is probably not of too great an interest except to the basic research workers, but you may be wondering why there are so many different herbicides and different type formulations on the market. To say that Simizin is made by condensing cyanuric chloride with diethyl amine does not mean much to most people.

Prior to the last fifteen years, very few chemicals were developed specifically as weedkillers. Various corrosive acids, metal salts, Calcium Cyanamid, arsenical solutions and a few organics, such as dinitrocresol and pentachlorphenol, made up the entire weedkiller list. Any selectivity was dependent on the preferential wetting of the weeds versus the crop plants, or the ability of the crop plant to recover from moderate chemical injury. It was only as more basic ideas and information on plant physiology and biochemistry developed that new chemicals could be developed and tested, and formulations improved. Several chemicals that were screened as insecticides by the entomologists in the 30's were abandoned with note, "too toxic to the test plants," and were not revived until years later as herbicide candidates.

It should also be pointed out that the cost of the chemical as against the dosage required to get the desired effect may seriously limit the market or preclude a company from ever going into commercial production on a new chemical. Another business hazard is that cheaper materials for the same purpose may render the product unprofitable before research and test costs are recovered.

Herbicide products are trending to those of lowest possible animal toxicity, greater ease of handling, and formulations designed for specific uses. Because of specie resistance, weedkilling is getting to be more of a program, or "prescription-after-diagnosis" type of business for the large scale user,and multichemical formulations for "shotgun" application by other users. This is the basis of the need for the many kinds of chemicals in our Herbicide List.

Now, let us look at some of the formulation modifications in detail, starting with the older material.

The dinitrocresols are injurious to all plants, but weeds having a rosette growth habit as seedlings, or hairy leaves, can be killed in crops such as peas or flax because these crop plants shed the spray while the weeds collect enough to kill them. But, add a little wetting agent and at the same dosage of dinitro, everything is burned completely. Chemical application of the DN compounds and the use of organic amine salts has given better plant safety and longer residual value, but under certain weather conditions, volatility from the soil can still cause crop injury on seedlings.

Crabgrass can be controlled by the application of carefully measured and applied dilute sodium arsenite, or arsenic acid solutions, which are completely water soluble. In theory, if the same amount of arsenic was liberated from solid arsenic compounds by controlled solubility or chemical

reaction with soil elements, crabgrass should be controlled. Such was found to be the case. White arsenic, lead arsenate, calcium arsenate, calcium arsenite, or water soluble sodium arsenite, arsenic acid, DSMA, or ammonium arsenate on inert carrier pellets, if applied at a dosage related to the water soluble arsenic content, are all effective. From a practical standpoint, cost enters in not only for the initial usage, but how much reserve arsenic is present, and whether it is all available at once, or for a period of more than one season.

What has this got to do with formulation? The solid arsenic chemicals as formed occur as very fine powders that are filtered, dried and ground enough to break up the aggregates. These are suitable for spraying, but are dusty and not too free-flowing in the dry state unless combined with extenders, such as dry sand or dry fertilizers. Therefore, small grains or granules would be desirable that would work down to the duff layer, be free-flowing and low in fines and yet disintegrate to give maximum coverage.

This can be accomplished by taking the original dry powders, adding a core material, such as vermiculite, and using a pill-rolling technic with binders to give pellets; or the powder plus binders and water may be extruded, chopped and dried to give grains or pellets. These modifications add considerably to the basic costs.

A direct chemical process to produce grains of a special type calcium arsenate is the basis of K420 which has been tested here at Purdue. Certain physical characteristics of the reacting chemicals have given us a sticky engineering problem in scaling up for production - literally.

Many times the chemical and physical properties of the technical herbicide itself determine the type formulation which can be made, for example, CMU, Simizin and IPC are not only relatively insoluble in water, but in the most common solvents. They can only be used as wettable powders, paste suspensions, dust or pelleted forms. 2,4-D acid is not too soluble, but the salts are water soluble and the esters oil and solvent soluble.

Sometimes the chemists can take a hand in molecular juggling, and IPC has been modified to Chlor IPC, which can be dissolved, and it did not lose its grass killer effects. New analogs of Simizin are now under test that can be made into emulsifiable solution concentrates, but some species resistance may develop at the same time. Emulsions do not require the agitation in the sprayer during application that wettable powders do to prevent settling and uneven dosage, and are preferred when they are possible, or adapted to the control problem.

Some compounds, such as DSMA and Dalapon, are water soluble, and this may be desirable for rapid absorption, availability to the weeds, penetration to deep-rooted grasses, or rapid dissipation. But, in cases where longer surface effect on new seedlings is desired, dry application as granules for slow release may be indicated. Generally, a heavier dosage per unit area of chemical is necessary in these "fixed" dry adaptations, and the carriers may never release the last 5 to 15% of the active ingredient, if not properly selected.

Chemicals that are normally liquid or oily may be wanted on a dry carrier, or in wettable powder forms. To produce these products, highly absorbent dry inerts must be used, and there are definite limits of con-

centration which can be handled, sometimes not more than 25% of active. The other consideration may be that a lower strength material at a high poundage may give the user better coverage. Straight oil solutions of herbicides are seldom used in turf work, but are confined to brush control, special row crops and cotton.

If the chemical is effective only by root absorption, a spray that is largely intercepted by the leaves is a wasteful and ineffective formulation, and, in this instance, grains or pellets that drop to the ground are indicated regardless of the other characteristics of the herbicide.

Equipment for application is equally important as the formulations, so that uniform dosage is applied and the chemical is placed only where it is wanted. The emulsifiable concentrates did not really come into general usage until low gallonage sprayers were designed and built. If you think a minute, these tractor-mounted rigs are airplanes that move at 4 miles per hour.

No attempt has been made to cover specific formulation problems, such as selection of suitable emulsifiers that will remain stable on storage with 2,4-D that has a trace of free acid in the technical ester, or that may act as spreaders in the dilution, as well as emulsify the concentrate. Wetting agents that will suspend fine powders and not leave a tankful of foam. Packages of a kind and size to give convenient handling and measuring, and that will hold the contents until ready for use. Chelating agents to combat hard water salts which can curdle spray mixtures and cause nozzle plugging. Nor have we attempted to cover the specific manipulations involved in how to produce a formulation.

By their very nature, herbicides have to be produced in separate plants from insecticides and fungicides, but the types of equipment are the same, i.e., heated pots and tanks for dissolving, dry mills and blenders, tumbler mixers and filling equipment. Close teamwork is required between research people, field men and users to be sure that the problem is carefully analyzed, the proper chemical selected and the right formulation developed to do the best possible job.

We might think of a new herbicide as a piece of lead -- it has to be melted and molded to make a bullet and the bullet takes powder and a gun to shoot it, and the man using it has to know how to handle it and observe safety precautions in using it. Misused herbicides can be almost as dangerous.

It is hoped you now have a better idea of why there are so many formulation types produced and why all may not be suitable for use on your specific weed problems.

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UNDERSTANDING WEEDKILLERS - THEIR SALES

Cecil F. Kerr, Chipman Chemical Co.
Kalamazoo, Michigan

Years ago we thought of a salesman as a "peddler" - - that day has gone! The term originated when small craftsmen peddled their own wares. The dictionary defines a peddler as one who hawks, or does a petty business. Today the average salesman is dealing in big business. Man's way of life depends a great deal upon his influence.

Today a salesman must possess the willingness to learn, willingness to work, the art of making seconds count, determination, self-reliance, character, persuasiveness, a sense of humor, and simple, humble, genuine liking for people. This is the background for the understanding of selling weedkillers, or any product.

Salesmen of large companies are trained personnel who can be of real assistance in management problems of turf areas. Several years ago I was traveling in Iowa with another salesman, selling Aldrin to fertilizer companies. We stopped at a large plant and was ushered into the office of the president. He greeted us with a handshake, took our coats and immediately his secretary served us coffee. We naturally remarked how gracious this president was to two strangers. He stated, "I have always been a salesman, I have several salesmen for whom I expect similar treatment. But, a more basic reason, I learn more about what is new in the industry from you men, and how to apply these new developments in my own business than from any other single source."

A salesman must analyze his success and failures. He must know his products; he must know his customers and their needs. He must have ideas that aid in improving his customer's program. Sometime ago Dr. Daniel of Purdue University stated, "An idea without a product is useless." From this statement grew the development of Granulated Calcium Arsenate (Chip-Cal.)

Several years ago Dr. Daniel observed that golf course superintendents were having an increased volume of crabgrass since discontinuing the use of lead arsenate for grub control. This led to extensive testing of lead and calcium arsenate for crabgrass and Poa annua control. Daniel's research showed that twelve pounds of calcium arsenate was equivalent to twentyfour pounds of lead arsenate in controlling crabgrass. Research and experience showed that arsenate of lead would only slowly control Poa annua, but the more active calcium arsenate would eliminate this age-old problem.

Calcium arsenate in the powder state is as fine as flour. Golf Course Superintendents and consumers needed a vehicle to spread this material. Fertilizer, sand, corn gluten and vermiculite is being used extensively. However, we feel this problem is more adequately solved through a granulated product. A calcium arsenate weedkiller should not be dusty - - arsenical dust is somewhat dangerous and disagreeable to use. It should be granular for ease and safety of application, and should be packaged in units such as twelve, twenty-four and forty-eight pound packages for ease of measurement and application.

We have found that the package should be attractive and the directions for use should be simple and easy to understand, and should be applicable to a multitude of situations. The literature should be concise, read-

able, and the data should cover many varied conditions of temperature, rainfall, ice, dessication, continued usage of arsenates, thatch, matting and maintenance dosages.

The product must meet U.S.D.A. standards. Since the cranberry scare and the resulting "too sweeping" Delaney amendment, insecticides and herbicides have received a serious setback. In time the health of the nation could be threatened by serious food shortages because of over-population of insects and a serious infestation of weeds. There should be as much encouragement to industry as possible to maintain vigorous research.

Salesmen must plan and accomplish educational demonstrations. It is important that chairmen and directors understand the total weed-control program. At this time I would like to compliment each and everyone of our superintendents on what a fine job you have done in developing beautiful golf courses. However, more emphasis should be placed on public relations, particularly the education of our golf course members. Many successful superintendents are developing outstanding public relationship programs. A superintendent in Cincinnati published a notice on the locker room bulletin board each time a new project is in process on the course. Also, before and after pictures are posted explaining the renovation process.

Sales personnel must understand the total management program and the place of weedkillers in that program. There is no place for either high-pressure sales, or discouragement. We must plan long range programs.

We must be able to help analyze the management program, ever keeping in mind that no two turf areas are the same, that no two greens are the same, and each year the problems are different.

Salesmen should help interpret research from both industrial and university sources. Neither salesmen nor superintendents should adopt or throw out an idea or product with only one trial. There is much to be learned about weedkillers - - no product is a cure-all.

We can depend on new weedkillers to help solve many troublesome weed problems. With proper usage of chemicals, we have another tool to help build and maintain finer turf.

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FERTILIZER USE AND WEED CONTROL

H. B. Musser, Prof. Emeritus, Penn State University
University Park, Penna.

The relationship of fertilization to weed control is a triangle which the kind of fertilizer, the rate of application, and the time when it is used, are closely related. For example, the rate of application will depend on the kind that is used. Similarly, the kind and rate will affect the time of application.

Fertilization in relation to weed control also is closely related to fertilization for good quality turf. Thinning out of grass due to starvation or other causes allied to the use of fertilizers, is a principal cause of weed infestation. Weeds do not cause poor turf - poor turf causes weeds. When the fertilizer program is so adjusted that it will keep the turf in good condition, it also will be most effective in checking weed development.

The degree of this double-barreled effect is dependent, first on the kind of fertilizer used. The important considerations are:

1. What plant nutrients it contains. Grass requires a constant supply of available nitrogen, phosphate and potash. It also may need trace elements in varying quantities. The kind of fertilizer used, as determined by the nutrients it carries, must be based, fundamentally, on the best information obtainable on what is needed. Sources are soil and plant tissue tests, and, in the case of nitrogen, good judgment based on such things as growth rate, color and disease susceptibility.

2. The sources of nutrients. This applied primarily to nitrogen. There are 3 classes of nitrogen materials, based primarily on the rate at which the nitrogen becomes available after application. These are the fast, intermediate and slow groups. The distinction is important because it has a direct bearing on the time and rate of fertilizer use.

3. Ratios of Nutrients. This sometimes has a very direct effect on weed control. Where the nitrogen is too low in a complete fertilizer, it not only affects the growth rate and quality of the grass itself, but the excess of phosphate and potash over the nitrogen will stimulate such things as clover, which can get along, as the grass cannot, without the added nitrogen.

Fertilizer ratios also must be adjusted to the kind of nitrogen. If its source is a slowly releasing material, its ratio to the phosphate and potash must be higher than when it comes from a quick release material. The quantity becoming avaiable for plant use at any particular time from the slow acting sources will be much lower than the amount that will be supplied in the same time by the quick class of materials. Where the slower forms are used as the source of nitrogen in a fertilizer, the ratio of the nitrogen to the phosphate and potash should be two to three times as high as when it comes from quick release forms.

The Rate of Application is the second side of the fertilization triangle. This must be considered, first, from the standpoint of the total amounts needed over the growing season. The soil test, when properly made and interpreted, is still the best basis for determining phosphate and potash needs. When these are at a low level, as much as 6 to 8 pounds can be used efficiently per 1,000 sq.ft. per year. Rates can be reduced pro-

portionally as tests show higher availability levels.

Rates of nitrogen application are particularly important because of its direct effect on growth of both grass and weeds. Here again there is a direct inter-relationship with the kind of fertilizer used. It seldom is necessary or desirable to use more than a pound of quickly available nitrogen per 1,000 sq.ft. per application. With the slower forms, applications of 2 to 4 pounds are essential, if there is to be enough at any one time to meet growth requirements.

Rates also must be considered in relation to ratios of nutrients in the fertilizer and existing levels in the soil. Where soils are low in phosphate and potash, it would not be good economy, and might be even disastrous, to attempt to correct these deficiencies by using a high nitrogen complete fertilizer. To use a complete fertilizer having 2 to 3 parts of nitrogen, even in slow form, to one part of phosphate and potash, each, for this purpose would result in applying much more nitrogen than needed. In such cases it is practical to depend on a narrower ratio, such as 1:1:1, to build up initial supplies of P and K. Also, it is possible to apply the right quantity of nitrogen in a fertilizer having a 2:1:1, or 3:1:1 ratio, and get the additional phosphate and potash by using some superphosphate and muriate, or a 0-20-20.

Rates of fertilizer application also must be adjusted to the character of the soil. If sub-soil is well drained and moves water fast, and if the topsoil is open and sandy and drains rapidly, losses of soluble fertilizers by leaching will be high, and total rates, particularly of nitrogen and potash, will have to be higher than where the water moves more slowly and more is held in the soil. Applications will have to be made in small quantities at frequent intervals. In such cases it is particularly desirable to use the more slowly available forms of nitrogen to hold down losses of this very expensive nutrient.

Finally, there is a direct relationship between the rate and time of application. The most favorable growing conditions for cool season grasses are in the fall and spring. Fertilizers can and should be applied at heavier rates at these periods. Conversely, the warm season grasses grow best through the late spring and summer, and rates should be adjusted accordingly for them.

The timing of fertilizer applications probably has the most direct bearing on weed control. This applies particularly to weeds which have peak periods of activity, such as Poa annua, chickweed and the more troublesome summer grasses like crab and goosegrass. These plants need food, just as the good grasses do. Unfortunately, when they are active they take it faster than the desired grasses can. At such times fertilizer applications will only aggravate the problem. But, the proper timing of applications, in association with the right kind and rate, can be very effective in stimulating the good grasses and making them better able to compete successfully.

Annual bluegrass and chickweeds grow best during the cool weather of fall and early spring. The turfgrasses, possibly excepting the red fescues, slow down in the fall as temperatures decrease, and start growth later in the spring. Fertilizer applications should be adjusted to this where there is a weed problem. Late summer or early fall use of the more slowly available forms of nitrogen are particularly effective. Their peak nitrogen release comes at a time when the chances are good that the grasses will make better use of it than the weeds. It gives them a chance to develop a

vigorous, dense turf that is better able to hold down weed development as temperatures become more favorable for the latter. Also, there is less available nitrogen, as temperatures decrease, to keep Poa and chickweed growing. The difficulty of getting the same effect with quickly available nitrogen is self-evident. Applications must be made at frequent intervals throughout the fall period to keep the grass growing. This prevents any tapering off in available supplies. As the season advances and temperatures become more favorable for the weeds, they have a distinct advantage.

The reverse is true in the spring. Where Poa and chickweed are problems, fertilization should be delayed until the good grasses show unmistakable evidence of starting active growth. Such adjustments never are as satisfactory as those in the fall because of the normally greater variability that can be expected in spring weather. But certainly, an attempt to make them deserves consideration.

The same type of timing and fertilizer quality can be used to avoid excessive stimulation of summer grasses and weeds. Crabgrass starts about a month to six weeks after the turfgrasses become active. Goosegrass starts still later. The development of a dense turf prior to their appearance is one of the best defenses against these pests. The best way to assure this is to make the spring fertilizer application as soon as the grass is in condition to use it. Here again, the time of the peak availability of the nitrogen is the key to any material contribution that the fertilizer program can make to weed control. Under anything like normal weather conditions, the peak response to organic and other slow forms of nitrogen should occur prior to crabgrass invasion. Studies of the rate of nitrogen release from such materials show that it tapers off gradually as the summer advances. The decrease is slow and the grass has a chance to adjust itself to available levels. If it is vigorous and well-rooted, as it should be from the early feeding, it will do better than hold its own against the weeds.

Even where more frequent applications of slow forms may be needed, the slower, more uniform rate of nutrient release will be a definite advantage. It is good insurance against peaks of over-stimulation and valleys of starvation. An added advantage of such a program is that it will maintain density without producing excessive growth and succulence. This is especially desirable during the hot summer months when density and toughness of the turf are so necessary in resisting weed invasion and reducing injuries.

Nutrient deficiences most often show up first in the discoloration and death of the older leaves at the base of the plant. It has been observed,repeatedly, that the residual nitrogen which becomes available gradually from the slower materials is sufficient to keep these older leaves green and healthy, without excessive stimulation of new growth. This maintains turf density and quality without resorting to forcing practices.

The adjustment in timing of peak availability periods is much more difficult where there is complete reliance on quick forms of nitrogen. Peak responses come after every application. If weather conditions are favorable, this may result in at least temporary over-simulation, which may well be followed by a starvation period, particularly if the intervals between applications are too long. If crabgrass or other weeds are germinating at this time, they will have a distinct advantage. In their seedling stage they do not need large quantities of available nutrients, as they can get along very well at levels that are too low for the mature turfgrasses. With reduced competition, they develop rapidly. It often happens that the next

fertilizer application comes just when they are in the best stage to use it. Because of their fast growth rate they respond more rapidly than the good grasses and a full-fledged weed problem strikes.

This discussion of fertilization in relation to weed control has attempted to point up the necessity for a program that will do the best possible job of maintaining a good turf as a means of assuring maximum defense against weed invasion. It also has attempted to emphasize the importance of timing applications. Everyone with experience in this field will understand that no fertilizer program can, by itself, eliminate the weed problem. This is especially true where weeds already are present and the task is to get rid of them. But it should be just as evident that a good fertilizer program can help materially in preventing or reducing serious infestations. In this program the three basic inter-relationships of kind, rate and time cannot be forgotten or ignored. The best possible fertilizer, used at just the right rate, may only cause trouble if applied at the wrong time.

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FUNGICIDE CONTRIBUTION TO WEED CONTROL

James L. Holmes, Midwestern Agronomist, Green Section
La Salle Hotel, Chicago, Ill.

A talk on Fungicide Contribution to Weed Control must be centered around and mainly derived from observation. There is little published data which gives specific reference to the herbicidal characteristics of chemicals normally used as turf fungicides.

We are all aware that most of the fungicidal chemicals we use cause varying degrees of phytotoxicity to the turf, depending on the chemical, the environment and the amount used. Therefore, it follows that these fungicides will also be toxic to various weeds which are present. The degree of toxicity to weeds is a different matter. The data that are available indicates that only a few chemicals used as turf fungicides merit consideration as herbicides useful in turf work. Phenyl mercuric acetate is no doubt the outstanding example of a chemical which has a proven fungicidal-herbicidal action. Reports from many universities and other testing agences have proved the herbicidal value of this chemical in controlling crabgrass. (Digitaria spp.)

It appears that superior results are obtained if PMA is applied when crabgrass is in the seedling stage. Regular weekly applications are recommended at rates varying from 1/2 to 2 ounces per 1,000 sq.ft. Many turf superintendents regularly apply PMA starting at the time crabgrass seeds are germinating or before. A number of treating methods are followed. Either PMA is used alone as a fungicide-herbicide, or it is mixed with other fungicidal chemicals, such as thiram, cadmium containing compounds, or broad spectrum mixtures. Apparently neither the fungicidal or herbicidal qualities of PMA are affected when it is mixed with other chemicals. However, chemical mixtures should never stand or sit in the spray tank after they have been mixed. They should be used immediately.

At Bob O'Link Country Club last August, during the time when considerable fairway turf "went out", Bob Williams' fairways were in excellent condition and remained so. He credited this to the use of PMA at a rate of 0.8 qt. per acre, mixed with iron sulfate at a rate of 3 lbs. per acre. Six applications were made and Bob considers timing of treatment of utmost importance. In other words, get the treatment on when it is most needed, even if it is necessary to treat 2 or 3 times within a week.

Perhaps we should consider the herbicidal results obtained from treating the fairways at Bob O'Link was indirect. We are all aware of the fact that weed encroachment and spread is pronounced in areas where turf is weak and thin. We have all heard on many occasions that "the best weed control is a thick turf cover." If weeds do not have an opportunity to get started, they may never be a problem. Therefore, it follows that any chemical which assists turf in maintaining a tight cover is at least an indirect herbicide. Surely Bob will have less trouble with weed encroachment in his fairway turf because he maintained an area where weeds were less able to get started.

Most of us here have seen the fungicide test plots on the experimental putting green at Purdue. The results there prove that weeds are present in far greater quantities and qualities in the check areas, or where no turf fungicides were applied. This is outstanding evidence of the indirect herbicidal value of fungicides. Actually anything which assists turf to a vigorous growth can serve as an indirect herbicide. Fungicides protect the leaves that fertilizers help to produce, so both are important. The trend is toward chemicals which will have a many fold purpose. It is entirely possible that compounds will be introduced in the future which have herbicidal, fungicidal, nematocidal, insecticidal, etc. values.

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SECOND YEAR CRABGRASS CONTROL

James W. Brandt, Supt. Danville C. C.
Danville, Ill.

How many of you remember last summer? Wasn't it a wonderful year to grow grass? If you had plenty of moisture, nice pleasant days and cool nights, you must be from Canada or Alaska. We didn't have that.

My course, the Danville Country Club, is located sixty miles west of Lafayette. I would like to tell you of the conditions that actually prevailed at our course. The summer temperatures were above normal, and our rainfall far below average. Our rainfall from June 1 to September 26 was 1.96 inches. The annual average for this period is 14 inches. Our heaviest precipitation during this period was .46 inches. This doesn't do much to revive grass in a powder dry soil.

Here I am supposed to be giving a report on crabgrass control on unwatered bluegrass fairways. Some crabgrass did germinate in untreated areas, but withered and died from lack of moisture. The only crabgrass that did survive was that which received supplemental irrigation in untreated areas.

Before we talk of second year controls, I will review briefly what was done the first year. Nine plots totaling two acres were treated in March 1958. These included areas that had good soil and poor soil. Areas were also chosen where both light and heavy infestations of crabgrass had prevailed the previous year. 450 pounds of calcium arsenate (85% material) in powder form was applied per acre. The spreader used was a farm type, having half as many openings (8" rather than 4") as the golf course type spreader of the same mame.

This first series of slides will show the results observed the first year. The calcium arsenate really does look good. In treated areas we have a good dense bluegrass turf free from crabgrass. The untreated areas have a terrific infestation. On the basis of these results and what had been observed at Purdue, we decided to do our entire fairways. We used 435 lbs. of the 85% powder form of calcium arsenate per acre. This amounted to 9.75 tons, costing $ 2,200.00, spread on 45 acres of fairways. This was applied in February and March of 1959 in split applications; one-half being applied lengthwise of the fairways and one-half across the width of fairways. We had bought a new spreader, but found that the agitator was too small and too much bridging of the material occurred when using powder direct. We used the same farm type spreader that had been used the previous year.

In mid-April of this year we noted that some of our plots of the previous year were beginning to show some injury. This injury was not apparent during the winter months, nor did any of it show up in 1958. The plot showing the most severe injury had a definite pattern to the injury caused by faulty distribution of the calcium arsenate in the wide spreader openings. Our fairways are very low in phosphorus, so I decided to apply some to help overcome this injury to the bluegrass. 400 lbs. of 3-12-12 per acre was applied to the damaged areas. As the summer progressed, the injury became less apparent. The test plot areas of 1958 received only one-half the original rate, or 217 lbs. per acre in 1959, for a total of 667 lbs. for the two years.

Now, let us turn our attention to the fairways during the past dry season. By June 15 it was quite apparent that we were getting very good crabgrass control, but it was also true that the bluegrass was injured to some extent. Pictures taken in late fall show the streaks where arsenic accumulation caused injury.

The borders of the greens and tees that had been treated similarly were not showing this injury. In two areas of our fairways we started to water. This was to see if injury would persist if turf was given adequate moisture. On these watered areas all evidence of injury had disappeared by September 1, and the plots were free of crabgrass.

These pictures make the injury appear much worse than is the actual case. The grass is long in the undamaged areas and the slides do not show the new shoots being sent up by rhizomes in the damaged areas. I am sure that given adequate moisture the fairways will be playable and crabgrass-free for the coming year.

Our plan is to continue with annual applications of calcium arsenate at 110 lbs. or less per acre. We had enough material left from last year for this year's application, which will be mixed with a carrier of ground corncobs. Our distribution was uniform enough to give control of crabgrass. The distribution was not adequate to prevent the injury of

bluegrass in the areas of heavy concentration in a dry year. Uniformity of distribution is a must and this is very hard to achieve when using powder.

Our fertilizing program shall consist of 2 to 3 lbs. of actual nitrogen during the season with early fall applications of 1 pound of phosphorus and potash per 1,000 sq.ft. At these rates we will be applying more arsenic than phosphorus. I believe that the amount of phosphorus applied will not be enough to over-ride the benefit of our arsenic in the control of crabgrass.

The question often asked is, "Now that you have used the material for two years, what would your advice be to one contemplating a control program?" If you water fairways in the crabgrass belt, you must control crabgrass. If you can afford to water, I think that you can afford to control crabgrass. If you are going to use powder,which will be less than half the cost of pellets, you must be sure of uniform distribution. By the time you buy and mix with a carrier, powder may not be the most economical for you.

The story isn't complete. It is a long range program. Calcium arsenate has looked very good in years of adequate moisture. The disappointment that I experienced last year was due to poor or inadequate distribution. I am sure that calcium arsenate properly applied and in correct amounts will be very effective as a pre-emergence crabgrass control material.

Editor's note: (If direct undiluted powder use is attempted, then have one man ride spreader and constantly stir the powder to reduce bridging. Also, use a well adjusted spatter board, or rod to break up powder fall. Generally 80# Milorganite, corn gluten or dry sand will help 50# calcium arsenate feed through).

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MY EXPERIENCE IN POA ANNUA CONTROL

Marion Mendenhall, Supt., Kenwood C. Club,
Cincinnati, Ohio

For the past five or six years we have been using 10 to 20 lbs. of arsenate of lead per 1,000 sq.ft. on the Kenwood greens. But, the Poa annua continued to get a little worse each year until the greens had up to 25% infestation. Feeling that the arsenate of lead was giving doubtful control, it was decided in May 1958 to treat about 3,000 sq.ft. of one green with 16 lbs. of calcium arsenate. The control of Poa annua was outstanding, and there was only minor damage to the bent. The calcium arsenate was applied with a spray and where the spray overlapped, the damage occurred. Within 30 days the green had recovered and remained good through the season. My grounds committee watched this test very closely and were convinced that this program should be followed on all greens.

Because of words of caution from Charlie Wilson and the many unknown factors involved, I suggested that we treat just the Kenview greens. On March 20, 1959, 15 lbs. of calcium arsenate per 1,000 sq.ft. was sprayed on and washed off the leaf. No ill effects were felt and the greens were grow-

ing about normal. The first of May the greens were verticut and topdressed. For the next 4 or 5 weeks the greens were in very poor playing condition. Apparently the arsenate had taken effect about the time of the verticutting and the greens would not grow. The grass had a blue-gray color - like a frost burn. Light applications of sulphate of ammonia and Milorganite were used, but with little results. Of course, we could have applied some phosphate to counteract the arsenate, but then we would just be defeating our program. Very little bent was lost and no sodding was necessary, but the bent seemed to thin worse on the high areas. Because of the poor color, the greens looked much worse than they really were, and of course with no growth they had poor putting surface.

This period was very trying for the grounds committee and myself. We had made our first glaring mistake, that of not informing the entire membership in advance on what to expect. Like all clubs, we have the dozen or so grillroom greenskeepers who were sure that the greens were ruined forever, and would have gladly helped me pack my traveling bags. But, with warmer weather, the greens recovered and were in good condition the rest of the season. In fact, we had more difficulty during the summer with the Kendale greens which hadn't received the calcium arsenate. Of course, we now realize that verti-cutting, aerifying, or any program that might do some turf injury must be avoided during this slow growth period.

Now, did the treatment justify the end results? Yes, now that the winter weather has changed the color of the bent, it is easy to find any Poa annua. Many treated greens are nearly 100% clear of Poa annua. A few spots remain on some and only on 2 or 3 the results were not completely satisfactory.

What about the future? We plan to hold the toxicity with arsenate of lead and the results we experience this coming season will govern our future use of calcium arsenate.

The collars of our greens have been Poa annua for many years. Several years ago we started spriging Cohansey bent into the collars. This was done on wet days in the spring and fall by running the fairway aerifier with 1 inch spoons around the greens and pushing stolons into the holes. From our limited sod nursery we had sodded some strips around greens. All this was slowly gaining on the Poa annua.

In November 1958, twenty pounds and in March 1959, ten pounds for a total of thirty pounds of calcium arsenate was applied dry to the collars of all the greens. No damage to the bent could be seen. Perhaps this was due to the higher cut and the more vigorous growing habits of the Cohansey. Goosegrass had been especially bad on the collars in the past. But, in 1959 probably less than three baskets were removed from the collars. A small amount of sodding was done on the collars, and by mid-summer they were covered with bent. The golfer has been very complimentary on this phase of the program. We have several acres of fairways under test, but due to the very dry summer and poor fairway turf in general, no evaluation could be made.

In summary I eould like to leave these thoughts. The use of calcium arsenate on greens is a renovating program and must be sold with this understanding. There is no easy way to get rid of Poa annua. You have to get in and fight if you are going to win. And sometimes you get your ears knocked down before you find the right answer. Your club membership must be told the complete story and what they can expect. If they are satisfied with the

present playing conditions and will not sacrifice a few weeks pay for better greens in the future, find it out before you start on any renovating program.

Many unknown factors are governing the success or failure of the arsenicals. Can we determine the existing arsenate toxicity in the soil? What is the proper timing, weather conditions and amount to apply at any given period? Answers to these and many more questions must be found before full acceptance of the arsenicals will be found. There have been some reports of failures and criticism of the program. No doubt many factors other than the arsenicals contributed to these failure. Don't go overboard at this time - continue testing. Keep your eyes and ears open for we are just starting to learn how to best use the arsenicals.

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SOLVING THE POA ANNUA PROBLEM

W. H. Daniel, Purdue University
Lafayette, Indiana

Several turf managers report they are solving the Poa annua problem in fairways by growing it throughout the year. This includes repeated, frequent watering, at least fungicide treatments during disease attacks, often with PMA compounds, plus good aerification and fertility practices.

In an excellent article in U.S.G.A. Journal of September 1959, Dr. M. H. Ferguson points out that the abundance of Poa annua seed provides for ready invasion whenever wear or disease weaken bentgrasses or bermudas. He suggested a 12 point program for Poa annua control. However, ten of these were only concerned with growing good bentgrass. These are:

1. Provide for good drainage.
2. Use a vigorous bentgrass.
3. Keep phosphorus levels down - prefer a 4:1:2 ratio.
4. Topdress and cultivate to relieve surface compaction.
5. Do not keep soils saturated - hand rinse to protect bentgrass.
6. Keep thatch on greens to a minimum.
7. Move cup frequently - before bruising of traffic causes wilting.
8. Control insects and diseases.
9. Wetting agent may help get water penetration.
10. Fertilize bentgrass when Poa annua is weak.

Only the last two of twelve were specific on Poa annua

11. Use herbicides in test sites first - keeping out crabgrass reduces opening for Poa annua.
12. Use arsenicals to discourage vigor of Poa annua.

Certainly the above stresses the basic point that even with control of Poa annua you must maintain favorable management of the desired grass. Poa annua presents a special problem in fine turf maintenance. It may appear

as dense, fast growing turf, or as failing turf in greens, fairways, aprons and fine lawns. As with other weeds, one of the standard practices for reducing Poa annua has been maintaining a dense turf. Also, the initial contamination of turf areas with Poa annua may be very important in getting a thick infection.

The Poa annua problem can be

1. Denied.
2. Ignored, thus assumed to be little necessity to attempt control, or
3. You can plan a positive program. This includes attention to public relations, budget requirements, turf replanting, management changes and chemical utilization.

We often consider Poa annua an annual because it may seed within two months of germination. However, close observations show it may persist for two or more years by developing new roots and leaves at the terminals of stems, which actually serve as individual plants. We do know Poa annua often fails; generally when it is most wanted, leaving brown, unsightly areas with poor playability. This is why we would like to definitely control it.

Actually, solving the Poa annua problem can be correlated from three angles:

1. Interpreting the data from other fields
2. Research observations from greenhouse and plot tests.
3. Utilizing personal experiences of many over long periods

When combined there has been progress made.

The principal control existing today for Poa annua is the combination of good management practices, plus the use of arsenicals to prevent plant vigor and favor those species tolerant to arsenic. In 1952, and since that date, we have repeatedly observed that toxic concentrations of arsenic can reduce the vigor of Poa annua. Meanwhile, bluegrass (Poa pratensis) grows normally, for although the individual seedlings of Poa annua may be affected by any form of arsenic, we are most interested in those forms which have some safety in application and some ease of utilization in their normal application. Sodium arsenite would work as a source of arsenic accumulation, but it does not have a safety factor.

Continued research in the greenhouse shows that arsenic is picked up by the root system of Poa annua at all stages of growth when temperatures are cool and days are short. Also, when both phosphorus and arsenic are present in adequate supply, arsenic will predominate after an interval of time, let's say one year or less. However, arsenic, like phosphorus, is gradually fixed so that there is deterioration of the toxicity of arsenic with time on soils.

Repeatedly we have seen different selections of bluegrass and bentgrass selectively survive where arsenic has been used. When 2" soil cores from old, as well as new greens, have arsenic added, bluegrass grew normally while Poa annua was restricted. Further, when we test several soils we find that about the same amount of arsenic becomes toxic under greenhouse conditions. Probably more difference would be expected under field conditions.

Favorable observations in greenhouse studies has led to repeated applications of chemicals to turf areas. Norm Goetze tested 31 chemicals, all he could find, giving promise at Purdue 1956-57. Of the five that gave some

toxicity on Poa annua, the arsenicals gave the most selectivity when considering desired plant tolerance. More on that point later.

In our observations where even 5% of the turf area was bluegrass cover, within two years the bluegrass spread enough to make satisfactory turf when Poa annua and crabgrass competition were kept out. Isn't this a most encouraging fact?

Arsenic Recommendations

Based on repeated tests and by checking with other Experiment Stations, we have prepared recommendations on the use of calcium arsenate for lawns and fairways, based on the standard application of 12 lbs. formulation per 1,000 sq.ft. This attempts to apply slightly over 3 lbs. metallic arsenic per 1,000 sq.ft. This is summarized in Table 1.

The use of lead arsenate would be 50% more than calcium arsenate rates. Other chemicals (PAX, Pre-Kill, Stopps, Chip-Cal Gran., Di-met P.C.C. and Gen.Chem.Gran.) would be used as labeled. Most users want definite, complete seedling control, so should use adequate rates. Trying to skimp on material may give only a partial reduction, which is unsatisfactory.

Table 1. - Suggestions for Use of Calcium Arsenate

Weed	Condition of Turf	Formulation 1,000 sq.ft. powder lbs.	Formulation 1,000 sq.ft. granular lbs.	When to apply
ON LAWNS AND FAIRWAYS				
Crabgrass both hairy & smooth	unfertilized turfs or sandy soils	10	12	Any time before crabgrass germinates. Best in fall or early spring. May kill some existing crabgrass
	repeatedly fertilized turfs or clay soils	16	20	
Poa annua annual bluegrass	Must have desired turf present	12	16	Apply in early fall & again early spring for split applications
		6	10	
Chickweed,	smooth & mouse-eared	12	16	Early spring for killing may prevent fall seedlings
ON GOLF PUTTING GREENS				
Poa annua and crabgrass but not goosegrass	Matted and thatched bentgrass	6	8	Repeated each fall & spring until control is observed.
	Where lead arsenate has been repeatedly used	4	6	Be cautious
	Where winter dessication may be expected	4	6	Also aerify, or spike to open up soil. Apply water from tank if needed.
	On good greens	12	16	Apply one-half in week apart application.
	Where Poa is severe	12	16	Replug to desired bent. Overseed to Penncross. Rebuild.
To maintain toxicity in following year		2	6	Annually, or average.

Based on your observations, we are more cautious in applying calcium arsenate to golf greens. However, where used, we prefer light, repeated applications to build up toxicity in one calendar year, rather than attempting this in one application.

There are at least 15 crabgrass and Poa annua preventers on the market currently. The four pelleted arsenicals include: Chip-Cal granular, No-Crab Stopps, Di-met P.C.C., General Chemical Granular. These four are granular: / Pre-Kill, Cross Country, PAX. Also, both calcium and lead arsenate are available as powders, which may be of more interest where you wish economy and have application equipment.

The non-arsenicals, which would restrict the growth of Poa annua as a seedling when applied in toxic concentrations, are being sold primarily as crabgrass killers. Where you have a stand of desired grass to protect, you may be interested in testing these for Poa annua: Rid, Halt, Dow Crabgrass Killer, Chlordane. There is one difference - the arsenicals offer a buildup that may affect existing plants of Poa annua. The non-arsenicals would expect to affect only seedlings that may appear while the toxicity persists.

Looking at individual golf greens where arsenates have been used, most superintendents report it is a slow and painful process to remove Poa annua. The texture and density variation caused by Poa annua dying is most obvious. Therefore, Poa annua control in greens may often point out that the basic need was to replant; or to improve the turf so there is sufficient turf cover of bent rather than just the absence of Poa annua as a criteria. Somtimes plugging and sodding bring in excessive amounts of Poa annua from nursery sources.

We have some reports from large scale applications of arsenic that should be of interest. Jim Brandt, Superintendent of Danville Country Club, Illinois treated 2 acres of fairways as tests in 1958. Then treated fairway areas in March 1959 with powdery calcium arsenate at 450#/acre. All poa was removed and crabgrass prevented in fairways.

The tees received 12 lbs. in March 1958 and 10 lbs./1,000 sq.ft. in March 1959. After this Poa was present, but failed to grow and was completely gone by mid-May. Of interest the No. 15 tee was shaded and almost solid Poa. As Poa died, it was bare so had to be resodded. Mr. Brandt reports that he plans to use 100 lbs. CaAs per acre to maintain toxicity in tees and fairways, and continue to use light applications of lead arsenate 2 lbs./1,000/year for insect and Poa control on greens.

Mr. Eules Skaggs, Superintendent of Moraine Country Club, Dayton, Ohio writes - "We have some excellent results with calcium arsenate. Also, through lack of experience, we had some harmful results. Our first application made two years ago was too heavy 20#/1,000 powder in sprayer application/1,000 sq.ft. on greens, tees and aprons. We got a definite retardation of bents along with crabgrass kill and prevention, plus Poa restriction.

Our second application, made between October 15 and December 15, 1959, was easy to apply with Cyclone spreader as pelleted CaAs, using 8#/1,000 sq.ft. on greens, aprons and tees. After fill-in our greens are better than before starting treatments for Poa is less than 12% and getting less. If I had the program to do over, it would be the same. However, it's a drastic program for some. This has also controlled soft crabgrass, but we've not seen any effect on goosegrass."

Other Chemicals

Our current recommendation for arsenicals is not the last of testing new products. We tested Di-nitro in January 1952. However, the product discolors clothes badly - its restrictive effect on bent was obvious at normal rates.

Both U.C.L.A. and Purdue published in 1951 on Chloro-IPC hopes, based on tests, but its six weeks stunting of bent was too great. So, neither have been as selective, nor allowed as much leeway in use zs the arsenicals. Neither selectively killed existing Poa annua.

In 1957 research on Neburon showed it might be used on bluegrass when Poa annua is a minor component as a spring application, but not used on greens or where bent is a portion of the turf. In 1959 the compound Dacthal looks quite encouraging as a seedling preventer. We may soon hear of other products and we should continue testing other products for selective control where seedlings are the only problem.

In October 1959 Southern California Turf Culture, Youngner, reported on greenhouse and field tests. Based on their observations, calcium arsenate at 12 and 16 lbs. gave 50 and 70% reduction of Poa annua in area covered. Lead arsenate at 12 - 16 lbs. gave 70 and 75% control of Poa annua in one season. Also observed to give moderate control was 3 lbs. of Alanap, 8 lbs. of Neburon as active ingredient per acre. Vegedex, Randox, Sinizin and Eptam injured turf, or were not considered favorable.

New products should be coming on the market in the arsenical field. Several have been tested by Experiment Stations and companies producing them. Applying products uniformly will always be important. It is important to apply by the time you wish toxicity, for example, before magnolias blossom in the spring for crabgrass control, or before cool weather starts for Poa annua control.

We count on specie's tolerance to permit survival of desired grasses. Since bluegrass and bents grow more vigorously than Poa annua, it appears that uniform applications of arsenicals do offer a sound control program. Certainly we must continue testing new products.

Many will not be interested in immediate widespread use of arsenicals, but you are encouraged to make test applications on half of greens, aprons, tees, or lawn areas so that you determine its effectiveness as it builds up under your conditions. Those who have tested and found it effective may now be interested in budgeting a positive program for the years to come. Certainly there is little merit in producing complete crabgrass or Poa annua control so that only bare ground exists during the anticipated turf season. This is why both crabgrass and Poa annua control are most recommended for areas having a reasonably good stand of permanent turf which one wishes to protect by removing weedy grass competition. If reseeding or resodding is needed, consider getting the grass started and next season remove weedy grasses.

In Solving the Poa annua Problem you may use interpretations from other fields, research observations and personal experience. Poa annua control is not an easy program. However, you have reports of real progress and some positive suggestions, which can be incorporated into YOUR turf management program.

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WEED CONTROL IN TURF NURSERIES

Dale Habenicht, H. & E. Sod Nurseries, Inc.,
Tinley Park, Illinois

We are faced with the problem of getting sod ready to market within 12 to 18 months after seeding. Within this time all weeds have to be removed to provide a quality product. A general program has been developed to give adequate weed control economically and efficiently.

After seeding in the late summer, no selective weedkillers are used for weed control until the following spring. Broadleafs, which begin to grow early, are the first weeds to control. We use 2,4-D with an amine base applied at 1 pound of active ingredient per acre. Sometimes white clover is a problem at the same time. If so we also apply 2,4,5-T at a rate of 3/4 pound active ingredient per acre. If a repeat application is required, it is given 3 weeks after the first application. Applications are made with a power sprayer with the spray booms mounted on the front of the tractor. The chemicals are diluted with water and sprayed on at a rate of 25 gallons per acre.

Should knotweed become a problem, we treat while it is young when a spring application of 2,4,5-T, using 1 pound of active ingredient per acre, will give satisfactory control.

By the time summer comes, the turf has usually progressed, that it is dense enough to keep out new weeds. However, this is accomplished only by good maintenance. This included regular mowing, adequate watering,and proper fertilization.

Only occasionally are we bothered with crabgrass. The best time we have found for spraying crabgrass is in June before it competes with turf. D.S.M.A. in liquid form, applied at 10 pounds of active ingredient when the temperature is below 80 degrees, or 5 pounds of active ingredient when the temperature is above 80 degrees, will give us adequate control when two applications are made.

Chickweed is not a major problem in our turf areas. We use a hand pressure sprayer and spray only infested areas. Neburon 2# active/A, or 2,4,5-TP gives us satisfactory control.

In bent areas where Poa annua is a problem, we apply granulated Ca arsenate at the rate of 12 pounds per 1,000 sq.ft. in the fall of the year. Every succeeding year, 4 pounds per 1,000 sq.ft. is supplemented.

We consider bent growing in Merion a weed. To control it requires repeat applications of 2,4,5-T until the bent is thoroughly burned out.

In special turf areas where soil sterilization is beneficial, we use Dowfume MC-2 generally applying 1 pound of Dowfume per 100 sq.ft.

Selective weed control thus enables turf nurseries to grow weed-free turf within 12 to 18 months. Without it the time to grow good marketable sod would double.

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RECOGNIZING WEEDS IN TURF

John Gallagher, Amchem Products Co., Ambler, Pa.
James Beard, Graduate Fellow, Purdue University

Today, Jim Beard and I will try to help you to both recognize and identify weeds. Recognition is easier than identification, for Webster says recognition is "to know again," and identification is "to establish, as a particular thing." You can do this by knowing both general and fine specific characteristics.

Recognition

The general definition of a weed is a plant out of place. Therefore, recognition is easy - everything except the desired turfgrass species are weeds. Actually several features help you answer the question - What is it? First, consider the time of year. You don't expect to find crabgrass growing in the middle of the winter, and as a general rule, annual chickweed has disappeared from turf areas by mid-July.

Second, what are local soil environment conditions? Some weeds grow in wet, moist places; others do well and are more frequently found in dry, sandy or well-drained areas.

Third, soil pH and condition often dtermine the weed specie which will grow. Sheep sorrel is known as an indicator of acid soils,and knotweed is frequently found in tight, compacted soils.

Fourth, management practices, such as height of cut and fertility levels, can influence a weed population. Many of the same weeds found in the rough will not survive under putting green management, and most of you are aware of the difficulty of holding clover under high fertility levels.

Fifth, the physical characteristic of the plant itself can be used to help classify the weed. Annuals do not have vegetative reproductive parts, while most perennials do.

To avoid confusion, remember that weeds persisting and thriving under turfgrass management are of two distinct types. Some produce a very short stem or crown, with a rosette close to the ground, while others have root stocks below the surface, or runners on the soil. Successful lawn weeds are those with growing points close to the surface of the ground where they are not injured by frequent mowing.

Clues to Look For

The following include characteristics which help to classify a weed specie in a particular group.

I. Is it a grass or broadleaf weed?
   A. Grass weeds.
      1. Is it a clump type - single plant?
      2. Is it a sod former - loose or dense?
      3. Does it have stolons?
      4. Does it have underground rhizomes?

B. Is it a broadleaf weed?
   1. Is it a mat former?
   2. Does it form a rosette?
   3. Does it have spreading root stocks?
   4. What color are spreading root stocks?

II. Is it an annual or perennial?
   A. Annuals complete a life cycle within one year, reproduce by seed alone and have no vegetative reproductive units.
   B. Winter annuals germinate in the fall and complete their cycle by the following summer.
   C. Perennials may flower and seed the first year, but do have vegetative reproductive parts.

III. What time of year?
   A. Spring - summer annuals germinate and winter annuals flower.
   B. Summer - summer annuals flower and winter annuals seed. Perennials flower and seed.
   C. Fall - summer annuals seed, winter annuals and most perennials germinate.
   D. Winter - winter annuals rosette, while perennials rosette, or aerial parts die and disintegrate.

IV. What are environmental conditions?
   A. Wet - poor drainage, seepage and shade.
   B. Dry - soil type, excess slope and mounds.
   C. Compacted - tees, athletic field centers and cart tracks.
   D. pH - excess acidity.

V. What are maintenance conditions?
   A. Greens - tees
   B. Fairways - parks, lawns, athletic fields
   C. Roughs - roadsides

Identification

After general recognition has narrowed the possibilities, you can utilize specific plant characteristics in identifying each individual weed. To use the numerous keys available, we should be familiar with the terms and plant structures utilized.

A. Rhizomes - Is an underground stem which grows parallel to the surface. Each node of the rhizome is capable of initiating both roots and stems. In addition, a rhizome can act as a food storage organ and is more fleshy than roots. Rhizomes are usually characteristic of perennial, sod-forming grasses. These enable plants to survive summer drouths and other stress periods.
Example: quackgrass, bermudagrass, bluegrass, yarrow.

B. Stolons - Is a modified stem that grows above ground. Each node of the stolon is capable of producing both roots and shoots. Stolons are characteristic of dense, sod-forming plants.
Example: bentgrass, Zoysia, healall.

C. Fibrous root system - Many fine roots produced from the crown of the plant. This type of root system results in a bunchy habit of growth which does not form as dense a turf.
Example: ryegrass, annual bluegrass, goosegrass and crabgrass.

D. Tap Root System - With some small lateral branches this tap root is usually quite fleshy and functions as a food storage organ. Examples of broadleafed weeds with a tap root are dandelion, plantain and knotweed.

E. Stem Shape - Some weeds can be distinguished by the shape of their stems. Have four categories:

1. Round - weedy grasses - crabgrass
   broadleafed - knotweed
2. Flat - weedy grasses - orchardgrass, goosegrass
3. Triangular - weedy grasses - sedges, nutgrass
4. Square - broadleafs - Henbit, ground ivy

F. Stem color - A few weeds are identified by stem color.
Examples: Weedy grasses - goosegrass - silver to shiny white
barnyardgrass - deep reddish
foxtail - red stem in its young growth stage
Broadleafs - Rugels plantain - reddish.

G. Ligule - is a small, thin, papery, upright structure which is flush with the stem or culm and seated on the collar where the leaf blade joins sheath. Identified by the presence or absence of a ligule, as well as the size and the shape of the ligule, such as long, short, ring of hairs, smooth, or serrate.

H. Auriclé - is a thickened, fingerlike appendage, originating on the margins of the leaf at the junction of the sheath and the leaf blade. They occur in pairs and project around the stem or culm, and thus function in preventing the weight of the blade from pulling the sheaf away from the stem.

I. Pubescence - is a term used to describe the very fine hair-like projections occurring on plants. This pubescence, or hairy characteristic, may cover the entire leaf, or may occur only on the blade, collar, or sheath, upper or lower leaf surfaces.
Example: hairy crabgrass.

J. Glaborous - describes a smooth leaf, collar, or sheath which is completely void of hairs.
Example: smooth crabgrass, wild onion.

K. Leaf Shape - leaves can be entire or serrate and can be of many shapes. The grasses have narrow, long leaves with parallel veination.

Leaf Color - Flowers, smell, taste may also serve in identifying.
Poa annua - light green color
Nimblewill - light, grayish-green color and patchy.
Chickweed - light green color

References:

1. "Turf Management" - H. B. Musser - McGraw-Hill, New York (Publisher)
2. "Weeds" - W. C. Muenscher - MacMillan Company, New York "
3. "Weeds of the North Central States" - North Central Regional No. 36*
4. "Picture Aids to Grass Identification - Hartwig of Cornell, 109 Worth Street, Ithaca, New York.

*Published by University of Illinois, Urbana, Illinois, Circular 718.

FAIRWAY RENOVATION - PROGRESS REPORT

Paul W. Neff, Supt., Scioto C. C.,
Columbus, Ohio

The year 1959 was a very poor one about which to write a progress report. At least this was the case in our area and also in many others, according to reports which I have heard. It is advisable to spend a little time about the beginning of the renovation project as reported last year before getting into second year's results.

When I came to Scioto two years ago, the fairways were similar to others in that what had been bluegrass, due to demands of the golfers for closer cut turf and other factors, had become about 90% Poa annua, with a liberal seasoning of clover, knotweed and crabgrass. There were some spots of bluegrass and bent, but they were so far apart that it seemed with the best of care they would never fill in. It seemed hopeless to seed with so much competition. Accordingly, I recommended killing out everything and starting over.

In choosing the proper grass to replant, we seemed to be limited to bent, bermuda or Zoysia because of the demands of low cutting heights. Zoysia was ruled out because of almost seven months winter color and slow establishment. Bermuda was ruled out for the same color reasons and uncertain winter hardiness. It was decided that we would use bent grasses - 45% Highland, 45% Astoria and 10% Penncross.

The result of this renovation was a very good cover of bent, which was very pleasing to the golfers. When the grass first came up, it was a very pure stand of bent with very little Poa annua showing. During late winter and early spring more Poa annua showed up in thin spots. We knew, of course, that we would have Poa and always expect to, just as we still have some crabgrass even with very efficient remedies now available. Our hope is to keep it down to a small percentage, so that when it goes out in the summer, as it usually does, there will still be lots of grass instead of many bare places.

We are using 250 pounds per acre of lead arsenate annually, in March, to build up a toxicity in the soil. This year, in addition, we will use sprays of sodium arsenite, which were not used last year, because of the grass being new in the spring and the extreme heat in September.

Some bent was lost from fungus diseases, brownpatch and melting-out, during the worst part of last summer. The loss was greatest where there were many trees on west and south sides of a couple fairways and in lowest valleys. The pump, at one of the two wells, was "out of order" for a total of about four weeks in July and August. During part of this time we did not get very good water coverage due to low pressure or wind while watering in the daytime. Some grass was lost at edges and tee ends of fairways. Fairways that were rather open and well watered suffered very little.

All damaged areas were reseeded early in September, but the seedlings did not do as well as the year before because the heat held until October. This permitted further encroachment of Poa annua.

One short fairway, in low poor ground next to the lake, was treated at rate of 750 pounds per acre of lead arsenate as a test area. It appeared

to be about the poorest during March, right after treatment, but has greatly improved. This leads me to believe that arsenic toxicity will work. It would cost about $ 10,000 to have treated all fairways with lead arsenate at this rate, but we hope to achieve it by using about $ 3,000 per year for this purpose.

With a buildup of toxicity, normal weather conditions and better management, I believe control can be established, but as I have said before, Poa annua will always be with us unless there is a major break-thru in the chemical field.

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PLANTING FAIRWAYS AT BIG SPRING GOLF CLUB TO WARM SEASON GRASS

Ernie Schneider, Supt., Big Spring Golf Club,
Louisville, Ky.

Our Greens Chairman called a meeting of the Grounds Committee and myself to discuss what to do about the fairways. They were heavily infested with grubs, and had practically no turf. The decision was made to plant to U-3 Bermuda.

The soil pH ran from 5.6 to 6.2. Two tons of agricultural limestone per acre was spread. The fairways were then sprayed with 8 lbs. Chlordane per acre. Wade Stith, Manager of Lynde and Rowsey Grass Nurseries of Muskogee, Oklahoma was given the contract to plant 20 acres of fairways. The material was trucked here in sod that had been mowed at one-half inch, and was just beginning to green up. The sod was rolled out and shredded with a Park Special, which was equipped with a Par-Thatch Reel. The planting, which started April 15, was done with a Modified Bray Sprigger. To do the planting it took three men, one on the tractor which pulled the planter, one man hauling and loading the planter, and one doing the shredding. Nothing but stems and rhizomes were planted, 2 to 2-1/2" deep, rows 18" apart, a minimum of 75 bushels per acre. It took approximately four days to complete the planting. It was watered in as they planted with a 1-1/2" fire hose with an adjustable nozzle. The water lines were cut and two inch valves were installed to handle this operation.

1. The spraying started April 22, with a heavy application of 5 lbs. sodium arsenite and 6 ozs. 2,4-D per acre, to rid the fairways of knotweed, crabgrass, clover and other weeds.

2. The same treatment was repeated one week later. The golfers were now playing on bare ground. We got our first shower of rain about two weeks after the planting.

3. This brought on a new crop of crabgrass. I sprayed 3 lbs. of sodium arsenite and 6 ozs. 2,4-D.

4. A week later the same dosage was repeated. There was no Bermuda up above

the ground as yet, and the ground was drying. We have no fairway watering system so I rented a pump and some pipe, and borrowed pipe. I pumped out of the creek and out of the water mains. Off of this system, I was able to run from 7 to 9 sprinklers, and covered the fairways completely one time. The labor involved was tremendous, so I did not repeat this operation. This watering brought in the goosegrass.

5. The Bermuda was now just starting to come through. 1 and 1/2 lbs. of sodium arsenite and 6 ozs. of 2,4-D per acre was now sprayed. The same spraying was repeated ten days later.

6. After this I used two traveling sprinklers, which took eleven days to cover the twenty acres of fairways. We had no other rain until July 17. From then on we had more than our share.

I had wonderful control using the sodium arsenite and 2,4-D, but the death of the birds and other wildlife prompted me to stop using the sodium arsenite. We had made six heavy applications. There was a new crop of goosegrass which I left to grow until the seed heads just started to show. Then, I made two applications of materials such as Methar, Di-Met and Crab-E-Rad in August. We were very satisfied with this control as it wiped out the goosegrass for the time being. By now the Bermuda in most fairways had made wonderful progress, and this same spraying was repeated twice in September. The sprayer I used was a 150 gallon John Bean with a 14 ft. boom. I could cover 6 acres with one tank of material. All the spray applications contained some wetting agent.

The fertilizer program was as follows: Sprigs were planted with 200 lbs. Milorganite in the rows. When sprigs began to show, I used 300# 15-10-10 granular fertilizer to the acre. The next feeding was a month later, 100 lbs. 45% Urea to the acre. Three weeks later another application of 100 lbs. 45% Urea per acre. The next application was 150 lbs. 33% Ammonia Nitrate. The last fertilization was 300 lbs. Milorganite to the acre. For the season this totaled 215 - 55 - 30 lbs. of N - P_2O_5 - K_2O/A. By this time the coverage was almost complete. All fertilizer was applied with a three point hitch Cyclone Seeder. The fairways were aerified one time in late August.

The members of the Club are real happy with their U-3 Bermuda fairways, and we are going to complete the planting of the other fairways this spring.

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WHERE ARE WE WITH GRASSES?

Dwight Brown, The J. Chas. McCullough Seed Co.,
Cincinnati 1, Ohio

I feel quite honored to be privileged to substitute in part for Dr. Fred V. Grau, who was unable to be here to participate as planned earlier. To the layman, any sod is still sod. He little knows of the many changes that have taken place in sod nursery technique and management.

Let's look at the situation objectively. Upon examining the whole picture, we can divide it into three questions:

1. What can we use in new grasses?
2. What changes have resulted in sod management?
3. What is needed in selling?

1. What can we use in new grasses? Quite a few years ago, with the help and cooperation of State, Federal and private turf research, we knew that many new, but unproved strains and selections of our cool season grasses had become a reality. Today most of these are available at reasonable prices, and more are on their way. How far you go in incorporating grasses like Merion, Delta, Park, Newport and other bluegrasses and strains of the fine leaf fescues like Pennlawn, Illahee and others, depends on you alone. It would seem logical that a mixture of new strains, combined with old line standard types, will do a better job by:

a. Better year round color.
b. Better disease resistance.
c. Better rooting.
d. Thicker turf to crowd out weeds

2. What Changes Have Taken Place in Sod Management? Here, too, we have come a long way. Let's see what has changed.

a. Height of cut - After establishment of a sod field you've found a much better and versatile sod retained at cutting heights of $2\frac{1}{2}$ to 3 inches (root growth is directly proportional to top or leaf growth).

b. Weed Control - First step in this direction is learned when you see the advantages of taking one season before seeding a new sod field, leaving it fallow, but turned over several times in the spring and summer, each time another batch of weed growth is killed.

The ensuing sod from fall sown seed will be a tightly knit turf much more quickly by this method. Then, too,our constantly improving chemical aids now show promise of control of even some of our worst grassy enemies like crabgrass, goosegrass, Poa annua and even Muhlenbergia.

c. Insect Control - New chemicals here too leave little to be desired in keeping down insects which threaten turf, such as army worms, sodwebworms, etc.

d. Fungicides - In face of ever increasing numbers of fungus diseases, we have newer and ever-improving fungicides, to prevent severe leaf and plant loss.

e. Better Turf Feeding - Last, but not least, we have infinitely better fertilizers today. We have learned how to produce even feeding,and how to keep turf "well fed" and healthy.

3. What is needed in selling? All of the aforementioned "boons" to turf are important, but mean very little without promotion. It starts with consumer satisfaction by performance. Sod nurseries are selling a product from which you have removed the "do it yourself" portion. You must get to the consumer in some way to let him know what you have done to bring him

better turf. Perhaps you can take a page from some of the seed trade. Your markets vary just as in the seed business.

In closing, I would like to take a few minutes to discuss specialized turf and certain grasses. You all have, I am sure, your pet formulas for athletic fields, erosion control, terraces, air strips, lawn tennis courts, etc. A meeting of this type becomes your field laboratory, giving you a world of information to take home to constantly improve such formulas, but whatever you do - use the information!

I do want to mention one grass that I feel has become the "forgotten one" for highway use, namely Canada bluegrass. To me it is one of the most under-rated special purpose grasses today. It is, to be sure, not a true lawn turfgrass. I have seen it flourishing, however, under most adverse conditions. Last fall a certain university grounds superintendent called me to show me a stand of Canada bluegrass that he had not identified and wanted to know what it was. I found it doing a perfect job of statilization on a short stretch along a roadside cut. It needed no real maintenance as it grows little top leafage and was reseeding itself. I have seen Canada bluegrass along southern Indiana highway banks literally holding up tons of dirt from washout with its heavy root system.

What I have said is only intended to remind you of a few of the things that you can and must do to constantly promote your business and to take advantage of the constantly increasing supplementary market for other products like fertilizer, seeds for reseeding, weedkillers and fungicides. This market is yours for the effort.

Remember, when the grass is greener on the other side of the fence, someone may be taking care of it.

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KENTUCKY BLUEGRASS SEED PRODUCTION IN MINNESOTA

H. L. Thomas, Agronomy Dept., Univ. of Minn.,
St. Paul 1, Minn.

I should like to tell you about the Northern Minnesota Bluegrass Growers and about our experimental work with Kentucky bluegrass at the University. First, the University work.

In 1932 Arne Munzing at Svalof, Sweden showed that Kentucky bluegrass produced seed without gametic union, and that chromosome numbers differed among different strains, but that the progeny of a single plant were all alike in chromosome number. Later Nilsson, also at Svalof, showed that most Swedish Kentucky bluegrass was apomictic.

Fred W. Tinney, working at Wisconsin, published in 1940 a confirmation (with local collections) of the Svalof work, and also showed in greater detail how the apomixis proceeds. Reduction division is arrested before female gametes are produced and a cell in the muceleus develops a fertile

embryo, consisting entirely of mother tissue. However, fertilization with pollen is necessary for normal development of the endosperm.

The breeding work at Minnesota is based on these findings, and on published information on breeding experience at Wisconsin and Penn State. The thesis project of H. H. Kramer (now of the Purdue staff) made a valuable contribution during the early development stage of Minnesota work. Jens Clausen and co-workers at Stanford, California have uncovered information about the interaction of genotype and environment.

In 1937 bluegrass seed was collected from 60 different locations in Minnesota. These were broken down into individual plants, potted in the greenhouse and 281 vigorous ones used for an intensive selection program continuing over a number of years. Clonal material was grown in the field at St. Paul and Waseca. Based on recorded notes, the best lines were selected and seed was saved from them. In 1940 a check on apomixis was made by growing paired rows of clonal material and seed progeny. The evidence all pointed to the conclusion that the seed rows were just as uniform for all plant characters as the clones. This test was repeated in 1948 with similar results.

In 1943, the 50 best lines were seeded in broadcast plots 8' x 8' with four replications. These plots were studied intensively for total yield, summer yield, spring recovery, freedom from disease, vigor (especially seedling vigor) and desirability for lawns. Work by Hanson, Garber and Myers at Penn State had shown that a mixture of several apomictic lines were superior to any of the individuals in it. Accordingly the fifteen test lines were put together under the designation Minnesota 95. After three more years of testing at the central and branch experiment stations (as required of all recommended varieties of all crops in Minnesota) the mixture was named Park and released to the public.

We judge that Park is adapted to the northern half of the U.S. where rainfall is 20 inches or more and perhaps particularly well adapted to the upper Midwest.

On September 11, 1959 a variety test was planted at Rosemount, Minn. When rated Oct. 29 (at 7 weeks) for vigor of seedlings, the average rank was Park 1, Delta 2, Newport 3, Commercial 4, and Merion 5. Greenhouse tests showed the same seedling vigor ranks as field plots.

During the winter of 1960 the Department of Plant Pathology has collected some greenhouse data on relative disease response of these five varieties.

Response of Bluegrass Varieties to Stem Rust and Mildew Infection
Greenhouse Data 1960 Moore and Wilcoxson Minn. Exp. Sta.

Selection	Stem Ruse	Powdery Mildew
Park	moderately susceptible	moderately susceptible
Newport	" "	resistant
Delta	susceptible	resistant
Commercial	very susceptible	very susceptible
Merion	very susceptible	" "

Through the efforts of the Northern Minnesota Bluegrass Growers Association, the Legislature has given us a special appropriation for con-

tinuing and expanding our breeding and management studies. During the fall of 1959 about 2000 individual plants were collected over the state. These are being screened for disease resistance in the greenhouse. Results to date follow:

Disease notes in greenhouse to January 1960 of 1954 individual plants collected in the fall of 1959.

Disease Inoculated	No. of plants showing infection
Stem rust	373
Leaf rust	203
Mildew	294
Stem rust and leaf rust	109
Leaf rust and mildew	22
Stem rust and mildew	69
Stem rust, leaf rust and mildew	17
Leafspot	6
Clean	848
Total	1941

By March 1 the number of clean plants has been reduced to approximately 400. A collection of 1000 plants from the St. Paul campus is also being screened. Surviving plants will be grown in the field, increased apomicticly and selected for desirable turf characteristics.

An association of 150 farmers, located in the "rod and gun" country around Lake of the Woods on the Canadian border, comprise the Northern Minnesota Bluegrass Growers Association. It is a truly cooperative enterprise. These men have worked out their own improved techniques for seed production. Important points include: seeding rates of a pound or less per acre, harvesting with modern machinery, and liberal use of fertilizer and herbicides.

Mr. Charles Habstritt at Roseau has developed an excellent modern cleaning plant, with a method of removing lint from the seed. This plant can produce 500# per hour of heavy, bright, clean seed and is continually being improved. Production in 1959 was close to half a million pounds, and acreage has been expanded. Currently all seed is Certified.

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REMOVING PROBLEMS - BY REBUILDING

Dudley Smith, Supt., Silver Lake C. C.
Orland Park, Ill.

What possesses a man to completely destroy a putting green on Monday morning that several hundred golfers enjoyed using the day before? We did just that to three greens this past August. What led to this decision? The

small greens, only 3500 sq.ft. were outdated. The contour was saucer-shaped with very limited cupping area. Surface drainage was all in one direction - to the front. The soil was compacted to a near concrete state. Finally, the putting turf was composed 80% of a weed, Poa annua.

After reading Jim Holmes "Factors in Building a Green" in the Reporter, and Leon Howard's script from Purdue last year, we sent out soil and sand to Mr. Howard for his analysis and recommendation. For the actual construction we selected Ray Didier, whose experience and achievements speak for themselves.

The problems of starting are three: Devloping sod for the new area, establishing temporary greens, and ordering necessary supplies.

Raise Your Own Nursery

The putting green sod, Toronto C-15, was grown in a 25,000 sq.ft. nursery that had been stolonized the previous year. The area was first grommed in May when it was mowed, raked and fed with 10-6-4. The bent was aerified twice in June. Verti-cutting the cores served to topdress the area, and kick up stones that were near the surface. After topdressing, we were able to mow regularly at 5/16 in. During July and August the nursery received the same organic feeding, watering schedule, fungicide treatment, and 1/4 in.. mowing as the putting greens. Unquestionably it was the finest turf on the entire golf course.

Two acres of sod for the banks of the new greens were selected in the rough close to the construction site, but with a source of water available. The turf was a weed-free Kentucky bluegrass - fescue mix. The height of cut was dropped to 3/4 inc. and mowed weekly. We fed this area once, and kept it watered with sprinklers and hoses so that it would be easy to strip when needed.

Temporary Greens

Nothing arouses the golfers wrath faster than temporary greens. Unfortunately, we had to establish three of them. We shaved down the fairway about 125 ft. short of the green, overseeded with bent, aerified, topdressed with a mix that included Terralite. The temporaries were fed and watered regularly, and cut with greensmowers. A nice crop of crabgrass developed, but the complaints were few. To improve the appearance for Labor Day weekend, we colored the greens with Auragreen. We failed to treat for worms, and our mistake was realized in September when cleaning wormcasts became a daily morning chore. One additional thought, our temporaries averaged 2,000 sq.ft., but the design of each varied to try and distract the attention focused upon them.

Supplies

Order your supplies ahead of time. Once construction starts you don't want machinery sitting idle waiting for something to be delivered. Our three new greens required:

30 lengths of 1-1/2 in. pipe
8 Rainbird water valves
210 bags of coarse Terralite
600 ft. drainage tile
450 tons #2 Torpdeo sand (soil mixture)
95 " #1 " " (sand traps)
400 yds. Merion bluegrass sod (aprons)
200 lbs. " " seed
100 " Kentucky bluegrass seed

Construction

Actual construction started Monday, August 17. We stripped the Poa annua infested sod off and hauled it away. The sand was cleaned from existing traps and saved for future use. The water lines were drained, pipe removed from the greens, and the lines capped about 50 ft. from the greens. Didier started work Wednesday, August 19. A measured quantity of #2 Torpedo was then spread and disked in for hours until the mixture was homogeneous. This process was repeated with more topsoil and sand. Over 125 tons of san were incorporated into each green.

Two six inch cuts were made over the entire area and the topsoil-sand mix was stockpiled. The new greens were then shaped and contoured with surface drainage in three directions. New traps were dug close enough to the putting area to prevent tractors and fairway units from compacting the area between traps and green. New drain tile was installed in the green and run all the way to the creeks. All new water pipe was used under the greens. Two bank valves were installed to necessitate less hose for hand watering, and one sod cup valve in the greens center. A uniform layer of the topsoil mixture was then spread over the total area (banks, aprons and putting area.)

70 bags of Terralite were mixed in the surface layer. The total area was graded smooth with a light tractor pulling a Lindsey drag. Rolling the surface with a power roller finished up Didier's construction work.

The sodding operation began by outlining the putting perimeter with strips of lath and laying the Merion aprons. A group of ten high school boys was hired to work for two successive weekend. With one crew cutting, rolling and hauling, and the second unloading and laying, the aprons and banks were sodded in short order. During the week our regular men sodded the C-15 bent. By cutting the bent sod thin, and with three men carrying and three men laying, our new 7,000 sq.ft. greens were sodded in a half day each. The new sodded area was thoroughly watered. When dry enough the new greens were rolled with a power roller, in all about twenty times. We top-dressed the putting area twice with the same mixture used in the foundation. The first few mowings were at 5/16 in. and then later 1/4 in. Much to our delight no scalping occurred, and the cracks healed over quickly. The three new greens were opened to play October 15, a little more than six weeks after our rid Poa annua campaign started.

After refilling the new traps with #1 Torpedo sand, we reseeded the stripped rough area with a 2 - 1 mix of Merion and Kentucky bluegrass. The bent nursery was enlarged to 30,000 sq.ft., additional sand was worked in, and then the area was stolonized to C-15 bent for future reconstruction. Perhaps this week control program seems drastic, but when your greens are infested with Poa annua why not eradicate the contributing factors.

PROGRESS REPORT ON ROOTZONE RESEARCH

Robert Montgomery, Graduate Fellow, Purdue University
Lafayette, Ind.

For many years we have been searching for ways of improving the rootzone of plants. Because of intense use and necessary high moisture content, golf greens are continually compacted and subjected to conditions which tend to destroy soil structure. Last year at this time, we had a report by Leon Howard from Texas A & M who discussed his work regarding putting green mixtures. His work considered the various proportions of sand, soil and peat one may use for constructing putting greens. Today I would like to talk with you regarding the research we are doing concerning putting green construction.

Many of you who attended the Conference last spring remember the work that John West, a senior in Turf Management, was carrying on in the greenhouse. John's special problem consisted of studying various soil mixes for the use of putting greens. Also, he was adding air in varying amounts into the rootzones and observing the effects this had on the turf. It was my pleasure to take over the project when John graduated. I completed the work John had started and began a new trial, using the same mixes which consisted of:

1. Soil alone
2. One part soil, one part peat, and three parts sand
3. A sand and peat mix, and
4. Hi-dri 90%, peat 10%

Many observations were made during the course of the experiment. The pots were rated for vigor, color and density of tops, the density, color and average length of roots. Also, the longest roots were recorded and other plant responses noted.

Such soil physical determinations as large, small and total pore space; bulk density; drainage rate, and oxygen movement in the soil were also made. Evaporation rate from bare areas of mixes was observed outside during summer conditions. The results of these experiments were so encouraging that we decided to carry on extensive tests of this nature on our experimental putting green, where we could measure the effects of weather and wear under use.

The Hi-dri mentioned previously is a calcined aggregate of clay, or more commonly called calcined clay aggregates (hereafter noted as C.C.A.) We soon learned that there are some 25 companies which make products of this nature, their main use being industrial oil and water absorbents.

We contacted various companies which mine their raw clay from Illinois, Mississippi, Georgia and Florida. The research being conducted at the present time is being supported by these companies and by a National Science Foundation Grant. We have included in our test 66 plots. Of these we have three different experiments;

Experiment A.: Depth of mix - Plots are 3' by 13-1/3', or 40 sq. ft. surface area. There are three reps of each plot which consist of 85% Turface, a C.C.A., and 15% screened peat by volume. This mixture is placed

over the existing soil at 0, 1, 2, 4, 8, and 12 in. depths. The purpose of this experiment will be to observe optimum depth of mix, nutrient retention in rootzone, speed of drying, penetration of roots into soil layer, and the ability of mixes to move moisture by capillary action.

Experiment B is sources and hardness studies. In this group of plots we have 24 different soil mixes which have 20 sq.ft. of surface and are 8" deep. The C.C.A. used in this study were as follows: Turface, Oil Dri, Star Enterprises, including both calcined and dried, Hi-dri, Florex, and Sol-Speedi-Dri. These were mixed with sand, peat and soil, or used alone. Both Experiment A and B are drained by tile lines which are about 18" deep.

Experiment C - Leaching and moisture tests. Six entries replicated four times and containing 10 cu. ft. of soil mix are included in this experiment. Plywood was used for forming the individual plots, then later removed. These were lined with a .006 pastic. The individual pits were drained with a 1" plastic pipe which contained numerous 1/4" holes. The pipe was covered with a 4" layer of pea gravel and this in turn by 2" of #3 sand. This left room for 12" of experimental mix on top. The pipe to each container drains into a large service pit 12' x 4' x 4' in which are located large plastic collection pails -- one for each individual plot. There are two such pits for the 24 plots included in this test. These pits are covered with removable pieces of plywood. The leachate is then easily accessible for observation and analysis.

The entries in test C are as follows:

Ratio by Volume

1. Turface 4, peat 1, soil 1
2. Sol-Speedi-Dri 6, peat 1
3. Hi-dri, peat 1
4. Turface 6, peat 1
5. Golf course mix (sand 4, peat 1, soil 1)
6. Soil only

The experiment is well under way. All mixtures germinated seed well, except one which was slower. After germination, the soil showed nitrogen deficiency as soon as did the artificial mixes. Erosionet was very helpful in reducing moisture loss and in applying water. Mowing and putting use of the area will begin this spring.

At the present time freeze and thaw tests are under way. A sample of each of the various 26 mixes was frozen and then thawed for five cycles, and then divided into one-half. The remaining part will be frozen and thawed until twenty cycles are completed. Tests will be run on these samples to see what the effect of such adverse conditions is on the various mixtures.

The various soil mixtures will be subjected to compaction studies. Visual ratings of the turf will be made throughout the summer, and clippings will be collected. Oxygen movement in the soil will be studied in great detail, and root development will be closely observed.

In summary - we wish to find out:

1. Amount of available water each sample will retain.

2. How well will each mixture stand up under repeated freezing and thawing, and what effect this has on the water absorption and holding capacity of the mix?

3. What is the variation in oxygen movement in the different mixes?

4. Can a desirable putting surface be maintained, using F.C.A. as a base for the soil mixture, and if so, how superior is it to other procedures?

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HOW GRASS SEEDLINGS MAKE TURF

Stephen L. Frazier, Graduate Assistant, Purdue University,
Lafayette, Indiana

The purpose of this study was to investigate the stages in seedling development of four cool season turfgrass species. These species were: Alta tall fescue, creeping red fescue, Penncross bentgrass, and Merion bluegrass. The morphology of tops and roots changes rapidly during the early portion of a new plant's life, and a better understanding of these changes and factors causing them can be an aid in establishing turfgrass species.

This study was conducted in controlled climate chambers, and field plots:

Germination. The effects of constant and alternating temperatures on germination of the seed was studied in the controlled climate chambers. Tall fescue and creeping red fescue germinated adequately under constant temperatures, but Penncross and Merion needed alternating temperatures for adequate germination. Initial germination was accelerated by higher temperatures, but did not always influence the highest percentage of germination.

Growth: Seedlings were grown under eight and sixteen hour day lengths at 60°, 70°, 80°, and 90° F. Minimum, adequate, and optimum moisture levels were maintained for each treatment. At lower temperatures, height was increased during early stages by increasing temperature, or lengthening day length. Root development generally paralleled top growth, but root vigor was lessened by increasing temperature, or shortening the photoperiod. With the exception of Penncross, increasing moisture levels from adequate to optimum, increased height in young plants.

Spring and Fall Field Studies. Penncross, Merion and creeping red fescue were seeded alone at one-fourth, recommended and twice the recommended rates, so that the effect of competition on growth and developmental characteristics could be studied. Generally, as the seeding rates were increased, the total number of developed tillers decreased. The numbers of tillers per plant was greater in the fall plantings. Roots were more

vigorous in the fall than in the spring. However, no observable differences due to competition were noted within a climatic period.

The densities of fall mulched plots were greater than fall and spring unmulched plots. With the exception of creeping red fescue, the densities of fall unmulched plots were greater than unmulched spring planted plots.

Tall fescue study. Alta tall fescue was seeded at 4 lbs./1,000 on April 23, and 34 days after germination the stand was mowed in alternating strips at heights of 1, and 1-1/2 inches.

No new tillers formed after mowing treatments started. Nevertheless, where mowing is expected, early and repeated mowings are preferred at the higher mowing height so that large amounts of photosynthesizing leaf areas are not removed, otherwise the portion remaining on the stem could not supply the plant with enough photosynthate to overcome adversity.

Cutting treatments had an effect on the total root number after the second mowing treatment, and plants receiving the lower cut had a lesser number of roots in comparison to those receiving the higher cut.

Roots are good indicators of a seedling's general health and vigor, and they should be well developed before imposing any managerial practices on the new seedling stand.

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PRODUCT MERCHANDISING

Sod Nurseryman Group Discussion

Eugene Johanningsmeyer, H. F. Godwin Co., Detroit
served as Chairman

Men have ideas - some good - some bad - pertaining to turf. An article in a recent magazine contained a number of factors involving merchandising any product, whether it be sod, seed, or grapefruit. There are many ways to go about selling a product. Many methods of advertising. One fellow in the selling business in the Detroit area had a clever card. There are two pictures - the first one shows a tomcat strutting along; the second a litter of kittens with the reading, "if you want good results you have to make calls."

In this business you may have to make calls, or you may not. If something very important is involved, it is always much nicer to have the personal touch of a personal call. Often times this isn't possible for wholesalers. The final consumer of sod is, of course, the homeowner. In this type of market we don't usually go out and knock on doors. Sometime people who are actually laying sod will do this in a new subdivision where they have almost 100% potential customers. They can either leave literature stuffers in a mail box in a select area, or go out and call door to door.

The important thing in selling any product is to know the product,

have faith in it, and be able to answer questions about it. The customer, whether homeowner, or landscape nurseryman installing sod, expect accurate and truthful answers, so we in merchandising should be able to provide this. In merchandising we have several factors -

COMPETITION as a word used alone embraces each source of supply which is available in a given market, and this includes the five acres as well as several hundred acres. The ideal of perfect competition is that every seller's product must be completely different from that of every other seller. Also,each seller must be indifferent as to whom he sells, and every buyer must be equally indifferent to whomever's product he is buying. Further, no buyer or seller can add to or take from the supply a quantity sufficient to affect the market price. Everyone, buyers and sellers alike, must be able to enter this market freely.

In competition these are important:

1. The number and size of buyers and sellers.
2. The demand, consumer preference and consumer differences.
3. The total quantity of sod which moves through the market

Perhaps there is less competition than we really think, for by definition, as used in this article - to have competition you have to have comparable products, comparable supply and demand, and prices near the same. Within small areas we have that, but because of transportation the sod market varies more than a food business.

PRICE always is of interest. When two persons pay the same for delivered sod, one is located twenty miles from the source, the other person very near, the person farther away has a better deal. There are some instances where the price the buyer pays is reduced for some reason. This is not always best. Maybe they use over-age merchandise. That is possible in the sod business.

Generally people in business, possibly not as much in our business as others, do use modern cost accounting methods for information as a base for the target price. In addition they consider the anticipated action of other sellers, the state of demand and the individual's one need to sell his product.

ADVERTISING embraces brand advertising, use of coupons, radio, TV, newspaper, etc. The big problem, to anyone selling, is to determine the effectiveness of their dollars spent for advertising. For Detroit newspaper space costs $ 9.00 per column inch. Radio and TV are more expensive. How can you determine the return for the advertising dollar spent? If someone has an answer everyone would like to hear it, including others from business and industry. In advertising it is easy to make a mistake. You might get your ad in the wrong magazine, or wrong paper. Once a dollar is spent it is gone - no way to get it back unless it brings something back to you as business.

Our big purpose of the meeting is to exchange knowledge.

Remarks from Audience

H. H. Godwin. In regard to competition, there is quite a tendency, when you find the product isn't moving, to cut price, assuming you are being under-sold some place, because sod has not been moving. Maybe you are being

out-sold rather than undercut in price! Find out which before you try to correct it.

Ben Warren. Lots of time someone may feel another sod grower is big competition. Our big competition is not sodgrowers, but the seed market. Sod is just honest competition with seed. In the Chicago area there have been some 100,000 built, but less than 7,000 used sod. With an active market sodgrowers should try to get more of that total market. One thing we did in the Chicago area was to form a Sod Growers Association of Illinois. We are well started, but young. Our thinking in advertising is to design it towards making the public think of sod when they think of new lawns. Certainly this is our big potential in Chicago, and it will take working together to change the thinking of the public. Next year we will know more about its success. We are interested in sod and think they should use the best and finest.

Dwight Brown. I am on the other side of the fence - the seed side of it. We all tend to overlook the tremendous market potential. Just walk down any street early in April and look at the lawns! Just look at the need for good grass! So many are not taking advantage of reseeding or resodding. All turf interests need some way to get our part of that potential consumer dollar. We have not scratched the surface.

We all first look at competition as a matter of price. Look a little differently and analyze it for what it means. We often feel competition must establish our basis for selling, but it doesn't have to. This is one trouble of the seed industry and perhaps so with sod. We should be able to make up our own minds about price and selling points for our product. Nevertheless, we need to be reasonably competitive to sell, but there are other means to meet competition. Many are aware we have had surpluses of several grasses. Some are trying to promote brands for better selling identification.

John Vaughan. Basically competition is anyone who is getting dollars before we do, regardless of where spent. The main thing in advertising is not to divide or limit, but to increase the sod market. As pointed out, few do anything to develop their market potential. How can we get them to buy our product at any price?

John Eberle. Competition may be reduced by education and organization.

Eugene Johanningsmeier. Education is a fine thing; the potential customer certainly could use a lot more of it. This is a tremendous task and all resources need to help in this. Education in the business of creating demand and understanding. Perhaps another year someone could talk in our session on the different ideas and methods we could use to get more of these consumer dollars.

Wade Stith. In a small town in the West, about 40,000, they have the greatest interest I know about. Seed and sod people concentrated on school grounds and athletic fields to produce turf like they never had before. Everybody isn't buying, but they are talking about improving home lawns more because of public awareness.

Eugene Johanningsmeier. Sounds like a good idea. Possibly extra effort to see these areas are improved and have some public relations

people present it would help others. The potential consumers will have more awareness of fine turf and ways they could have it.

Mr. Kearney, Wisconsin. I am comparatively new in the sod handling. We talk about competition and you pick up Better Homes and where is consumer education? In any area a homes parade with a good job of landscaping and sodding will be more attractive to buyers and provide consumer education. From the standpoint of productiveness we are on the way.

Eugene Johanningsmeier. How can we cover a national need which we see, although we are primarily interested in selling locally or regionally? Anyone have any suggestion?

Dwight Brown. Our economy today has given us such a wonderful impetus-something that our own efforts have not much to do with - leisure. People today are almost insisting on living outdoors which gives us a program. You don't have to sell them an item - they want a good lawn, it is becoming a status situation, so feel it necessary to have a lawn equal to their neighbors. The potential is that market. If you have one lawn enthusiast in a suburban area, the stage is set for promotion. You may approach that promotion as an individual concern, or as a trade association.

Have any of the sod people thought of putting out a little pamphlet, or supplied a demonstrational area for a front lawn? How about a small pamphlet on the care of the sod, a bit of information on watering, and seeding so they could help us - the poor seedsmen a bit?

Ben Warren. We have information leaflets and like them. So does our competitor on the south side, Dale Habenicht. It made a tremendous difference in the Chicago area. Successful business has a definite percent of their gross income alloted to going after new business. The advertising people tell us to budget somewhere in the range of 5 to 10% gross sales toward increased sales promotion. Promoting the use of our product as a means of getting a beautiful lawn with 5% of gross sales would be terrific sums of money. When paying income tax you are not taking that much out of your pocket. Just money isn't going to do the job - add to that a lot of work. No matter how successful a business is today, everyone should be very conscious of what is going to happen tomorrow - it will be different from today.

Eugene Johanningsmeier. Just because DuPont made a few bucks a few years ago they were not satisfied with that - they went ahead and promoted. Some sodgrowers may have definite reservation about spending 5% even for a good thing. A few could not do it even if they wanted.

Bill Johnson. In the Detroit area everyone wants to do something, but don't do anything to start. I would back up the individual sod nursery promotion. You have to go out and sell your sod. If you have good stuff they will buy. If not, advertising won't sell it long! Often people advertise to move a poor product. Maybe it is the fact that people are not aware of the fact that there is good sod available. Some people purchase field sod, which is a cow pasture, but a poor buy for them.

R. Kelly, Portage Oil Co. Our part in turf is custom spraying, primarily with liquid fertilizer. Our basic problem was to advise a program. The golf course manager follows a definite program.

You talk about consumer education. In building good turf this is

quite a task because there are many varied ideas and it is confusing. The most difficult thing to do is to get people to comply. I know your package dealers have trouble getting them to read the labels. The basic task is to get information uniform. We have a section on homes and gardens. One Sunday you will read one article, the next Sunday another article. We had one about watering - it was general consensus deep watering not so often, then someone said light watering -- that was retracted. You jump too quickly. A consistent program should be a step.

Eugene Johanningsmeier. Education is always a problem. A lot of misinformation is given out. I think O. M. Scott should be commended on a wonderful job - in advertising and consumer education, although at times not in agreement with other people, who think they know something about a particular subject. They make booboos sometimes. Then the question - is misinformation better than no information from the standpoint of stimulating interest? Soon the consumer has to be on his toes to determine which is good information and which isn't.

John Eberle. Michigan State is starting a program in cooperation with the Michigan Association of nurseries, and the Michigan Nursery group is the only one that is recognized in the state. It goes back to co-operation within an organization.

Eugene Johanningsmeier. I am not sure but what cooperation would be a better word than organization. Any time that organization is mentioned, I think of a certain degree of regementation. This is what you have when you have a state chapter issuing requests to local groups throughout the state. State groups carry a lot of weight. A non-profit organization with education its primary motive, can get a lot of free and cheap advertising, plus a lot of good help and assistance, so this is another direction in which education can be approached.

John Anderson. A combined effort on homeowner education - "Live outside and love it" could be a manuscript on care and use, which could do a reasonably good job.

Eugene Johanningsmeier. We must end this discussion. We haven't heard from Mr. Ruthven, who is doing an excellent business in Toronto.

W. H. C. Ruthven. I think it might be a good idea to hold various horticultural meetings during the winter, to have a representative of various business interests. We tried newspaper advertising last year. Also, used radio on Saturday morning in connection with Garden Shows. We found it quite effective. Your idea of having someone represented - ideally you would like to have someone on repeated programs, possibly for 10 - 15 minutes, talking about the virtues of using sod. We would advertise fertilizer, etc., and developed tremendous interest.

Editor's note: (Considerable was not recorded, and abstracts of ideas were made wherever possible.)

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MICROCLIMATE AND TURF

James B. Beard, Graduate Fellow, Purdue University
Lafayette, Indiana

The summertime loss of bentgrass roots on putting greens greatly increases management problems. We are attempting to find the factors causing this.

In the fall of 1957 studies were initiated in the controlled climate chambers with temperature treatments of 60°, 70°, 80° and 90° F. Each temperature treatment had two types of top management, cut daily at 1/4 inch and uncut. Root observation boxes, sixteen inches deep with one sloping glass side, were used to observe and record the rate and characteristics of root growth.

The results showed that the rate of root growth was approximately the same in the temperature range from 60° to 80° F. However, under the 90° F. conditions the rate of root growth was sharply reduced. When the roots were harvested it was found that as temperature increased from 60° to 90° F. the total amount of roots decreased. These results were similar for both the cut and uncut treatments. Since the rate of root growth was approximately the same at 60°, 70°, and 80° F., but the total amount of roots was decreased as temperature increased; this suggests that higher temperatures increase the rate of maturation of bentgrass roots. It was also shown that cutting reduced both the rate and total amount of root growth in all cases.

Outside on the experimental putting green, temperatures were continuously measured three times an hour at heights of 1, 12 and 36 inches above ground, in the turf mat itself and at depths of 1/2, 1-1/2, 3, 6, 12 and 18 inches below ground. The greatest variation in temperature occurred at one inch above ground. Temperature fluctuations throughout the upper two inches of soil were practically the same and were diurnal in nature; following very closely the above ground temperature. At the eighteen inch depth the temperature variation was seasonal in nature.

Soil moisture was measured three times a day at depths of 1, 2, 4 and 6 inches below ground, using a portable wheatstone bridge. Results showed the soil moisture to be near field capacity throughout the summer period. Light intensity was measured in total units per day by a light integrator type apparatus.

Bentgrass roots were observed by means of three glass sided root observation boxes built in the putting green. Root color ratings were taken at depths of 5, 10 and 15 inches as percentages in each of four categories. In addition, root number counts were made on cores at depths of 2, 5, 10 and 15 inches. Top responses measured included total yield on a dry weight basis and the percentage composition of nitrogen, phosphorus and potassium in the leaves.

All the above data was collected in the summer of 1958 and entered on IBM punch cards. By use of electronic computing machines, nine single and multiple regression correlation analysis were made. This statistical analysis is used to determine the degrees to which each environmental factor and combination of factors influence root growth.

The results showed that temperature was the major environmental factor that could be used with the most consistency in accounting for the variation in root growth throughout the summer. Light was second in importance, but due to the type of measurement taken, it is not known whether this is a direct result of photosynthate production, or just another function of temperature. Soil moisture proved very low in its ability to predict root variation, since the soil moisture was held at or near field capacity throughout the summer.

Based on these findings, it was concluded that temperature was the major environmental factor influencing bentgrass root growth under good putting green management.

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WHERE ARE WE WITH GRASSES?

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The turfgrass seed industry is going through many interesting changes. The gradual shift from a seed shortage to a seed surplus era has been hastened by a sharp increase in foreign supplies. Major emphasis in the past has been placed on production problems. Currently more emphasis is being placed on quality and consumers are now in a position to demand better quality.

Seed grass mixtures for the retail trade have been composed of many components, thus giving a larger marketing area for an individual mixture. As more is learned about the adaptations of individual varieties, mixtures will probably become more simple. In fact, newer yet undeveloped varieties will be adapted to relatively small areas. This inevitable trend is being opposed by the larger turfgrass seed firms because it would complicate their marketing processes. However, a similar trend developed with the advent of hybrid corn. Hybrids are now bred for rather small areas and are probably handled by large firms. When improved varieties are developed, competition will force the firms to market a particular variety in only its best area of adaptation.

Eventually as more varieties become available, each of them will represent a relatively smaller share of the total market. This will necessitate closer regulation of production. Contract growing will probably be used for this purpose, and will also result in better quality seed because the firms will choose the most efficient grower. Similar transitions have occurred in the alfalfa seed industry and the situations are quite analogous.

Most of the above described situations are in the future, and their early signs are just appearing. In the meantime, seed consumers can be much more quality discerning both in germination and purity. Labels in most states list purity, germination, inert, other crop weeds and noxious weeds. Much of the individual data behind these listings is not included.

This information is available from the seed laboratory which made the test with the permission of the seller. Wholesale purchasers of seed should make better use of this information in selecting only the higher quality seed lots.

No attempt to outline the advantages and drawbacks of the individual varieties will be made here. Caution in accepting many of the newer varieties, until they have been tested in the consuming area, is expressed. Several new varieties are currently being promoted without complete testing.

The turfgrass situation is extremely complex and will probably become even more confused before some of the earlier described changes develop. In the meantime, use of better quality seed lots of accepted varieties handled by reputable firms is recommended.

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MACHINERY FOR WEED CONTROL

Norman R. Goetze

Attempts have been made to perfect equipment for the mechanical removal of weeds from turf. With the exception of the hoe and the grapefruit knife, most other innovations have not been totally effective.

The rotary horizontal mower has improved the overall appearance of poorer quality turf by mowing everything more uniformly. It does not decrease the content of weeds, but instead masks their presence by even cutting. On weed-free lawns, the rotary mower tends to shred the turfgrass leaves instead of making a clean-cut like the reel type.

Several types of vertical mowers are now available. They are based on the principle that most weedy species have prostrate growing leaves, stems, or stolons and that desirable grasses have an upright form of growth. Periodical vertical mowing removes much of the larger weed growth with only minor damage to the desirable turfgrasses. The number of weedy plants is never reduced, but the weed cover is temporarily reduced.

In spite ofmany errors being currently made in chemical pesticide research, new chemicals will continue to be developed. Many of these will be difficult to formulate and will need to be more carefully handled and applied than most of those currently in use because of more complex chemical structure, and because of less selectivity between weeds and desirable turf.

An ideal field sprayer should be composed of the following components:

Nozzles: Fan type nozzles usually give more uniform distribution than oval or cone types if properly adjusted. Some operators are now arranging them on the booms so that they overlap and the entire area is sprayed twice. Variations in individual nozzles caused by wear or partial clogging do not cause such a marked variation in total field application when over-

lapped in this manner. Spray materials should be applied in a vertical direction to avoid drift and to assure that all aerial portions of the plant are equally treated. Wettable powders and emulsion cause a certain amount of wear on nozzle tips and they should be replaced periodically. Some operators are using plastic instead of brass because they are more economical to replace and are not corroded by highly ionic spray solutions, or fertilizer materials. To avoid gradual nozzle clogging, remove the screens to allow wettable powder to pass freely through the tip. If the nozzle outlets from the boom arise from the top of the boom, less dirt and sediment settle in the tips.

Booms: When nozzles are set to overlap so that all areas are double covered, the booms can be set higher to permit easier travel over rough terrain. Booms can be more easier cleaned by having plugs or valves at the outer ends. If these are opened and full spray pressure is applied, most dirt and sediment can be easily removed. This is far more effective than draining the boom by removal of the nozzle outlets. Booms should be located on the front of the spray unit to give more maneuverability, and to allow easier and more frequent nozzle checking by the operator. A piece of plywood placed either in front of the radiator, or directly behind the boom on the traction unit will prevent radiator fan distortion of the spray pattern. Mirrors placed on the hood of the tractor will permit visual inspection of all nozzle units from the operator's seat. Booms should be so arranged that any or all can be operated in odd fields or terrain. Valves should be located on each boom supply line so that unused booms can be easily shut off.

Lines, Gauges and Valves: Plastic or rubber hoses are preferred over metal lines because of ease of application and breakages caused by vibration. These lines do wear out, but their over-all performance is better than metal. The line pressure gauge should be located adjacent to the speedometer so that a constant check of pressure and speed will insure a constant uniform rate of application. A fast acting line valve should be located near the pressure gauge to allow checking of pressure as spraying is started.

Pump: Both piston and gear type pumps perform equally well with spray solutions. Wettable powders and emulsions cause a faster rate of wear on both types of pumps. Recent improvements in plastic gear pumps have made them economical enough to be frequently replaced instead of costly repairs on permanent equipment. The main feature of any type of pump is that it deliver more than required at the highest rate of spraying to allow a constant pressure at all times. Secondly, the pump must be easy to clean to prevent damage to the pump and contamination when using different types of spray materials.

Agitation: Positive mechanical agitation is a necessity for wettable powders and most other types of spray formulations. Not all mechanical agitators do an acceptable job. The efficiency of agitation can be easily checked by noting any powders left in the corners of the empty tank. Simply moving the paddles on the shaft will often correct cases of poor agitation.

Tank: There is a vigorous controversy about the various types of materials used for tanks. Actually none of the present materials are completely resistant to damage if not properly cleaned. Consequently, the main criterion in tank design is ease of cleaning. If the tank can be cleaned

with little expenditure of time, it will more probably be thoroughly cleaned after each use and will give a much longer life.

Power Unit: Separate power units, or power from a live power take-off, work equally well as long as a constant pressure can be delivered at all desired rates of traction speed.

Auxiliary Equipment: Sprayers used on most turf operations should be equipped for higher pressure hand spraying. Provisions should be made for easy conversion of the by-pass to higher pressure. Many man hours are expended in coiling and storing hose lines. Automatic rewinding hose reels are inexpensive and save much labor.

Increased availability of dry formulations of pesticides has encouraged many newer models of dry type spreaders. They are all basically of two types, rotary and conventional types. The rotary types will effectively handle only the heavier formulations but avoid the disadvantages of skips and overlaps. The formulations based on lighter dry vermiculite types are not readily handled with rotary type because they cannot be easily and uniformly thrown sufficient distances.

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LANDSCAPE PRINCIPLES

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The objective of landscape planning is to develop the land involved for maximum use, health, and enjoyment. The objectives remain the same for a small home grounds, an industrial site, or a public area. In order to reach those objectives, each problem must be evaluated, analyzed, and finally planned according to the situation. Although the procedure of planning may be the same from one landscape design plan to another, the plans cannot be identical. Each plan is, figuratively speaking, a "custom built plan." This is true of small home grounds, small rural acreages, parks, school grounds, church grounds, or industrial grounds.

In the procedure of planning, there are principles that remain constant. There is opportunity for creative thinking and planning that will prevent monotony or "sameness" from place to place. This ability to create lies within the realm of fine art and should be encouraged among all who will discover the facts, apply the underlying principles of art, and use the best available information relative to the problem.

Before learning the basic art principles in landscape planning, a few facts must have become established which are the foundation of reasonably good analysis of the problem, and without which a design for living in the most functional, attractive, and sanitary surrounding will not be realized.

1. Evaluate and analyze the present conditions. Find the bad points about the place, and without sentiment, at least in this initial examination.

The exploring mind will cast off any pre-determined ideas in this initial stage of planning. The mind must be open for later rationalization so that component parts are purely incidental to the whole design.

2. A good plan must be based upon a thorough analysis of the situation. That is to say that before the selection of plants to use, a wide range of coordination is necessary. Methods and information relative to various kinds of engineering, work practices, architecture, soils, social life of the family and community, soil conservation, health and sanitation, ability to pay and labor relationship, and management. A good plan will coordinate all of these and possibly other factors with the basic art principles to determine plant masses. At this stage of planning, kinds of plants are not yet of any concern.

3. Acknowledge that making allowances for future developments is wise when it does not prevent the reasonable progress that you anticipate.

4. Every good landscape is a study in space composition. Even with a segment of the home grounds this is true, because the segment is to be a portion of the whole composition. Since this is true, a perception of the whole design, except for detail, is necessary.

5. Regardless of how much is done, it must be in good order. In other words, assuming all is done correctly in design, will you understand it and maintain it?

6. One must understand that landscape planning is an art and not a craft. Handicraft enters after the complete mental process of planning. Art is expressed in the creation of the plan, craft with the construction and completion.

The Application of Art

Landscape art is the result of continued growth and summarization of experiences, impressions of other work and of nature. Every individual has an inherent character and personality which is intangible and which will be expressed in the design. A good landscape plan is based on five sound and unchanging principles of art.

These five principles are accepted as basic to all good art and architecture: simplicity, scale relationship, balance, sequence or gradation and focalization of interest or climax. Applied in this plan they will establish unity and harmony. A few remarks about art principles may be helpful.

Unity - A sense of "oneness". Each component part in the plan has been controlled to harmonize with the other parts and together the composition is unified. Unity can be had by designing an orderly and related system of land-use areas within the plan, similarity in architectural treatment (style, mass and color), controlling the effects of lines as expressed in walks, drives, fences, plant masses in scale relationship to land areas and structural masses within the boundaries, and by harmony of form, texture, and color within the plant masses and other related plants.

The goal of the plan is harmony. This is achieved when the mental reaction to the five basic principles of art are in agreement. Beauty is complete unity of organization. Ugliness is lack of unit.

* The Basic Five Principles of Art

1. Simplicity - A few kinds of plants well combined are better than a collection of many kinds. The same is true of lines and forms.

2. Scale - The proportionate size of one part of a landscape to another and of each part to the whole must be stabilized to be harmonious. The attention should be directed to the scale relation that tree and shrub masses bear to one another, or to their surroundings. The length of line of masses on the ground and the length of shadows cast affect the scale relationship as well as the height and the breadth of mass.

3. Balance -

   Symmetrical balance - means regular balance as two identical forms on either side of a center line called the line of axis. This type of balance may look hard and unnatural. It is a characteristic of a formal landscape design. It denotes the man-made.

   Occult balance - Natural scenes are the result of unequal spacing and unequal masses. Occult, or unsymmetrical balance, is attained in a similar way on opposite sides of same axis or view.

4. Sequence or Gradation - The change and movement of the eye is the result of the placement of plants, or plant masses in a pre-determined succession with knowledge and experience so as to retain unity and harmony of the whole scene.

5. Focalization of interest or Climax - The gradual and easy movement of the eye leading up to a focal point to make a pleasant, stimulating and lasting impression on the mind is "focalization of interest." The focal point, or climax, may be different in accordance with the general plan. In one case it may be a bird bath, in another a statue. Other cases might call for a shelter house, a rose arbor, a pool, a pond, a group of trees, a single tree, or a sunset. There is much latitude.

In conclusion, it is important that one observe and analyze the landscapes he sees and familiarize himself with these design principles so that their consideration becomes automatic. Whether planning the layout for a new landscape, re-working a landscape area, or maintaining a landscaped area, any action taken should be based on these fundamental principles. For example, a maintenance man may not realize whether it makes any difference that a shrub mass is leggy and open, whereas it must be a full mass, faced down from tall to low plants in order to meet the requirements of artistic principles. Or, a plant may need to be held at a given height, breadth and density in contrast to another that should be pruned and fertilized in order to hasten the time it will fulfill it's requirements for greater height, shadow placement, or shade. There are too many other examples to mention here. However, as regards turf, these principles need to be understood in relation to turf quality. One can imagine a

*Planting Design by Florence B. Robinson, Whittlesey House, Garden Series.

case where the removal of a tree, or at least the manner of pruning for the sake of just growing better grass might destroy the effectiveness of design principles. There may be an opportunity for the use of ground covers other than grass that could contribute more to the effectiveness of landscape design than either of the above ideas.

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GOOD LANDSCAPING IS GOOD BUSINESS

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The maintenance of industrial and institutional grounds has become very important during recent years. Careless, inadequate maintenance invites loss of morale and efficiency of employees in industrial plants. Good maintenance means timely repairs, and cleanup, constant inspection, and a never-ending endeavor to maintain clean, neat and orderly outdoor surroundings.

Not only the pleasure-bent public, but also economy-minded industry is moving out into the countryside. Highways are lined with the lawns of handsome new buildings which might be mistaken for schools were it not for the neat signboards identifying them as factories, offices, or laboratories. Both owners and employees take pride in carefully landscaped grounds, which advertise the firm to passing motorists. For such companies good maintenance has become a necessity. The schools and hospitals they resemble are becoming even more conscious of the need for good maintenance, since they often make practical use of their attractive grounds.

Unfortunately, the cost of maintenance has increased along with its imprtance, and those responsible must exercise their ingenuity to stretch available dollars as far as possible. This means utilizing mechanical equipment, chemicals, and all sorts of labor-saving devices. For those responsible for public rather than company grounds, it also means formulating policies and standards that will demonstrate to the holders of the purse strings the need for adequate budgets.

For grounds which merely form a setting for a building or a group of buildings, the maintenance problems may be fairly simple, although probably not so simple as a layman or a member of the board of directors might picture them. For grounds intended for recreational use, however, the problem becomes more complex. Besides lawns, flowers and ornamental shrubbery, there are wide scenic drives, overlooks and forests, and such facilities as visitor's reception buildings, picnic areas, playgrounds, swimming pools, access roads, and parking areas -- with attendant traffic problems. Many large tracts require special planning for drainage and waste disposal because of watershed complications.

Maintenance and Design

Unless maintenance problems are carefully considered in the design of all these structures and grounds, those responsible for their upkeep will have difficulty both in planning for maintenance and in doing the actual work. Maintenance budgets are notoriously inadequate, and poor design can only make them more so. If possible a competent maintenance engineer or landscape architect should be retained as an advisory member of every design staff, to check maintenance provisions. Otherwise, arrangements should be made for the plans to be reviewed by field personnel, who should give them close scrutiny. This constructive criticism should help to iron out many maintenance problems before construction begins.

It is the landscape architect, however, who is responsible for creating the design. He should be interested in all the ground components of any particular project, and make careful studies to determine the kinds of plantings - trees, shrubbery, turf - that best suits each specific use. In addition to the maintenance of plantings and special facilities, there is erosion control, the control of insect pests and plant diseases, equipment maintenance and the never ending problem of budgeting available funds. In planning for maintenance it is first necessary to formulate: (A) objectives, (B) standards, and (C) a maintenance plan.

Maintenance Objectives

The general objectives of maintenance are to insure the clean and orderly appearance of grounds, structures and facilities, and to protect the health, safety and convenience of the people using them. Specific objectives, however, must be formulated to suit each situation. Type and intensity of use vary widely. Some areas require thorough and frequent cleaning, weeding, seeding, fertilizing spraying, or repair, while others less frequently used or partially left in their natural state can be maintained on a much less exacting schedule. Good judgment must be used in setting up both objectives and standards.

Maintenance Standards

For the purpose of establishing maintenance standards, most lands requiring maintenance can be classified into two major area:

Area 1 includes all grounds surrounding the major and auxiliary structures considered a part of the operating unit, and those areas in parks and other public lands defined or developed specifically for use by the general public, including picnic areas, observation points, entrance triangles from highways, and major access roads to the general developed area.

Area 2 includes meadow, pasture, farm and forest lands within public grounds property lines, and all other areas not covered under Area 1.

Planting and Care of Trees and Shrubs

Adequate preparation of the soil before planting trees and shrubs reduces future maintenance problems. Ample depth of topsoil should be provided for plant materials, and holes should be excavated and refilled for specimen trees. Generally the depth of topsoil required varies with the

species of plant, but a good rule to follow is to provide a maximum amount of good topsoil and organic matter for back-fill. Topsoil for individual trees, shrubs and evergreens will vary with the size of the plant and the size of the ball.

Competition for food, water and sunlight sometimes prevents satisfactory growth of cultivated plants. If the competition is from weeds, the remedy is usually mulching and tillage. Weed control requires much more attention in new plantings than in old ones, because in the top growth of newly set plants there is less foliage to discourage weeds.

Summary

Simple and specific as this subject of landscape maintenance sounds, it can be subdivided into several phases. For one thing, its objectives may be either esthetic - looking to the creation and perpetuation of lovely and artistic effects, or purely practical, looking to the health and growth of the plant materials, or the condition of the project as a whole in relation to its use and enjoyment. As with all complicated tasks that stretch over a long period, it is well to plan the year's work ahead and lay it out according to some sort of program or calendar.

Perhaps the chief necessity in planning any sort of maintenance program is to visualize the project as a whole, to realize the living nature of its plants and their needs, and to appreciate the value of getting the right thing done at the right time and in the right way. Considering particularly the lawn areas or the landscape plant materials, maintenance in general involves especially spraying, pruning, mulching, feeding, watering and cultivating. No attempt should be made to develop an extensive project until a careful estimate has been made of the probable cost of its future maintenance.

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