1970

TURF CONFERENCE PROCEEDINGS

Sponsored by the

MIDWEST REGIONAL TURF FOUNDATION

and

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PROCEEDINGS OF THE

1970

MIDWEST REGIONAL TURF CONFERENCE

(More)

The 46 talks included in these Proceedings are condensations of talks by speakers before sections and divisions of the 1970 M.R.T.F. Conference. We appreciated the willingness of the speakers to participate and prepare material for your reading. Proceedings of each annual Conference since 1948 have been prepared. A limited number of 1962, 1963, 1964, 1965 and 1966 Proceedings are available at $ 1.00 per copy. 1969 Proceedings are $ 2.00 each.

A copy of these Proceedings were mailed to:

The 680 attending the 1970 Midwest Turf Conference
One person of each member organization within the Midwest Regional Turf Foundation not represented at the Conference
List of those in educational activities.

Additional copies are available at $ 2.00 each from:

W. H. Daniel, Executive Secretary
Midwest Regional Turf Foundation
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Lafayette, Indiana 47907

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PRESIDENT'S REPORT

R. C. Meier, Jr., Pres., Turf Equipment Sales Co.
Cincinnati, Ohio

Welcome to the 33rd Annual Purdue Turf Conference, which is also the 25th Anniversary of the incorporation of the Midwest Regional Turf Foundation. Our organization has become one of the most widely known turf research centers in the country. I am proud to have had the privilege of serving as President of the M.R.T.F. this past year. My sincere thanks go to the Purdue staff, and to my fellow Board members for their work in planning and conducting this Conference.

This coming year will see us faced with some new challenges in Turf Management, such as government interest in sources of pollution. It may come about that you will have to get along with far fewer fungicides and pesticides to maintain your turf than you have had available in the past.

A usual, the problem of money, or rather the lack of it, will be an even greater factor in your daily operations. You must mechanize and automate your operations wherever possible in order to get the best return on your budget dollars. Your participation in these Turf Conferences shows your desire to learn how to do just that.

We have grown from 180 members in 1950 to about 350 in 1960, and now have nearly 370 members. Attendance at these Conferences has gone up from 340 in 1950 to 600 in 1960, and to 770 last year. These growth statistics show that we must be doing something right.

There is scarcely a golf course, cemetery, park, or even a front lawn in the seven states comprising our membership sources that has not benefited in some way from the work done by Dr. Bill Daniel and his staff here at Purdue.

This Conference marks Dr. Bill's twentieth anniversary as Executive Secretary of the Foundation. The success of our organization is due primarily to Dr. Bill's devotion to our trade, and the support of his staff shepherded by Kaye House.

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WOULD YOU HIRE YOURSELF?

A talk given by Rev. Dr. Joe Wick,
First Christian Church, Lafayette, Indiana

What is your estimate of yourself? Is it inferiority covered over by superiority acting?
What is your attitude about others? --- Do you whittle on others?
Do you feel you get the dirty deal? --- Do you have a built-in tolerance?
Do you have convictions?
Are you cooperative?
What is your attitude toward work?
What are you doing to improve yourself?
Do you have a sense of humor?
Do you laugh with others - not at others? ---- Can you laugh at yourself?
If so, then you should hire yourself!

A QUARTER CENTURY OF TURF SEED

William L. Jeffers, Oliger Seed Company,
Akron, Ohio

So much has occurred in the seed industry in recent months that I will devote more time to the present and future, and gloss over the past to give you a picture of the migration of seed production from the Kentucky and Midwest areas.

In my opinion, Kentucky bluegrass is a very high form of plant life. Let us consider a tiny bluegrass seed -- so tiny that it takes over two million to weigh one pound, yet it is so important that without grass and grass seed our civilization could not survive on this earth.

The definition that I like best for a seed appears on the stationery of the Oregon Seed Growers League -- "A seed is a small plant packaged for shipping." It is a dormant plant, has a built-in food supply, and a protective coat that enables it to retain its vitality for months or years. When this package is opened properly, by that I mean given favorable conditions for germination, it will be able to establish itself in a hostile world of frost, hail, rain, and even hard earth, and enough will survive to keep the earth well-dressed with a pleasing green garb. Let us,in respect for a seed, ponder a partial quote from E. L. Peterson -- "One of Nature's most tightly held secrets is confined within the cover of a viable seed. All the accumulated knowledge of mankind stands in wonderment before this mystery of life."

For the sake of brevity, let me start with a few figures from Kentucky production of bluegrass. In 1960 the production of clean seed in Kentucky was 10 million pounds estimate. A steady decline shows in the 1968's figure of 747 thousand pounds, and the 1969 crop was nearly half that figure. These same statistics follow us westward where conditions are more favorable.

Now, we look at the growers in the Northwest. The first commercial field of bluegrass was planted from seed stock procured from the Midwest by Mr. Ed Geary of Klamath Falls, Oregon, in the mid-30's. This resulted in a poor stand, and as a result was plowed under only to find some volunteer seedlings persist and establish into an excellent stand. This variety, known as Geary bluegrass, was planted in a field in Idaho in 1950 and is today, 20 years later, still in production.

In the mid-30's, the first trials of grass seed in the Spokane, Washington area were planted by a Mr. P. K. Jones, a high school agriculture teacher, as a school project. His tests indicated a promising future in this area for grass seed production. Thus, beginning in the 40's, and a trend by '44, the hub of seed production began moving westward.

Several factors were responsible for this movement, namely:

1. Low humidity and low rainfall during the growing season resulted in dry, plump, viable seed, and leeway in harvest operations.
2. Wind, rain, and hailstorms during the harvest season are almost non-existent, guaranteeing the farmer a better chance of a seed harvest with higher yields.
3. An ample water supply for irrigation was available in some areas where rainfall was limited.
4. The soil types in the Pacific Northwest seemed ideal to grow healthy plants capable of producing large quantities of high quality seeds.

In addition, by modernization of production techniques and intensive farming of acreage, the farmer was able to increase his revenue by growing green beans,

under contract for a large packer, on acreage that would remain in summer fallow in order to kill previous grass variety volunteers. Because of the newness of the turfgrass industry in the Northwest, many new and improvised methods of harvesting and cleaning were developed.

Now, we come to the future outlook, not only in the Pacific Northwest, but to our North American continent. There is a serious problem besetting the seed producing industry. For many years it has been a cultural practice to burn the field stubble after harvest in August through September. This is necessary to stimulate seehead production by the grass plant and a subsequent seed yield. Furthermore, it removes loose straw, controls disease, insects, rodents and weeds while returning minerals to the soil. Although the smoke is non-toxic, it is visible and creates a cloudy condition if the winds aloft do not move it up and away.

We are all aware of the anti-pollution kick that prevails in the land today. Recently in Ohio a bill was introduced that would ban the use of any material toxic to man or other animals. This might include common table salt. If you recall several years ago in Rochester, N. Y., a certain hospital, by accident, used table salt in place of sugar in baby formula, resulting in the death of several infants. The adoption of a bill like this would cause the loss of one-fourth billion dollars per year to agriculture just in Ohio.

In Cleveland, Ohio, last week a contractor was fined $ 50.00 under a newly enacted city ordinance that prohibits a bonfire. In this instance his men were razing a building and burned some of the lumber to keep warm. The judge, in his remarks, said he had no other course. Under the present wording of the ordinance it could mean the end of Campfire Girls and Boy Scouts within the city limits.

To point out the results of curtailing burning, here are some figures for 1968 in Oregon. Due to the rains that came in the summer, starting in mid-August and almost without relief through September, very little acreage was burned, with the result that 40% of the perennial ryegrass was not harvested, and bentgrasses of all kinds and varieties were left in the fields. For example, yields of Astoria bentgrass seed available in the hands of growers for the market this year is completely exhausted. From a yield of 350 lbs. to 400 lbs. to the acre, the average was closer to 75 to 100 lbs.

Who is going to pay the load of this increase in cost? - The consumer, of course. The State of Oregon, Department of Environmental Quality, has set a goal of no open burning of any kind by 1972. This is serious to the welfare of the growers. One of my suppliers in Oregon has been leading an industry group trying to reach some compromise with the control officials, and he told me recently that it has taken five years off his life. At any rate, prepare your customers for higher prices and perhaps lower quality. Seed yields could drop by one-fourth to one-half, and the newer dense turf varieties, such as Fylking 0217, Pennstar, Merion, Windsor and others, will be more affected than the more open common types.

Another problem involving successful production of grass seed relates to the use of insecticides, herbicides, and fertilizers. Despite present public clamor, DDT has been an effective and useful tool in the control of sod webworms and wire worms in seed fields.

There has also been much progress made in the field of seed testing. The analysts are able to do a much better job in looking at seed for harmful weed and crop seeds that would be harmful in special purpose turf.

Much needs to be done in updating the certification of Kentucky bluegrass varieties. Poa annua is not, at the present, on the list of weed seeds to be noted in an examination of seed for certification, nor is the presence of bentgrass

called to the attention of the buyer. It is included in the crop content on the tag.

Indiana is now going to enforce Section 4(a) and (h) of their seed law. This requires the commonly accepted name of each kind and variety of agricultural seed to be stated on the label. So, more and more is being done to protect the consumer. We have moved from 200 pound yields in the Midwest production area, and can point to yields of 400 pounds to 1800 pounds per acre in the Northwest. We have the production potential for new varieties and their frequency will increase.

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MODERN FERTILIZERS, MANUFACTURE AND DISTRIBUTION

D. B. Pfleiderer, Agrico Chemical Company,
Memphis, Tennessee

Within a discussion of Modern Fertilizers, Manufacture and Distribution there is so much to tell, so much new technology, and so many new things.

Our industry is changing; new and better products are being made. We're entering a new decade -- it's an excellent time to summarize the happenings of the past ten years, and it's time to look forward to the next decade. As we discuss this topic of modern fertilizers, I hope you will get a better insight or appreciation of the objectives of a fertilizer company, and how we can work more closely to accomplish a common goal -- to use fertilizers to produce the finest turf possible. Research and industry must "team up" to find common solutions to turf problems.

Technology is the key to the growth of any industry, and it's no different in the turf industry. One of the keys of technology for growing turf is fertilizer. Today you just don't buy a bag of fertilizer - you buy a "package of plant food technology." This costs money, and the plant food industry is no different than any other industry -- there must be a pay-off! In this case, it's a "pay-off" to the grass, and to the people that manufacture, distribute and use the product.

First, let's take a look at the "pay-off" to grass. Before a new product is born, we must determine the needs of growing grass! Each grass specie has different nutrient requirements. How the grass is managed also affects nutritional levels, and today these needs may go beyond nitrogen, phosphate and potash.

Soil Testing

With today's modern tools we have little difficulty in determing the needs of grass. The most useful tool is soil testing. This test tells us the nutrients in the soil that are available for grass growth. Today you should put emphasis on this method of determining what turf areas really need.

Plant Analysis

By means of spectrographic analysis, we can determine the amount of nutrients found in the clippings from the growing plant. Plant analysis is particularly useful in determining the need for secondary and micro-nutrients. Where a severe shortage of a secondary or micro-nutrient occurs, nitrogen, phosphorus and potash cannot be effective. With plant analysis information, fertilizers can be formulated in a manner

to add certain elements that may be short in a particular area.

These two tests are vital in determing whether a new product meets the needs of growing grass. From this information, agronomic specifications for a new product can be written.

Trends in Nutrient Needs of Grass

Grass growing under differing conditions have specific needs. We can see some general trends taking place today. The most common trend is toward high nitrogen, low phosphorus, and medium potash fertilizer. This situation is occurring mainly in areas that have received heavy applications of fertilizer in the past. Generally grass clippings are removed. Fertilizer having the analysis of 12-4-8, 16-5-11, and 16-4-12 are common.

There is a trend toward high analysis products. Due to technology, higher labor and shipping costs fertilizers today have the analysis of 20-5-10, 30-5-10, and 24-4-12. For starting, 2:1:1 ratios are often used.

A recent trend is toward the use of phosphorus-free fertilizers. In large turf areas, such as golf courses, the arsenics are becoming popular for use in control of Poa annua. High phosphorus levels tend to counteract the effectiveness of the arsenic. A very common fertilizer used in this situation is one having an analysis of 20-0-10.

Prices vary considerably. How does one determine which product to recommend? Actually it is very simple if we use the Good, Better, Best philosophy based on quality.

When making a fertilizer that falls into the best range, we are placing emphasis on the needs of turf with soil and plant analysis as a guide. For example, a product that is high in nitrogen, low in phosphorus and medium in potash. Nitrogen should be of a slow-release and non-burning type, even though it costs four times as much as water-soluble nitrogen. Because of possible high pH and high salt concentration in greens, we must stay away from the chloride ion which means using sulfate of potash. Since high nitrogen upsets the nitrogen/sulfur ratio, sulfur is needed for good results. Because of the high pH, the iron in soils may be unavailable. Using information in this manner means development of the most advanced fertilizers possible.

Fertilizer products classified in the better range means equal importance is placed on needs of grass and price. This would be a good, general-purpose product for a turf area to be fertilized once a year, and where grass clippings are not removed. Such a fertilizer would contain only small amounts of water insoluble nitrogen.

A fertilizer product that is classified as good, generally considers price with little consideration given to turf quality. It would be an all-mineral product, and composed of low-cost sources of nutrients.

Manufacturing Fertilizers

The fertilizer industry is no longer a "scavenger industry." Most introgen comes from large plants (1000 tons a day) where ammonia is synthesized from the nitrogen in the air. Both phosphorus and potash come from mines (as rock phosphate and potash salts) in the various parts of the world. Five common methods of making N-P-K fertilizers are: (a) chemical mixed, (b) nitric phosphates, (c) blending, (d) fluid fertilizers, and (e) dry mixed fertilizers. Depending on the situation, . .

any one method of making fertilizers may offer advantages over the others.

What New Products or Practices Can Be Seen in the Future?

More emphasis will be placed on water-soluble fertilizers, which may be applied in combination with various pesticides and herbicides. This can save labor and sometimes the products compliment the effectiveness of each. This practice will become more widely used where early winter fertilization becomes an accepted practice.

Two criterias important in turf fertilizers are non-burning and slow-release. The most popular non-burning and slow-release nitrogen today is urea formaldehyde combinations. It's also costly. Coating and mixing of plastics, waxes, sulfurs, and asphalts with nitrogen products, to mention only a few, are under various phases of development today. The person that finds a lower cost and more effective slow-release and non-turning nitrogen will be a hero to the turf industry.

Another trend is combination fertilizer and dry pesticide products containing two or more pest control products. Much caution needs to be exercised in this area! Make sure the combination products you buy are from a company that has extensive research to "back-up" the performance of their products.

Look for big things from growth regulators. New products that limit or regulates the growth of grass will soon begin to move into the marketplace. Undoubtedly this will bring change to fertilizers and feeding programs.

Many other areas must be investigated before a product becomes a reality. Some questions that readily come to mind are:

a. Does it meet state regulations?
b. What should be the density of the product?
c. What should be the package size?
d. What price must be charged for this product?

Distribution

In fertilizer application the greatest innovation has been the spinner spreaders. They reduce labor, eliminate "skipped areas," and are easier to use.

Another new practice that bears watching is late fall or early-winter fertilization. Research shows that this timing favors root development during the months when plants appear to be semi-dormant. Also watch the practice of using fertilizers, particularly urea as a de-icer.

If a new product shows "pay-off" potentials to both the grass and the people who make, distribute and use it, "a product is born." The product must be promoted, and if we have done our "homework" the product should receive "customer acceptance." A high degree of customer acceptance means we have completed the developmental cycle that arose from customer need. A bag of fertilizer is truly a "Package of Technology" for user satisfaction and result!

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MODERNIZING MAPLE BLUFF

William Eckert, Supt., Maple Bluff Country Club,
Madison, Wisconsin

In February, 1968, our Club signed a contract with an Architect-contractor to remodel our golf course. Plans called for the construction of 6 greens, 9 tees, 2 fairways, and 2 small lakes. The changes were made to give us larger tees, improve some obsolete greens, and make better use of the relatively small amount of land we had available, plus much needed water hazards.

The plan consisted of a line drawing of the golf course in which the location of the changes was shown, and a seventeen page contract, containing four pages of technical specifications. The contract was rather loosely worded and gave a great deal of flexibility to the Architect-contractor.

The Architect-contractor arrived in early April to purchase materials for the green and tee mix. He got samples of sand from various local sources, and analyzed them using the "eyeball" technique. The sand he chose for the mix was graded, with particle sizes ranging all the way from very fine sand to include 11% fine gravel.

The soil used in the mix was chosen by the same method. It was a sandy loam with a rather high percentage of silt. Most of the sand in the soil fell into the fine sand category. The peat used in the mix was a good, fibrous material purchased in bulk from an Indiana firm.

The sand, soil and peat were pre-mixed with a large front-end loader in a ratio of five parts sand, five parts soil, and two parts peat. Following pre-mixing, the material was run through a large Royer Shredder for final mixing. The resulting mix had a textural classification of loamy sand. This grading greatly increases the compactability of the soil, while decreasing the porosity and permeability. The very fine gravel is hard on equipment, increases traffic injury to the turf, and makes it extremely difficult to set cups.

While the green mix was being made, work had started on the golf course. Since the golf course was to be kept open and playable during the entire construction program, work started first in areas that were out of play. Two small lakes, with a combined area of one acre, were dug, and the resulting fill was used to build subgrades for the greens and tees. The lakes, when completed, were sealed with Bentonite, which was incorporated into the upper layer of soil.

The old course was left intact until after July 4. At that time temporary greens, which had previously been cut in the fairways, were put into use. Then, several old greens and tees were removed, a large hill was lowered, and the rough grading of all the new greens and tees was finished.

Our greens average a little less than 6000 sq.ft. in size. They were built with 12" of mix placed directly over 4" of 3/4" washed stone. Tile lines were laid under the stone to carry off excess water. The irrigation system for the greens consists of 4 or 5 rotary pop-up sprinklers on the perimeter of the green controlled by a manual valve.

Tees are raised above the surrounding area, level from right to left, and sloped from front to rear. They are topsoiled with green mix to a depth of 6".

All construction was finished by September 1, and the course was seeded at this time. Greens and tees were seeded with 1 lb./1,000 sq.ft. of Penncross bentgrass. Banks and fairways were seeded with 1 lb./1,000 sq.ft. of a mixture con-

taining 40% Seaside, 40% Astoria, and 20% Highland bentgrass. Seeding was done using a rotary spreader. Ey the end of the growing season all of the newly seeded areas had been mowed several times.

During the winter trap sand was brought in by truck and dumped in the new sand traps. In early spring the new traps were edged, and the sand was spread evenly to a depth of 4".

Since the Architect-contractor had promised the membership that they would be playing on the new golf course by Memorial Day of the year following construction, we were more or less stuck with this as an opening date. By this time the new greens were growing well, but they were not really ready for traffic. We topdressed the new greens five times prior to the Memorial Day opening date to insure that the putting surfaces would level and smooth.

The course was opened for play on Memorial Day, 1969. A few problems became immediately apparent. The very fine gravel in the mix seemed to magnify the effects of traffic, and wear was a problem in some areas. The mix compacted readily, and the infiltration rate was very low. This compaction was so much of a problem that this spring we are planning on aerating the greens, removing the plugs, and filling the aerification holes with calcined clay in an effort to reduce compaction, and increase the infiltration rate.

Shortly after opening the new part of the golf course, our crew installed nearly a half mile of golf cart paths. These paths were 8 ft. wide, and consisted of 2" of hot-mix asphalt laid down with a paving machine over a 4" gravel base.

I am sure that if we could repeat our modernization program we would make some changes. However, overall, our members are quite happy with their new golf course. They are already beginning to plan future changes in the golf course. While these will not be as extensive as the changes that have just been completed, still they are part of a continuing effort to modernize Maple Bluff.

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REVISING KENWOOD COUNTRY CLUB

Marion Mendenhall, Supt., Cincinnati, Ohio

If the federal highway system in your area is not complete, you may find your club doing some new construction, for those planners seem to be looking for open spaces to concrete. About 25% of the golf courses in our area are being affected by highway work.

In the Cincinnati area, I-71 crossed Swain Fields and both 18's at Kenwood. Cross Country destroyed the third nine at Swain Fields. Circle Freeway crossed Tanager Woods, and will cross Twin Oaks. The Appalachian Highway as now planned will cross Bon Aire, Indian Valley, and Terrace Park; Maketewah and Summit Hills will be bisected by new city connections. With this in mind I would like to relate our experience.

We found the Ohio Highway Department to be fair as long as we could prove all costs. Our Club income fell considerably when the holes were reduced to 27, . .

but being a non-profit Club we could not collect for loss of business and inconvenience at the time of reconstruction.

When the first rumors of a highway being routed across your course are heard is the time to get organized. By being in on the first planning, you may influence the highway engineers and save some special feature of your course.

A real estate appraiser should be hired at once, should be in charge of all state contacts and stay with the project to the end. It is too much to expect Club officials to give all the time necessary and, in general, they will be out of office before final negotiations are complete. From the time of our first meeting until payment was made, 6-1/2 years had passed. During this period we had 3 Club Presidents and 2 Grounds Chairman.

At this time a good architect should be hired and his plans ready long before any negotiation starts. The Superintendent can be a great asset to his Club by working closely with the architect and the real estate appraiser. There are many items that are not golf course construction which may be affected indirectly by the highway, such as rerouting the electric and telephone, sewer, water lines, road repair and fencing, etc.

One of the problems we had was re-routing the power to the equipment shed. The rule of thumb is the state must replace with like kind - no better, no worse. Our electric power and telephone service was overhead and entered our property from the rear, an area in the path of the expressway. The new service was to come from the clubhouse, and since all our other services were underground, we insisted that the service to the equipment shed also be underground. We found the clubhouse did not have enough power to service this addition, so in the end all new underground power lines and transformers were installed. These additional costs were approved by the state because we had proof of cost.

Our Club drive, like most of yours, did not have a heavy base needed to hold up under heavy equipment, especially trucks hauling fill. When these facts were brought out money for necessary repairs was allowed.

Abutting Club property on the south was over 50 acres which was so hilly that home builders could not afford to put in streets and sewers. This being the only property available, the Club purchased it.

That fine gentleman and our good friend, Bill Diddel, who had designed our original 36 holes, agreed to try and design a playable course. Over a two-year period he spent many days walking these hills, and did a fine job planning the new holes on this nearly impossible terrain.

Several golf course contractors were sent plans of the proposed changes, and we had a number of bids submitted, but because of the federal government's on-again, off-again attitude we could not give a golf course contractor a starting date. After a couple of years of this we decided to borrow money and start clearing ground. Now we found the contractors we wanted were committed to other jobs. The Club officials decided that the Club would be the general contractor.

Now our job was to keep 36 holes in play until August at which time we would reduce to 27 holes and start changing these 9 holes being played. Construction of 9 new greens, 14 fairways, 14 tees, and putting in automatic water system on the new holes was started. Now, this could have been a very satisfying experience, but turned into a real nightmare because of rock and weather.

As general contractors we hired all equipment by the hour, and usually had 5 dozers or pans working and trenching equipment. Our crew installed all electric, water, and tile lines, completed final grading, seeding and stolonizing greens. Straw blowing was by contract. Because the area was so rocky, steep and short hauls, we used crawler tractors pulling pans a good deal of the time. Of course, most of the time we couldn't use rubber-tired pans on the steep terrain.

Rock proved to be our greatest problem in installing the water lines. A Bontam back hoe proved to be too light for the rock layers. Some dynamiting was necessary. Where the rock was not too bad a Cleveland trencher was used, but it was necessary to get a Link Belt with a 30-inch bucket to pull the bigger rock. The way we installed the water lines in these areas was the Link Belt would stack all the rock on one side of the ditch, we would bed the water pipe in with 6" of fill below and 12 above. The pan would deposit soil on the opposite side of the ditch, then a D4 would push this soil over the pipe fill; then all the rock and rubble was trucked away and used as fill. As you can imagine, this was very expensive construction.

By August 15 we had 3 fairways seeded and strawed. By the time the grass was up an inch we had a cloudburst and everything was washed away. Then in September we had two more washing rains. The soil washed off the fairways and across a road about a half mile away and was so deep the county highway crew had to clean it off with a grader and fire hose. These first fairways were seeded six times that fall. Of course, this was an unusually bad year for new construction. In spite of all the trouble we had our costs were about $40,000 under contractor's bids. Overhead that contractors would have, such as office taxes, superintendent's time, etc., were not included.

This fall we completed the automatic system on the last 15 holes. Our costs were $ 30,000 under contractors estimates. Of course, we had our own trencher and back hoe, working conditions and weather were perfect, and again no overhead costs were charged. An added benefit of doing our own installation was we laid 110 volt lines in the trenches, and now have 12 electric water coolers over the course.

Because some of the new holes were so steep and the turf new, the Club officials decided to have blacktop cart paths completely around one course. These have proven very beneficial to our golfers in the spring when it is wet. We can and do let golfers play this course nearly all year. An additional benefit is that we can get our small equipment out when the ground is wet.

A new prefab equipment building is one of our most important improvements. It is a 70' x 120' clear span metal building with 24 ft. overhead doors at each end so that we can drive our 9-gang mowers through. We feel we get more use out of a building with no inside walls so the only partition is a modern locker room and air-conditioned office in one corner. In the repair shop corner we have an overhead furnace and fire-proof canvas walls which can be rolled up and down. In this type of building roof insulation is a must to stip condensation.

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SPEEDY GOLF

Robert A. Buck, National Golf Foundation,
Chicago, Illinois

Growth of Golfers

The latest study by the NGF for the United States indicates that there are 9.5 million golfers who play 15 rounds or more per year, and an additional 2.1 million who play less than 15 rounds. The increase in the last ten years has been 130%, with more than 5 million taking up the game in the over 15 round category. Where do these golfers play? About 15% play at private clubs, 40% at daily fee courses, and 45% at municipal courses. Of the total players, 67% are men, 25% are women, and 11% are juniors. Public course players now outnumber private club players more than 5 to 1, and we have 85% of the golfers playing on 55% of the total courses.

Golf Facility Growth

A study of NGF golf facility statistics during the last ten years reveals that overall growth of all types was 66%, or an increase of 3935, to bring the 1969 total to 9926. Semi-private or daily fee courses have more than doubled with an increase of 107% to 4192. Municipal courses have increased 46% to 1275, and private clubs 44% to 4459, respectively.

Growth in Next 20 Years

"Bill Pack, Executive Director of NGF, predicts that the number of golfers will triple to 36 million. Half will be women, up from the present 22%. The sport will be so popular that high schools will have physical education classes in golf as a matter of routine. New courses will be developed in all types of residential and resort complexes, with the boom in the public and semi-private areas. The cost of operating private courses will go out of sight."

Slow Play

With the terrific increase in the popularity of the game has come the problem of slow play. Weekend golf in major population areas has been crippled by $5\frac{1}{2}$ to 6 hour rounds of creeping paralysis. This condition has caused many players to give up the game and has discouraged others from starting. There have been many reasons cited for the problem, such as more players, longer courses, blind holes, rules and TV tournaments.

The Foundation believes the major cause is the failure of golfers to learn the rules and customs of proper play. Golf pros and instructors have concentrated on the swing and the mechanics of the game and failed to impress on beginners proper conduct on the links. Golf course operators and directors of clubs have failed to impress and enforce the rules and customs upon their players and members. The cure is a concentrated effort to educate and enforce speedy play. This is the responsibility of management. The benefits will be a more enjoyable game for the majority of golfers. Private clubs will be able to increase their memberships and spread the burden of increasing costs of operation. Public course operators will realize increased revenues, and more golfers will be able to play regularly.

Speedy Play Program

In 1968 the Foundation, in an effort to assist management of courses, estab-

lished the Speedy Play Program. It included a poster program revolving around a rabbit who pointed out etiquette and hints to speed play. More than 300,00 posters and publications were mailed to over 9600 courses and clubs. More than 2000 courses replied that the program was well received and the posters were used. In 1969, a compact booklet including 22 posters about 8 x 10 was mailed to every golf facility in the country. To date the Foundation has expended more than $ 60,000 to encourage faster play. For the future, the Foundation has in the mill a film on golf rules and etiquette that will emphasize faster play.

As a part of the program, a speedy system of reservations and starting times was provided. It was based on the fact that any foursome can play 18 holes in 4 hours or less. It used 18 tee-off times on each nine, with 7-minute intervals, and one open time each two hours. After 2 hrs. 6 min. 144 golfers had teed off, and the course was closed until 4:22 while all golfers completed their rounds. Within this each foursome has a reservation for their second nine, and thus an incentive to make it on time. Using this system and two complete cycles, 288 golfers could play a round by 8:44. A total of 432 golfers could play if three cycles were used (within 13 hours). This system was put into effect by 173 courses and did speed play with favorable comments by 90% of the golfers.

In summary, there is a slow play problem. The cure is up to each golfer in learning to play correctly. Management must educate the golfer and enforce the rules and methods that speed play. "Speedy" will help - put him to work on your course!

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PURDUE'S LANDSCAPE TRAINING PROGRAM

F. O. Lanphear, Dept. of Horticulture,
Purdue University, Lafayette, Indiana.

With the increasing emphasis on environmental quality, it is appropriate to consider changes that are occuring towards meeting these demands. Six years ago in 1964 the Department of Horticulture at Purdue University initiated a new program in Landscape Architecture.

Initially there was one full-time teacher of landscape architecture, plus supporting staff, to serve the 15 students enrolled in this program. In 1967 a second teacher was added, and in 1969 a total of three full-time teachers were involved. Student enrollment grew from 15 in 1964 to over 70 in 1969. Since the program started, over 20 students have graduated and taken excellent jobs with various landscape architecture firms and government agencies. At least two have jobs with golf course architects. Beginning salaries average $8500, with some starting as high as $10,000.

Landscape architecture is concerned with the planning of land for the maximum use and enjoyment of people. The scope is greater than most people realize. It includes regional land-use planning, highway and parkway design, planning of parks and recreation areas, institutions, housing developments, residences, commercial and industrial sites, golf courses, and other areas.

Because of the broad scope of the profession the training is comprehensive and intensive. In addition to many courses in landscape architecture and art,

considerable training is provided in plant materials, ecology, soils, geology, grading and drainage, landscape construction, as well as background in the social sciences. The types of problems students do in the classroom begin with a residential design problem in the sophomore year, and become larger and more complex in the junior and senior years. This semester the seniors are doing a regional land-use study of Tippecanoe County.

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THE LANDSCAPE CAN REDUCE POLLUTION

F. O. Lanphear, Purdue University

We are all conscious of the importance of good landscape planning in creating a more attractive environment. Yet, have you considered the role of the landscape in reducing various forms of pollution and other environmental stresses?

The role of plants in modifying the microclimate is recognized by many. The use of trees for windbreaks and in providing shade has been practiced for many years, To what extent can vegetation in the larger landscape be used to reduce human stresses caused by pollution?

One type of pollution that is characteristic in cities is thermal pollution, producing what is known as the "heat island" effect. This is increased air temperature due to the high absorption of solar energy by concrete and asphalt that covers so much of our cities, as well as the heat from auto exhausts, air conditioning units, etc. Temperature differences of 10°F or more are quite common between the city and surrounding countryside, particularly during the night.

This can be modified in localized areas by the type of ground cover that is used. For example, air temperature over artificial turf has been measured to be 8 - 12° higher than over natural turf. Whereas buildings and pavement absorb 90-95% of the incoming solar energy, foliage only absorbs 50-60%. In addition, evaporative cooling from vegetation further reduces the air temperature.

A comparison of the air temperature in St. Louis between city parks, 92°, and the downtown business district, 102°, revealed a 10°F difference. The effectiveness of grass and trees in reflecting the sun's radiation in contrast to the heat absorption and storage of asphalt and concrete was dramatic. Lesser but equally important differences of 2-4° were noted between open and tree-lined streets.

The second influence investigated was the effect of plantings on noise reduction. Generally, vegetation is most effective in reducing irritating high frequency noise. Some plants 25 to 50 feet wide reduced noise at higher frequencies 10 to 20 decibels, more than 50%, while the lower frequencies were less effectively reduced. Large pine and spruce plantings, 50 to 100 ft. wide, are also capable of reducing some of the lower frequency noise, characteristic of traffic, as much as 50%.

The lowest frequencies, which are the most difficult to eliminate but fortunately the least annoying, are not affected by plantings. Plantings of a single species usually exhibit a non-reducing zone about midway between the low and high frequencies.

Effective evergreens for year-around noise reduction are arborvitae, douglas fir, spruce and pine, all of which have foliage to the ground. Other evergreens, such as hemlock holly and juniper are not as effective. Some good deciduous plants are thickets of sassafras and pawpaw, as well as mixed species. Size and density of the plantings is critical in noise control, with hedges and other narrow plantings relatively ineffective. Proper selection and spacing of plants, along with proper land grading, could contribute significantly to the alleviation of noise along highways and other problem areas.

Finally, the effects of vegetation on reducing air pollution was considered. It has been suggested that trees and green belts remove various types of air pollutants, both gases and solids particles. Based on sulfur dioxide (SO_2) uptake studies of Douglas fir, it was calculated that a 15" DBH tree has the potential of removing 43.5 lbs. of SO_2 per year if the concentration of SO_2 was 0.25 ppm. If the SO_2 level gets much higher the plants would be injured, but they can tolerate this lower level indefinitely. Putting this into perspective, greater St. Louis pumps 455,000 tons of SO_2 into the air annually. Theoretically, 50 million trees, or 5% of the land space, could absorb this much, assuming the SO_2 content remained constant at 0.25 ppm. Although these exact conditions do not exist, the significance of vegetation as a potential secondary filter or control is apparent. However, without primary pollutant controls the pollution may reach levels that injure the plants, making them useless for any purpose.

It is important to consider the implications of these results. Most people acknowledge the beauty of trees and shrubs in the landscape; yet man is so quick to obliterate them with bulldozers as he continues to expand. This allows for a few more cars to be parked on our urban land which is rapidly becoming completely paved. The argument for beauty, unfortunately, has been no match for economic progress and expediency. The challenge seems to be how to get more people and cars into smaller spaces.

Human comfort is frequently sacrificed for efficiency and economy. It is imperative that we give greater emphasis to the environment perceived at the human scale. People can relate to trees and landscape plantings, whereas skyscrapers overpower them. Visual pleasure and stimulation from landscape plantings is greatly needed in our man-made sterile environment.

Since beauty is often overlooked in city planning, the functional role of plants in maintaining an environment favorable for man must be emphasized. I have described three ways in which plants improve man's environment. There are many others. In fact, we should not ignore the role of plants in supplying the oxygen on which our lives depend.

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CARTS AND GOLFERS TODAY

Lee Record, Mid-Continent Director,
USGA Green Section, Crystal Lake, Illinois

In 1953 there were 1,000 golf carts in use. In 1963 there were 70,000. In 1965 there were an estimated 100,000. The February, 1970 issue of "GOLFDOM" has the following article - "THE YEAR OF THE GOLF CAR." A summary of this article is this - in 1969 there were 205,700 rented golf cars at 7618 regulation golf courses. This

is 85.7% of all regulation golf courses. The projected total number of rentals for 1970 is 243,800. Total revenue from rentals jumped from 126 in 1968 to 143 million dollars in 1969. This is big business.

The golf professional is reaping the golf car revenue harvest at many private and semi-private country clubs. 50% of the golf professionals retain 100% of the profit at private country clubs, while 58.9% retain 100% of the profit at semi-private country clubs.

How does this affect you, the golf course superintendent of 1970? Where do you get your money to build, repair and improve new and existing golf cart paths or roads? What new pieces of equipment, or hours of overtime do you have to convert so another 500 feet of cart paths can be installed this year? The budget was cut some place - it had to be.

Back in 1960, a decade ago, one Chicago club reported a gross income of $137,790 from golf cart rentals. At $ 9.00 a round you had to have 15,311 golf carts go out. This is exactly the number of rounds reported at this club in 1960.

The sixties and the golf carts continued to move right along. In 1966 the USGA Green Section staff conducted a nationwide golf cart survey. Questions and answers asked in this survey are still being asked today.

Question: What percentage of golfers use carts on your course?

Answer: The greatest number of "carted golfers" was found in the West (60-70%). The Southwest followed with (60%), South (30-60%), Midwest (30%), and the East (20%). What percentage of members use golf carts at your course today?

Question: How many golf carts are used on your golf course?
Answer: Pick a number from 1 to 250 and you would be right. Today, 1970, it is estimated there will be 32 golf cars per fleet of the 7618 facilities comprising the 85.7% of regulation golf courses in the United States.

Question: Does the club expect a profit from carts, or only that they pay their own way, including the cost of repairing the damage they cause to the course?
Answer: Can't help but make a profit! We expect to break even, but are enjoying the profit. With only 75 members we expect no oprofit. However, the club could not hire a professional without cart proceeds going to him.

No profit expected. If there is one it goes into the general fund.

We expect to make a profit near $ 24,000 annually after all expenses.

Question: What percentage of cart income actually goes toward course maintenance?
Answer: Despite the years of accumulated evidence and thousands of written words proving the contrary, most clubs obviously feel the cart has done little or, at most, insignificant damage to their course. This is truly amazing! The survey showed only 25% of the clubs allocating all, or at least a percentage of cart income to course maintenance. Frequently the allocation is restricted to cart path development. One club actually replied, "Carts do no damage."

For the turf man it is a frustrating predicament to discover golf cart money going into items such as new carpets and interior decorations for the clubhouse, while an inadequate 50-year old system of irrigation is continually breaking down,

mowing and new maintenance equipment is sorely needed, and through it all, the golf carts keep wearing out the turf near every green, tee and along some fairways. And, a final

Question: During adverse weather, who determines if carts may be used?
Answer: Nationwide, 60% of the superintendents make this determination. The next most frequently mentioned was the golf professional (15%), and then the greens chairman, followed by other club officials.

The summary of the 1966 survey showed the very real need in golf cart administration. How serious is the golf cart problem at our country clubs today? What can be done about improving the situation that may exist? Golf carts are here to stay, and work with them we will.

Charles Baskin, Superintendent at the Waterbury C.C., Connecticut, didn't let the golf carts get the best of him when they were introduced at his course a few years back. His course was one of the last golf courses on the East coast to be invaded by golf carts, and this was brought about by elder member demands.

Charlie had an understanding greens chairman and golfing membership. He initiated a five year golf cart path program. He went to the board before the golf carts arrived, and proposed that X amount of dollars be spent each year for cart paths, bridges, etc. He picked out weak areas first and these areas took precedent over each other. He also gave the board an approximate cost of labor and materials for each year's work based on the present day market. He planned for it, he worked for it, and he has, I'm sure, been rewarded for his efforts as a golf course superintendent.

The question I ask you this afternoon is - "Have you done everything that is required of a golf course superintendent to improve and stay abreast of the 1970 golf cart problem that may exist at your country club?"

I haven't mentioned the golfer in relation to the golf cart. After all, the golfer has been looking over your shoulder with every one of the problems that have been confronting you. His smile is bigger than ever. He just watched you ride across the green with your truckster as you applied your fungicides. Yesterday, remember how he watched you ride across the green with your other truckster as you topdressed and applied fertilizer?

The golfer will continue to ride everywhere - across tees, around collars and into bunkers. He'll park on approaches and run into trees. He can't help it if he misses the bridge or gets stuck in a wet, non-drained area on the course - he's only human.

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TURFGRASS RESEARCH IN THE SOUTHERN STATES

Coleman Y. Ward, Dept. of Agronomy
Mississippi State University, College Station, Miss.

Turfgrass research in the Southern states is not unlike turf research in other regions of the United States -- only the species differ.

Because the mid- and lower South has a mean summer temperature of about 80°, the cool season grasses of the Northeast are limited in use to the extreme upper South. Tall fescue (Festuca arundinacea)is the chief cool seascn species used for turf in the upper south. Its primary use is for roadsides and utility areas. Some use is made of creeping bentgrass on carefully managed putting greens in the Appalachian foothills.

The primary permanent warm season turfgrasses used in the South are: bahia, bermuda, centipede, St. Augustine and Zoysia.

Bahia - Research with bahia (Paspalum notatum) is conducted in Florida, Georgia, Alabama and Mississippi. This grass was introduced from Brazil and is best adapted to the lower South. It is widely used on roadsides and for low quality lawns. It is popular because it is very drought tolerant, has good shade tolerance, and requires minimal soil fertility. Conversely, it is coarse-textured and constantly produces objectionable seedheads. Florida is conducting a selection program to develop a fine-textured turf-type bahiagrass.

Centipede - (Eremochloa ophiuroides) introduced from China about 60 years ago, centipede is truly a grass for the "weekend fishing enthusiast." It requires low maintenance. Research in Alabama and Mississippi show severe "winter killing" when more than 3 lbs. of nitrogen per 1000 sq.ft. were applied to centipede sod. Research also shows centipede mowed at 1-1/2" about once every 7 to 10 days survives longer than when mowed closer or more lax.

Oklawn (developed by W. W. Hfffine at Oklahoma State) is the only named variety, but Florida, Mississippi and North Carolina are selecting for more uniformity in this species.

Bermuda - unquestionably the bermudas are the most important grasses for lawn and sports turf in the South.

Numerous experiments are underway in almost every southern state to determine the management and fertility needs of bermuda turf. The hybrids are used for fine turf areas, but common is still very popular for fairways, roadsides and home lawns.

Hybrids are used for greens, tees and to a lesser extent for fairways. Most athletic fields are also planted to hybrids. Tifdwarf is rapidly replacing Tifgreen as the major bermudagrass on golf putting greens. The most popular hybrid for fairways is Tifway (419), but because of thatch control problems a more open type bermudagrass is more practical.

Dr. Glenn Burton, USDA Geneticist at Tifton, Georgia, has been responsible for the development of the very popular Tifton series of bermudagrass. Tiflawn (1952), Tiffine (1953), Tifgreen (1956), Tifway (1960), and Tifdwarf (1965).

Bermudagrass requires large quantities of nitrogen to produce a dense turf. Bermuda fairways, lawns and park areas need 5 to 10 lbs. of nitrogen per 1000 sq. ft. during the growing season. The amount varies with traffic level.

Research in Florida shows putting greens used 1 lb. of nitrogen every two weeks, or 26 lbs. per 1000 sq.ft. annually. In the midsouth, a rate of 18 lbs. per 1,000 sq.ft. is adequate (Ward - Mississippi). Tees and athletic fields need about 12 lbs. of nitrogen per 1000 sq.ft. annually.

Bermudagrasses by nature are thatchy - soil topdressing by use of a prescribed mix, or utilizing aerification cores has been shown to be very effective

in reducing thatch. Topdressing two or three times annually, and/or aerification 3 or 4 times per season, greatly reduced thatch in Tifgreen bermudagrass turf in experimental plots in Mississippi. In the same study vertical mowing (no soil contact) every 2 or 3 weeks proved effective in thatch control, but more important it smoothed the putting surface of bermudagrass putting greens.

St. Augustine: Surveys show more homeowners in the South prefer St. Augustine for home lawns over all other turfgrasses. This fast-growing, corase-textured grass is a native of the West Indies. It is propagated vegetatively, mainly by sprigs.

Much turf research has been devoted to St. Augustine because of its susceptibility to several diseases and insects. Control of the chinch bug in St. Augustine turf is a multi-million dollar business in the lower south. The popularity of St. Augustine for home lawns is related to its ability to grow in dense shade. It is subject to winter-kill in the upper south.

Zoysiagrasses - Because of the over-zealous advertising, the Zoysiagrasses have suffered abuse in the South. Introduced from the Orient at the turn of the century, the Zoysias have slowly increased in popularity as a lawn turf. Meyer, (released in 1952) a strain developed by the USDA-USGA, is most popular in the upper south, while the variety Emerald is more popular in the coastal areas.

Research in Florida, Alabama, North Carolina and Mississippi shows Zoysia turf needs 4 to 8 lbs. of nitrogen 1000 sq.ft. per season, the higher rate being used in Florida.

Zoysia turf benefits from vertical mowing in late winter to remove thatch. Zoysia has never been widely used on golf courses because of its slow recovery from injury. Tests in Mississippi show it to be very wear resistant.

Future Turf Research - In 1967 twelve Southern states organized the Southern Regional Turf Research Group. Annual meetings are held in a different state each year to review research and exchange ideas for solving regional problems

State	Person	Department	University	City
Alabama	Ray Dickens	Agronomy	Auburn	Auburn
Arkansas	Charles Murdock	Agronomy	Arkansas	Fayetteville
Florida	Granville Horn & Harry Meyers	Ornamental Hort.	Florida	Gainesville
	Evert Burt and Al Dudeck	do	Florida	Ft. Lauderdale
Georgia	George Kozelnicky	Plant Pathology	Georgia	Athens
Kentucky	Hayden Watkins	Horticulture	Kentucky	Lexington
Louisiana	William Young	Horticulture	L.S.U.	Baton Rouge
Mississippi	Coleman Y. Ward	Agronomy	Miss.State	State College
North Carolina	William Gilbert	Crop Sciences	N.C. State	Raleigh
Oklahoma	Wayne Huffine	Agronomy	Okla. State	Stillwater
South Carolina	Fred Ledeboer	Horticulture	Clemson	Clemson
Tennessee	Lloyd Callahan	Agronomy	U. of Tenn.	Knoxville
Texas	George Menn	Soils & Crop Sciences	Tex. A & M	College Station

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PHYSIOLOGY AND GOOD TURF

Coleman Y. Ward

Really healthy, well-managed turf plants should always have an abundant supply of soluble reserve carbohydrates. An inadequate supply of soluble carbohydrates makes turf plants vulnerable to stress caused by disease, drought or unfavorable temperatures.

A turf manager can insure against a loss of turf quality by understanding how turf plants grow and accumulate reserve carbohydrates.

The Tiller - The Unit of a Grass Plant

A putting green or any expanse of turf is a mass of interspersed leaves and stems, and the number of these parts appears to be endless; but if examined carefully, we find that turf is made up of repetitive basic units - tillers. A tiller is a single stem, its nodes, leaves and roots. If a tiller is separated from the grass plant it will survive, and if given the proper environment will soon give rise to many new tillers. These new tillers arise from adventious buds near the crown of the old tiller, or from buds in the axils of leaves. They also arise from the nodes of rhizomes or stolons.

A grass plant consists of a single tiller soon after germination of a seed, but a mature grass plant may consist of more than 100 tillers. In a developing grass plant a new tiller is supplied nutrients by adjacent tillers until the new tiller has about four leaves. It then develops a root system and may become independent.

Cool season grasses, i.e., bentgrass, develop new tillers primarily in the spring and fall season. This fact implies that a tiller lives about six months, though some tillers may live an entire season before being replaced.

The rate of new tiller formation is increased by an abundant supply of nitrogen fertilizer. Formation of new tillers is also limited or promoted by the carbohydrate status of the old tillers.

Leaf Growth- The tiller is important in turf culture only because it consists of a stem containing leaf bearing nodes. It is the leaf which provides the surface for foot traffic, the putt of the golfer and beauty for the eye.

The stem gives rise to several leaves, each originating on alternate sides of the stem with the youngest leaf emerging from the apex through a cowl formed by the last emerged leaf. Each leaf consists of a sheath and blade which continue to elongate until the collar which divides them is well defined. The leaf has a much shorter life than the tiller. The rate of leaf death is fairly constant under a steady environment. New leaves emerge about as fast as old ones die, thus the number of leaves remains unchanged in a favorable environment.

The environment has a large influence on leaf size and life span. A leaf lives longer under lower temperatures (10°C) than higher temperatures (20°C).

Young fully expanded leaves maximize photosynthesis and are most responsible for accumulating excess carbohydrates used to produce new tillers, expanding leaves, or for storage in roots and crowns. As a leaf ages it decreases in photosynthetic activity, often living at the expense of new leaves. Vertical mowing or cultural practices which remove older plant tissue helps keep turf more vigorous.

Carbohydrate Reserves - During favorable periods of growth grass plants accumulate soluble carbohydrates in various storage tissues for later use in respiration and growth. These carbohydrates are usually simple and complex sugars, though warm season grasses store reserve energy as starch.

These reserve carbohydrates are stored in the lower internodes of the tiller, and in rhizomes and stolons. Carbohydrate reserves from these storage sites are rapidly depleted during periods of stress, or rapid growth of leaves, or new tillers. This depletion implies that the reserves are used for development of new tissue, or for respiration.

Grasses accumulate large amounts of reserve carbohydrates during cool periods especially during late fall. During hot summer months grasses rarely accumulate reserve carbohydrates. During the summer period large amounts of energy are used in respiration, transpiration of water and repair of tissue damaged by traffic.

Frequent close clipping and nitrogen fertilization deplete carbohydrate reserves in grass tissue. It is believed that too much nitrogen weakens grass plants by stimulating excessive growth at the expense of reserve carbohydrates. Plants weakened in this manner are highly vulnerable to disease or other stress factors.

Turfgrass managers of cool season turfgrasses are cautioned against the use of large amounts of nitrogen on turf during the hot summer season. Since close, frequent clipping reduces carbohydrate reserves, a more lax mowing regime is in order during periods of excessive heat or turf injury. For example, if you are mowing greens daily at 3/16 inch, it would aid the grass to raise the height of cut to 1/4 inch, and occasionally allow two days between mowings. This will allow for more leaf tissue to become active in photosynthesis and give it more time to accumulate increased reserves. The amount of increase may be slight, but a small difference may enable the turf to survive the rigors of a tournament, or a week of above normal temperature.

Harmonize Grooming Practices with the Season

The season regiments the grass plant mainly through significant changes in temperature. Roots grow profusely in late fall and very early spring when temperatures are too low for optimum top growth. Since roots need oxygen to grow, the spring and fall are ideal for aerification. In summer root growth may almost stop. In fact, long roots (6-10") developed during spring may die abruptly under stress. The new roots emerging at nodes will be short (1-2") and weak. High temperature, high N availability, low cut, low oxygen in soil, favor such root response.

The death rate of leaves is also high during the summer because of high temperatures. Irrigation practices should insure that the grass is cooled by light, frequent watering in periods of high temperatures. Syringing the grass not only cools it, but supplies water, keeps the leaf blades turgid, and reduces respiration.

Understanding the influence of the season on plant growth enables you to regulate cultural practices in such a manner as to increase the life span of a leaf or tiller. Increasing the life span of a leaf means healthier turf.

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UPGRADING PUBLIC TURF

Ariel C. Hunt, Asst. Park Superintendent
Evansville, Indiana

Public turf includes athletic fields, (football, baseball, golf, etc.), parks, boulevards, highway right of ways, and so on. Upgrading public turf is not much different than upgrading other turf except that it is quite often more difficult to do because of an inadequate budget, lack of receptive labor, and the absence of a knowledgeable person to formulate and administer an organized maintenance plan.

We are fortunate in Evansville to have a Mayor, a Park Board, and the Superintendent who had upgrading of the entire park system at heart, and who gets things done rather than just talking about it, and this is probably where upgrading public turf actually becomes a reality.

A Park Board should be informed as to the advantages of developing various types of good turf and the disadvantage if it isn't developed. It is a justice that needs be served on the public that they know their tax dollar is being spent cautiously but effectively. Growing good turf and maintaining it with good management is proof the public needs. Good results with the amount of money available is a goal.

Any new park development or grounds development, such as we have around our new City-County Civic Complex in Evansville, should be checked in the planning, drawing and specification stages by a person who is knowledgeable in the fields of turf, as well as trees, shrubs, ground covers and soil. Herein lies the secret to the establishment of vegetative items in the landscape that will be pleasant, enduring utilitarian and still provide a minimum amount of maintenance.

There have been instances where I have seen old buildings razed, and bricks, mortar and other debris let lay to be covered over with from 4" to 8" of silty clay; then people like you and me are supposed to grow bluegrass turf, plant hollies, japanese yews, azaleas and other acid loving plants. For the first year things may look pretty good in such a situation, but when the grass roots and other plant roots begin to reach down into the soil (if you can call it that) things begin to happen.

Through weathering and capillary action the soil becomes higly alkaline from the mortar, compacted, oxygen-depleted, and generally looks like a bleak, contorted nightmare. Now its too late to do much improvement, and now it would cost a fortune to start over! All this could have been avoided if proper planning had been initiated.

Any of you who are responsible for the development of any planted area, be it a golf course, a park, a mall or even a boulevard, make sure you are there in the planning stage, or appoint someone who is knowledgeable in all phases of plant establishment. Those areas of turf that need to be upgraded must be analyzed:

1. What kind of soil exists?
2. Is there good drainage?
3. What kind of grass exists, if any?
4. Can water be made available? Automatic?
5. How can foot traffic be minimized?
6. What's its purpose?

After getting answers, then proceed as needed:

1. Improve the soil
2. Select a grass suited for its use, maintenance and environmental adaptation.
3. Make water accessible, if possible
4. Select a fertilizer
5. Plant at an optimum time
6. Close area, if possible, until turf is established.

Upgrading public turf involves a conscientious selling job. It is sometimes questionable whether one tries to convince the public that a certain area should be improved with good turf coverage, whether it be for aesthetic purposes, or for utility purposes, or both. Quite often it is more effective to develop an area, and then let the results (providing you have good ones) speak for themselves. Most people will sanction or reject a situation on the basis of "show me", or "I've got to see it to believe it." Whatever approach is used to attain favorable public opinion one must use the news media, garden clubs, the Chamber of Commerce, Redevelopment and Urban Renewal Commissions, and any other groups or departments that may help to get your point across.

An effective approach to upgrading blighted areas is to bring the problems before clubs and civic groups. These organizations are constantly looking for projects that will benefit the entire community. My own experiences through this medium has been very successful. Groups have actually asked me to suggest projects that they could initiate. Frequently they tell me they have "X" number of dollars to spend -- "What project could be finalized with this number of dollars?"

Finally, I would like to re-emphasize the necessity of leadership in upgrading the community in respect to landscaping of which upgrading turf is, in my opinion, the literal basis of most landscape development. The leadership should be made up of people who have a genuine interest (an interest almost approaching an avocation) in upgrading, renewing, redeveloping the community in which they live, work and play. Do not overload your committees with people who merely want to get their name on the list and never show up for meetings.

Upgrading is a serious but pleasant business. Air, soil and water pollution are serious problems we all share, and the federal government is beginning to crack the whip. The population explosion, soil erosion, land and housing shortages, and urban decay are major problems that need to be corrected quickly, and in order to solve these problems dedicated people are needed.

Establishing and upgrading public turf will help foster pride in the community, lend a sense of well being and hopefully inspire the public to apply their energies to the solving of other critical problems.

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SUCCESS WITH ARSENICS ON 50 ACRES

Paul Frankowski, Supt. Beverly C.C.
Chicago, Illinois

In 1966, while Ted Woehrle was Superintendent at Beverly County Club, he initiated, with the help of Dr. W. H. Daniel of Purdue, a plan to rid the fairways of Poa annua. When he left in 1968, I was hired because I was familiar with the

program and supported it 100%. Further, I had to agree to continue the program that had been set up.

One of the most important parts of a program such as this is the backing of your membership. You can never attain 100% approval, but good communication is very important. Ted put out the following letter to the members, explaining the program, and what they could expect in the coming years:

SUBJECT: Condition of Fairway Turf

To: Members of Beverly Country Club

The turf on our fairways consists of bent and Poa annua, with Poa annua predominating. Poa annua is considered a weedy grass, very vigorous in the spring and fall, but suffers in the summer or winter, and has been tagged as "failure grass" by many superintendents. Poa annua is very difficult to maintain in hot and adverse weather, particularly at Beverly Country Club, because of the poor soil structure------

Various superintendents during the past two or three decades have been fighting this problem, but always seem to lose Poa annua during the peak of the golfing season. All known methods of saving Poa annua have been tried with little success.

Faced with this annual failure of the fairways for which a solution up to the present time has not been available, the Grounds Committee and the Board decided to investigate a long-range program for improving the fairways. Inasmuch as the Poa annua was incapable of being maintained, the problem seemed to resolve to whether or not there was a type of grass available to give us fairways which would withstand Beverly's heavy play in the hot, humid weather.

We consulted with Dr. W. H. Daniel, Turf Specialist at Purdue University. He has been following our activities at Beverly since 1950, and was aware of our problem. At our request, he observed conditions, and recommended we rid ourselves of the Poa annua and substitute bluegrass.

The new bluegrass developed in the last few years may be cut to 3/4 inch, and possibly lower, and maintained with much less moisture. It must be recognized that our fairways will not be 100% bluegrass, but instead of the present combination of bent and Poa annua, it will be a combination of bent and bluegrass.

The transition period of changing from Poa annua to bluegrass will take about two years. It will be a period that will be noticed just as the new clubhouse construction was noticed. There will be periods when we will be playing Winter Rules, and the golf course will look bad. The conversion of the north nine will be attempted on an accelerated program and could be a drastic change. The south nine will be started on a much slower program.

The Program

First, we must control the growth of Poa annua. This is done chemically with calcium arsenate. It is sprayed on in several applications. As the Poa annua begins to show up and die, we will then repeatedly overseed the bluegrasses. The schedule to be followed is basically this:

1966	Early August	Drill seed bluegrass into existing turf
	Middle August	First application of calcium arsenate
	End of August	Second application of calcium arsenate
	Early September	Second seeding of bluegrasses

Late fall we will make a dormant seeding if time and weather permit.

1967	Early spring	Third application of calcium arsenate
	Early spring	Another seeding if necessary
	After Western Open	Fourth application of calcium arsenate
	Early fall	Last seeding

Not all the existing Poa annua will be killed in this operation.

As mentioned earlier, there will be times when this treatment will appear drastic. Bear with us - we believe the end result will justify the means.

The Board and Grounds Committee believe this is necessary to give Beverly fine fairways. Give us your cooperation and understanding. We will be going through a rough period of great anxiety and frustration, plus a great deal of hard work.

(Editor's note. When the poa weakened, bentgrass spread rapidly so the overseeding of bluegrasses was changed to include bent. In 1967 the course had gone from 95% Poa annua to 98% bent and bluegrasses).

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SUCCESS WITH ARSENICS ON 40 ACRES

Louis E. Miller, Supt., Louisville C. C.,
Louisville, Kentucky

When I became Superintendent of the Louisville C. C., in March, 1967, the fairways were just over a year old. They had been seeded to a mixture of Newport and Common bluegrass, plus Highland, Colonial and Penncross bents. The bents were definitely predominating, and quite frankly, I was skeptical about using arsenicals.

Poa annua comprised about 20% of the fairway turf. My predecessor had applied 200 lbs. per acre the previous October, and there was enough material on hand to apply another 400 lbs. per acre. After careful deliberation and talking with people who had had some experience with the product, I decided to carry on with the program.

I applied 200 lbs. in March, 1967. During that summer there was a loss of Poa annua, most of which I attribute to the heat. Crabgrass was very limited, but there was a high population of white clover. The clover was eliminated in August by spraying the second and fourth week with MCPP, at a rate of 5 pints per acre.

That fall many low-lying areas in the fairways had to be drained as calcium arsenate in the low spots was toxic. Drainage was accomplished by running

thousands of feet of plastic drain tile with surface catch basins, plus slit trenches. Both types of drainage perform quite well.

In October another 200 lbs. of calcium arsenate per acre was applied.

Beginning in January of 1968 large straw-colored areas started to show up on most of the fairways in varying sizes and proportions, from a few feet to several hundred feet in diameter.

In February the severity increased, and at that point I thought it might be winter desiccation.

About the middle of March the grass had started to turn green everywhere except in those brown areas. Closer observation showed a definite yellowness tinging the grass in most all fairways. At this point I was convinced it was arsenical toxicity. Dr. Daniel advised to apply some water soluble phosphate as soon as possible. I located a 10-52-8 made by the W. R. Grace Company, and began spraying the fairways at a rate of 30 lbs. per acre. Three applications gave me just a little over 1 lb. actual P_2O_5. I also used some granular 0-46-0 in the most severe areas.

Within three weeks the fairways had healed almost completely. Only 12 lbs. calcium arsenate was used up to this time, which is under the 16 lb. rate where, theoretically, control should be attained.

In August, 1968, a terrific heat wave hit the Louisville area and temperatures and humidity were in the 90's for two weeks. This would not have been so bad except the water company curtailed my use of daytime watering. As a result I had to stop syringing my fairways, and lost No. 1 and No. 18 fairways. These two fairways were completely renovated and seeded on August 28, and by the end of September they were 95% covered.

In October, 1968, another 100 lbs. per acre of calcium arsenate was applied. Another 100 lbs. of calcium arsenate was applied in April '69.

The remaining Poa wss almost wiped out entirely during the difficult summer of 1969. Overall I was very well satisfied with the performance of the fairways.

In August, 1969, another 100 lbs. of calcium arsenate was applied, almost two months earlier than had been done in the past. Here again timing was of the utmost importance for what little Poa germinated, it withered and died soon.

To date 18 lbs. of formulation has reduced the Poa annua to less than 2% of the fairway turf. Soft crabgrass and goosegrass are practically nil. After three years of being on calcium arsenate I am quite satisfied with the results.

There are other things which must be taken into consideration. My fertilizer program is geared around the reduction of soluble phosphorous. 200 lbs. of ureaform per acre are applied in May and October. In June, July, and August 350# of Milorganite are applied per acre. Potash is applied in late October at the rate 200 lbs. per acre in the sulfate form. This works out to approximately 4.5 lbs. of N, 1 lb. of P_2O_5, and 2.5 lbs. of K_2O.

All fertilizer is applied with a rotary-type spreader, whereas all calcium arsenate is applied with a 10 ft. drop-type spreader. The drop-type is much slower, but by using chain drag markers it is extremely accurate and much easier to use, especially in tight areas up around the green, and when turning.

One application of MCPP at the rate of 5 pints per acre is made in late April to knock out any clover, chickweed, etc.

The most critical aspect of raising bent fairways this far south is disease control. The humidity is always very high and likewise the temperatures. This leaves us with every disease in the book.

The fungicide program is based on PMAS, liquid Cadmium chloride, Thiram, Parzate C, and Koban, to name a few. These fungicides are used separately, or in a program together if the situation so warrants. A typical spray application would be 12 oz. of PMAS, 12 oz. Cadmium chloride, and 6 lbs. of Parzate C, or Thiram, per acre in 50 gal. of water, using a boom-type sprayer. We spray on the dew pattern and it usually takes two mornings to complete the 40 acres.

Usually 10 to 12 applications are sufficient, depending upon the weather from April to October. There are some new fungicides that are in the experimental stage that give about twice the residual, and I feel the number of fungicide applications can be cut in half in a year or two.

As far as insecticides are concerned, Sevin 80% WP is used at the rate of 11 lbs. per acre, and usually three spray applications per year are sufficient.

In this type of fairway management program all of the aforementioned would be practically impossible if it were not for automatic irrigation. The fairways are dual-row automatic and comprise a very integral part in the management program. This applied not only to the regular watering program, but daytime syringing of the fairways that is carried out religiously whenever the temperatures exceed 90°.

Mechanical maintenance consists of aerification three times a year, using the 3/4 closed spoon and crushing the plugs using a chain link drag. This brings up about 12,000 lbs. of soil per acre and acts as a good topdressing which helps to decompose thatch better than a vertical mowing does.

In areas where the Poa was completely dead by the middle of July, such as in the front of greens, stripping and sodding was done rather than overseeding. When the nursery stock ran out a single strip of sod was taken from the fairway next to the rough and replaced with bluegrass sod.

I must say that the last three years have been very challenging, but the results well worth the time and money spent. I feel that calcium arsenate is an excellent herbicide, but must be used with discretion and forethought. It is not a black and white situation of applying X number of pounds of material and getting control of Poa annua and crabgrass. There is a very definite gray area inbetween and many variables that can affect the results of the material. I hope that this paper has brought to light some of these variables that go into developing a successful fairway program.

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SUCCESS WITH ARSENICS ON 32 ACRES - BLUEGRASS FAIRWAYS

Carl G. Hopphan, Supt., Aurora C. C.,
Aurora, Illinois

A manual, quick-coupling fairway watering system was installed at the Aurora Country Club during the fall of 1937. Year by year what originally was pure bluegrass

changed into a Poa-bluegrass combination. I personally spent ten growing seasons watching my fairways blossom beautifully up until July and then no matter how hard or whatever I tried that blasting hot Sunday afternoon would come along when there were players all over the golf course witnessing the big show "EXIT POA." The summer of 1966 I spent a lot of time thinking about how can a guy look so good one day, and then all of a sudden you're a heel with a lot of dead Poa.

The day after Labor Day, 1966, I first presented Dr. Daniel's arsenical program to remove Poa to my Grounds and Green Chairman. Convincing him of our need for this program was not too difficult for we had 32 acres of proof. A general meeting of the entire membership to acquaint them provided a great deal of encouragement. I explained the complete program, giving costs, time elements, and most important of all I painted an extremely black picture of how our fairways would look before success was achieved. It was pointed out that even if the entire program was only 50% successful, it would be progress.

Now, we are all set to put the show on the road. Tri-calcium arsenate and a seed blend of equal portions of Merion, Newport and Delta bluegrasses are sitting in the doorway of my maintenance barn. A McCormack-Deering 5' drill seeder was purchased at a farm auction sale to slit the seed into contact with the soil. My overseeding program had barely started before I could see that this drill seeder was not the answer, because a heavy thatch condition prevented our cutting into the top soil layer.

While attending the Fall Turf Clinic of the Midwest G.C.S.A. at Medinah C.C., I had quite a long talk with Dr. Daniel about my seeding program. I still have the scratch pad sketches that were made up designing a seeder attachment to my 548 Aero-blade. The rest of that winter was devoted to putting together a homemade seeder, consisting of approximately $ 90.00 material costs. Two spreader hoppers, angle iron, and used milking machine tit cups were blended together into what eventually was a working charm. Please don't ask me to give labor costs for this project.

Beginning with the 1.5 lbs. of tri-calcium arsenate during the fall of '66, 4 lbs. more was sprayed to our fairways and watered-in the latter part of April, 1967. The first two weeks of April saw our new seeder beautifully laying approximately 8 seeds per lineal inch into a slit to put the seed just below the thatch, lying in direct contact with the soil. Excess thatch was dragged with a mat and swept up. A point - the Aero-blade did a much better job and seemed to labor far less, if the soil was semi-moist before slitting was started.

A second and third seeding was applied during May, crossing from different directions in the areas where the dead Poa was really thick.

After 2 lbs. more of tri-calcium arsenate in June, I restricted my watering, putting only enough moisture on to keep the new seed growing actively.

After Labor Day, 2 more pounds of tri-calcium arsenate were applied to all fairways, thus reaching a total of 9.5 lbs. per 1,000 sq.ft.

Another cross-seeding was put down in early fall in the thin areas.

My feeding program throughout 1967 consisted of 5.5 lbs. of nitrogen, no phosphorous, and 4 lbs. of potash per 1,000 sq.ft.

During spring 1968, a little Poa germinated, and the new seeding was filling in the bare spots very nicely. I was far more amazed at how the old established bluegrass plants were filling in the bare spots now that they had no competition from the Poa. Our time and efforts were now devoted to hand-scratching smaller dead Poa

spots and following up with hand-seeding and topdressing. A number of the approaches to our greens, where the Poa had been quite dense, were patch sodded. Due to concentrated traffic and daily mower turning, seed development seemed too slow.

The 1968 program consisted of 3 lbs. of nitrogen, no phosphorous, 4 lbs. potash, and 2 lbs. tri-calcium arsenate per 1,000 sq.ft.

In 1969, I started out the growing season with about twelve areas on different fairways where, due to puddled water standing for extended periods of time, the turf was completely killed. These pocket areas were cut out with a sod cutter, filled level with new dirt; then narrow trench drains were extended into the rough, and back-filled with pea gravel. The raised areas were then seeded.

Applied in 1969 were 3.6 lbs. of nitrogen, 1.8 lbs. phosphorous, 6.3 lbs. of potash, and 2 lbs. of tri-calcium arsenate.

My fungicide program for fairways the past two seasons has consisted of four monthly applications (April 15, May 15, June 15, and July 15). It is applied to the turf by helicopter in a semi-mist form. Laboratory tests have shown excellent protection against leafspot. This method of applying fungicides insures me being able to get the product on the turf when it is most needed. The last time our fairways were sprayed the pilot started at 6 A.M., and he was flushing his saddle tanks in our parking lot at 8:20 A.M.

To rate our fairway Poa program as a 90% success, I feel, would be judging it moderately. Increased amounts of potash have very definitely helped to create a broader and stiffer bluegrass blade. Proof of this comes from the many good golfers that play our course and comment on how well the ball sits high on the turf. All fairways are mowed daily, weather permitting, and our height of cut is slightly over one inch.

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POA ANNUA ROOTZONE TOXICITY WITH ARSENIC

Raymond P. Freeborg, Graduate Student in Turf,
Purdue University

In dealing with the problem of arsenic toxicity to plants, one of the first steps is to consider the factors that make up the problem. For example, we know that arsenic is available either in an organic or inorganic form. Organic forms are most soluble, and include the disodium and monsodium methylarsonates, calcium propylarsonate, and others. These are used to selectively kill crabgrass, etc.

The principal inorganic form of arsenic now in use is that of calcium arsenate. Lead arsenate has been widely used over many years. The more clay and organic matter in the soil, the greater the amounts of arsenic that are fixed on these soil and organic matter particles. Sandier soils have less fixation. Thus, heavy soils will fix more arsenic than will light soils. Heavy soils would, therefore, require higher rates of arsenic to obtain toxic levels than that required for the lighter, sandier soils.

Roots will pick up either P or As. When phosphorous is equal to or greater than the amount of arsenic, the potential toxicity of arsenic is reduced.

Plants vary in their tolerance to arsenic. Bluegrass, ryegrass, sorghum, and orchardgrass are among the most tolerant grasses. There have been instances where some arsenic has actually stimulated plant growth. Where wheat and rye (cereal) were grown under high rates of calcium arsenate, wheat was stimulated at rates in excess of 750 lbs. per acre, and rye (cereal) was stimulated by all rates including the 6,000 lb. rate/acre.

Arsenic accumulates in higher concentrations in roots than in the tops of plants. One investigation involved barley grown on a western orchard soil where arsenic had been used as an insecticide. It was found to contain only 13 ppm in the tops, and over 1,200 ppm in the roots.

Arsenic affects the plants by two possible methods:

1. When arsenic enters the plant root, it may replace phosphate in adenosine triphosphate, (ATP), an energy supplying substance necessary for plant growth. When arsenic replaces the phosphate, the energy usually formed by splitting phosphate from ATP and forming either adenosine diphosphate or adenosine monophosphate is no longer available within the plant, and new growth stops.

2. Arsenic may interfere with enzyme activity. It is known that arsenites can inhibit a wide range of enzymes by the formation of thioarsenates. There is the possibility of both.

Wet soils, and cloudy, overcast days have been shown to increase arsenic toxicity to Poa annua. Why? It may be the result of a slightly greater amount of arsenic in soil-water solution, making more arsenic available to plants. Another factor may be a lower light intensity, further weakening the Poa annua and making it even more susceptible to an increased level of arsenic.

Both phosphorous and arsenic have several somewhat similar qualities. For example, it is currently understood that there is very little phosphorous in the soil-water solution, (about 0.1 to 1.0 ppm). Most of the phosphate is fixed either by the soil clay or soil organic matter.

Phosphate is made available by diffusion from soil clay, or organic matter, to the root through the soil-water solution. Its availability is closely related to root contact with the soil, and a diffusion gradient.

The soil phosphorous test currently used here at Purdue's Soil Testing Laboratory, is a weak acid extractant. It is a .03 N NH_4, plus 0.025 N H_2SO_4 solution. Once the extract has been collected it is treated with ammonium molybdate and stannous chloride. The intensity of this blue color produced is measured and converted to pounds available per acre.

Results of extracting 0-2" soils with 0.75 N HCL - Atomic spectrometer data

IDENTIFICATION	Estimate phosphate/A lbs.	Estimate arsenic/A lbs.
Lafayette C. C. No. 1 green	110	60
Lafayette C. C. No. 1 fairway	79	12
Louisville C. C. No. 3 rough	74	3
Point O'Woods C. C. No. 1 fairway	131	4
Point O'Woods C. C. No. 16 fairway	216	14
Point O'Woods C. C. No. 1 green	162	14
C. C. Indianapolis No. 14 fairway	216	15
C. C. Indianapolis No. 14 green	167	57
C. C. Indianapolis No. 14 rough	216	14
Beverly C. C. No. 8 green, low spot	200	22
Beverly C. C. No. 8 fairway, low spot	156	10
White silica sand (control)	5.0	4

Currently there are several techniques for measuring arsenic concentrations in solution. For example, there is arsenic distillation as arsine; also separation of arsenic from contaminants, such as phosphorus and silica, using potential differences in solubilities in organic solvents, and use of neutron activation analysis. All three are acceptable and accurate methods of measurement, but each has its limitations.

The first two are wet chemical methods requiring precise techniques and strictly controlled operating conditions which are often not desirable for practical use in a soil testing laboratory. Neutron activation analysis is very sensitive, but the necessary equipment is very expensive. We have been using atomic absorption spectrometry which is already in use in many soil testing laboratories. Sensitivities are accurate in the range of 2 ppm, which is adequate for soil testing. The techniques required are simple, rapid and economical.

With good extractant and measurement techniques, arsenic amounts extracted from the soil and plant response can be correlated. At this point we will, in effect, be asking the plant how much arsenic is necessary to kill it. Then by analyzing a soil for arsenic and knowing what is needed, determine how much additional arsenic is necessary to maintain Poa annua control. This would eliminate some of the risk.

Some method of accurately measuring and controlling soil arsenic levels may become even more important in view of the current policy of the Health, Education, and Welfare Department in its critical review of herbicides such as arsenic, and possible restrictions on arsenic use which may result.

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PRE-EMERGE WITH BALAN

Gary Johnson, Elanco Products Company,
Indianapolis, Indiana

Pre-emergence control with Balan has now been a reality in the professional turf care industry for the last three years. I would like to discuss the chemical Balan so the turf manager may have a broader knowledge of the chemical, and in turn decide now Balan may be beneficial to you in your endeavor to manage and promote desirable turf. Before we proceed, let's define terms.

ANNUALS. - An annual plant complets its life cycle from seed in less than one year. They are generally easy to control. However, because of their abundance of seed and fast growth, they are very persistent. Annuals can be classified as summer annuals and winter annuals. Summer annuals germinate in the spring, make most of their growth during the summer, and usually mature and die in the fall. The seeds lie dormant in the soil until the next spring. An example in turf would be - crabgrass, foxtail, and goosegrass.

Winter annuals germinate in the fall and winter, and usually mature seeds in the spring or early summer before dying. High soil temperatures tend to inhibit germination. An example in turf would be downy brome, cheat, penny cress, and earlier authorities consider annual bluegrass (Poa annua) as a winter annual also.

PRE-EMERGENCE CHEMICALS. - Pre-emergence chemicals must be applied before the

weeds emerge from the soil. These chemicals are effective by killing the dormant or germinating weed seeds before or as they germinate. Application to prevent summer germinating annuals in this area should be applied before the first of May.

POST-EMERGENCE CHEMICALS - Post-emergence chemicals are employed to kill the unwanted weeds after they have emerged from the soil.

CRABGRASS (Digitaia sanguinalis , YELLOW AND GREEN FOXTAIL (Setaria), BARNYARD GRASS, WATERGRASS (Echinochloa crusgalli), GOOSEGRASS, SILVER CRABGRASS, (Eleusine indica), ANNUAL BLUEGRASS, POA (Poa annua)- These weeds may be definied as annual grassy-type weeds mostly demonstrated as summer annuals with the exception of annual bluegrass which germinates predominantly in the early fall.

ACTIVE INGREDIENT - that percentage of the formulated product which represents the herbicide being used to prevent weed seed germination. Balan 2.5% granular is recommended at 2 lbs. of active ingredient per acre, or 80 lbs. of formulated granular.

Achieving Good Control of Crabgrass and Goosegrass

Three years ago Balan was advertised to give good crabgrass control at rates of 1.5 lbs. of active ingredient. This did not leave any margin for error for even distribution and effective crabgrass control.

Goosegrass is a different species, germinates later, and is most difficult to prevent. Some of the trouble lies in early applications attempting to control crabgrass and not being at full strength at the time of goosegrass germination. Many plan a half-rate touch-up after 3 - 4 weeks to assure goosegrass control.

Poa annua in General

Poa annua, annual bluegrass, is definitely a horse of a different color. To control or prevent it with a pre-emergence chemical it takes a different concept, and a somewhat different philosophy of management. Poa is not an annual; some species of Poa live on a three year cycle; the species is evolving now termed "Super Poa," and so on. Regardless of the plant's ability to live from one year to the next, under the definition previously offered, if the plant has the ability to grow from seed and produce seed within one growing season, it is an annual. I think we will all agree crabgrass is an annual; however, in Southern Florida, where a killing frost does not exist, crabgrass may live for several years before it dies. Conclusion: Poa is an annual, but it may live from year to year. Poa annua has the ability to germinate anytime. The majority of Poa annua germinates in the fall after periods of extreme summer stress.

Balan and Poa Prevention

I suggest the application be made after the last summer stress period, and prior to ideal fall GERMINATING CONDITIONS. This date may be earlier than you think. Through the central states of Indiana, Illinois and Iowa, if I had to pick a date for application I would suggest August 10. Now remember, this program is not going to eliminate Poa annua - it is only going to reduce Poa competition by preventing seeds from germinating. Thus, the desirable turf thrives without competition. Several superintendents using Balan are making two applications - one fall and another early spring. When considering a spring application, again timing becomes very important, and application must be made prior to Poa annua germination.

In summarizing, I have recommended a fall application of 2 lbs. of active in-

gredient. If a spring application is employed for both Poa annua and crabgrass prevention, the 2 lb. rate should be applied.

The question is often asked, "How many years must I make applications?" It will depend on the percentage of desirable turf present when you start, irrigation, cultural practices employed, and - of course - OLD MOTHER NATURE. The Balan program is one which the superintendent can control.

Seeding - Seeding is very critical with Balan. At the lowest rates reseeding should be delayed six weeks, and when using the chemical at the higher rates a twelve week period is suggested. When making early spring applications for Poa annua prevention the waiting period should be delayed even longer because of cold soil temperatures.

Seedling Turf - Balan should not be applied in the spring to turfgrasses planted the previous fall. The chemical should be applied only to established turf.

Irrigation - As much as possible, your irrigation program should be designed to grow the desirable species.

Aerification - Aerification should be done before application, or delayed to the latter days of the expected control period. Aerification can bring up untreated soil and seeds, as well as expose untreated soil in the aerifier hole.

Vertical Thinning - Vertical thinning should not affect control unless the vertical blades chop too deeply into thatch, or into the soil. Spiking should also be eliminated for a period immediately after treatment.

Application - Application can be difficult. It is not that the granules are too fine - most golf courses just do not have equipment designed to apply them. Broadcast applications can be used; however, precautions must be taken against application during windy conditions. The best means of application is the drop type spreader with openings no further than 3 inches apart. A scatterboard, or splashboard is also a requirement.

Crabgrass prevention is history. Poa annua prevention is still part of the new horizon; however, it is soon to become common practice in the turfgrass industry. Weed control by any means is only as good as the man selecting and applying the herbicides. There is always more than one way to climb the mountain. It behooves you, the turfgrass manager, to beware of the dangers and invesigate the alternatives.

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POA ANNUA
PRE EMERG CONTROL WITH PRE-SAN
and
RESTRICTIONS WITH PO-SAN

Stan Frederiksen, Mallinckrodt Chemical Works
St. Louis, Missouri

It is a privilege to discuss the pre-emergence and post-emergence approaches to Poa annua control with the two products in our line designed specifically for

these purposes. I'm hopeful we can all learn from sharing views on a number of ideas for getting rid of turfdom's number one weedgrass pest - Poa annua.

"Poa annua" was one of the first pests ever to come to my attention when I began serving Mallinckrodt in the turf field in 1954 -- and I first heard it mentioned by Dr. Bill Daniel when he presented a paper on this subject at the 1954 International Turfgrass Conference in St. Louis. Long before that -- and, of course ever since, Poa annua has been considered one of the turf manager's most troublesome maintenance problems -- perhaps the worst problem when you realize that:

1. Poa is a program topic on practically every major turf conference,
2. It was the only topic discussed for three days at the 1968 Wisconsin turf management symposium.
3. It has been a major turf problem on practically every questionnaire answered by turf managers.
4. It has been a focal point of study at every major research station.

5. It was the single subject of the in-depth nationwide survey published in February, 1969, which showed that:
   - 5.1 95% of all turf managers questioned reported they had Poa (We believe 100% actually have at least some of it)
   - 5.2 76% reported Poa in greens, tees and fairways
   - 5.3 80% who have Poa want to get rid of it
   - 5.4 Most important, while all who consider Poa a problem want to get rid of it, the vast majority --
     a. Want to eliminate it gradually
     b. Want desirable grasses to fill in areas as they are vacated by Poa
     c. Want no toxic residues in the soil
     d. Want no damage to, or disturbance of, desirable turf species.
     e. Want to be able to reseed desirable grasses any time with assurance of full germination.
     f. Consider Poa the most difficult of all weedgrasses to control.

   - 5.5. More than 52% of superintendents are treating some parts of their course for Poa control - SOME ON A PREVENTIVE BASIS

   - 5.6 Less than 5% feel they're successfully controlling FAIRWAY Poa -- and less than 15% really feel they're eliminating PUTTING GREEN Poa.

Efforts to control Poa began decades ago. Some of the early controls were, to say the least "colorful" -- other quite dramatic. Some "post-emergence" controls have the disadvantage of killing everything.

1. Sodium arsenite solution - works well in dormant bermuda turf.
2. "Scorched earth" a program in which a boom with flame jets burning fuel oil is used to "burn off" the Poa.
3. Soil sterilants, such as Methyl bromide and Vapam, which, again, kill everything growing and all seeds in the soil, enabling reseeding after a waiting period.
4. Paraquat - a relatively recent erradicant which kills surface vegetation, and permits reseeding soon after the treatment.

Good pre-emergent materials came to the fore within the past decade. Among these were the arsenicals, which discourage the Poa, yet allows desirable species to grow. More recently pre-emergent controls have come to the fore. Dow's Zytron became popular; then was removed -- DACTHAL, AZAK, PRE-SAN, BETASAN, and

BALAN - Each has their good points and limitations.

PRE-SAN has had an excellent history. It is fully pre-emergent in activity with 4 - 5 months residual in the soil. It's the only pre-emergence chemical specifically recommended and labeled as SAFE on bentgrass putting turf. It completely controls not only Poa annua, but the other two of the "big three" weedgrass pests as well -- crabgrass and goosegrass. It has been used on the same bent putting turf on some courses as long as 6 years -- in several instances as much as two full applications (one spring and one fall) per year.

Pre-San can be neutralized in the soil, should the need arise, with modest applications of activated charcoal so that immediate reseeding can be done with assurance. As to cost, the full PRE-SAN rate costs only about $60-65 per treatment per acre per year.

The idea of strictly FAIRWAY Poa annua control is relatively new. Now, the benefits of gradual poa elimination emerges an entirely new product - PO-SAN. It involves an entirely new concept -- getting rid of the Poa by

a. Retarding its growth, and
b. By inhibiting its production of seedheads

Dr. Roy Goss of Washington State lauded the idea and said - "If you destroy the capacity of the Poa plant to reproduce itself, the species must ultimately disappear." This pretty well sums up the PO-SAN concept, and what PO-SAN does.

PO-SAN is a combination of some growth retardants discovered by our Researcher, Bill Serbousek. After tests for four years, plus golf course tests in 1969, PO-SAN registration for fairway Poa annua control has just been received from Washington. Briefly, here's how this material works. Let's assume a fairway that contains about 60% Poa and 40% bluegrass - bentgrass - fescue misture.

1. The superintendent establishes when his fairway Poa is growing well in very early spring, and judges when he should see the first seeheads on the Poa.

2. A week or two before he expects the first Poa seedheads to appear, he applied PO-SAN to the entire fairway - at the rate of one gallon per acre in 30 to 50 gallons of water - just enough to wet the foliage -- not enough to waste by excess loss in the mat-thatch, or in the soil. Applications should be made when the PO-SAN will thoroughly dry on the foliage, that is, several hours before any rain is expected, or any irrigation is undertaken.

3. That's all there is to it - except to follow normal maintenance practices as regards fertility, watering, disease control, etc.

4. Within a week or so, a slight chlorosis should appear on the treated turf - this should be expected - it indicates the PO-SAN is being absorbed by the grass plants.

5. After another week or two, the chlorosis will have disappeared, and the turf - especially the Poa - will become deep green, dense and sturdy -- and WITHOUT SEEDHEADS (or at least with less than 5% of the seedheads the Poa normally would produce).

6. As the spring and summer move along, the bluegrasses, bents, fescues will seem to become sturdy and aggressive - moving into areas where the Poa slowed down and/or retreated.

7. As summer heat arrives, the retarded Poa annua will appear more heat and drouth-resistant than untreated Poa, and less likely to be "burned out" by the summer sun. It is as if the PO-SAN has encouraged the Poa to put into sturdiness and stamina and better density the effort that would normally have gone into excess seedhead production.

8. Should summer's heat be so high as to "burn out" the treated Poa, the superintendent has no restrictions because:
   a. The desirable species will be gradually filling the spaces
   b. You can reseed desirable grasses at any time because PO-SAN leaves NO soil residues.

9. At the end of the season, the Poa population of the fairway will be substantially reduced - at least as much as 25%, but more likely up to 75%, as was the case in our major tests. In Oregon, a single 1969 spring application on a fairway of 70% Poa found the same fairway in the fall of 1969 with less than 20% Poa. The superintendent was impressed with the Poa reduction, of course, but was even more impressed with how the bentgrass filled in as the Poa retreated. He reported - "I've never seen such aggressive bluegrass."

10. The following spring there will be much less Poa because Poa seedheads were not produced -- were therefore not planted - and therefore are not present to germinate into a new Poa crop. As you see, the PO-SAN concept literally provides for Poa to gradually disappear, and desirable grasses to "take over."

You'll agree the concept is of outstanding interest - and of tremendous impact. Buy enough to treat early - definitely before the masses of Poa seedheads appear -- half of a fairway or two. The cost will be just a bit less than $50.00 per acre.

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POA ANNUA CONTROL WITH DACTHAL

From comments by
Steve Derrick, Diamond Shamrock Company
Cleveland, Ohio

Because Dacthal is a pre-emergence herbicide that kills only germinating weed seeds, it cannot be used to eliminate established Poa annua, but only to control growth of germinating seed. To eliminate mature plants, watering is kept to a minimum allowable by good management. It only takes a short time during warm, dry periods to get rid of established plants, although it is sometimes better to kill the weed gradually when the infestation is more than 15-20%, or where normal watering must be maintained.

Befor applying Dacthal, such practices as verticutting, de-thatching and aeration should be finished so as not to dig up new, untreated weed seeds after treatment.

Where no reseeding is anticipated for a full season, apply Dacthal W-75 at 20 lbs. per acre in late August. Add 12 lbs. in late March or early April to control spring-germinating crabgrass.

Where spring re-seeding is planned, a single annual application of 20 lbs. of Dacthal is recommended in late August.

For best results, the Dacthal Poa annua control program should be continued for years.

Dacthal has better than a 90 day half-life. Also, it is little affected by sun or leaching.

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STRIPE SMUT
INFECTION, DISEASE DEVELOPMENT, and SPREAD

Clinton F. Hodges, Depts. of Horticulture & Agronomy
Iowa State University, Ames, Iowa

Leaf smuts are responsible for severe damage to turfgrasses throughout the eastern and midwestern United States. Stripe smut, Ustilago striiformis (West.) Niessl, is generally recognized as the primary pathogen involved. However, flag smut, (Urocystis agropyri (Preuss) Schrot., has become more prevalent, and may, in some instances, be more common than stripe smut. Both pathogens are recognized primarily for their ability to damage Kentucky bluegrass, Poa pratensis L., and its cultivars.

In recent years, however, the occurrence of stripe smut on creeping bentgrass, Agrostis palustris Huds., has increased at a fairly rapid rate. In 1965, the cultivars Evansville, Pennlu, Seaside, Toronto (C-15), and Washington (C-50) were reported to be infected by stripe smut. Since 1965, Arlington, (C-1), Congressional (C-19), Old Orchard (C-52), Penncross, and numerous experimental cultivars, have been found stripe-smutted. The potential importance of this disease on creeping bentgrass in regard to its ability to do extensive damage is not yet entirely known.

Stripe Smut on Kentucky Bluegrass

Spore germination and infection. To understand the complexity and persistence of stripe smut on Kentucky bluegrass, it is necessary to begin with germination and penetration characteristics of teliospores. The teliospores of stripe smut are produced in tremendous numbers in diseased plants, and upon the death of the plants are deposited in the soil. Once in the soil they are capable of persisting for long periods of time. It is probable that the astronomical numbers of teliospores produced represent a characteristic necessary to the survival of the pathogen. This is apparent in at least three aspects of the germination and infection process.

1. Teliospore germination is extremely low, usually 1% or less; therefore, large numbers of teliospores must be produced to insure infections.

2. Unlike most fungal pathogens of turfgrasses, when teliospores germinate the promycelia (germ tubes) do not penetrate the plant tissue directly. The teliospores, or more precisely the nuclei of the promycelia, belong to different compatibility groups, and compatible nuclei must come together in a single cell in one of several ways before infection can occur. Once compati-

ble nuclei are present in the same cell, the cell proliferates "infectious hyphae," which infects the plant.

3. The production of "infectious hyphae" does not, however, insure infection. Infection can occur only through coleoptiles of germinating seed, axillary crown buds, and axillary buds on rhizome nodes. The stripe smut pathogen does not penetrate mature tissues.

The specific characteristics and requirements of this pathogen in regard to germination and infection explains why masses of teliospores must be produced for the survival of the pathogen. It also explains the low percentage of primary infections via coleoptiles (— 5%) crown buds, (—13%), and rhizome node buds (— 12%).

Pathogen development and establishment within Kentucky bluegrass. Development of the pathogen within the plant will vary with the specific meristem infected, i.e., coleoptile, axillary crown bud, or axillary buds or rhizome nodes. When infection occurs via coleoptiles the pathogen grows throughout all parts of the developing seedling, except the roots, and becomes perennially established in the crown. The pathogen then grows from the crowns with all rhizomes and tillers. If infection occurs through an axillary crown bud the fungus grows only in the direction of the developing bud and becomes perennial in the crown produced from the developing bud. The fungus does not grow into the crown on which the infected bud is located. Infection via axillary buds on rhizome nodes is similar to that of crown buds. The pathogen becomes perennial in the crown formed by the bud, but it does not grow into the rhizome to which the bud is attached.

The perennial character of stripe smut in relation to disease spread and dissemination. The perennial character of stripe smut in crowns of infected plants is responsible for increasing the number of diseased plants in a given area. This occurs in two ways:

1. Once the pathogen is established in crowns, all tillers and rhizomes produced from the crowns are smutted. Such tillers and rhizomes eventually form perennially infected crowns and the cycle is continued indefinitely for as long as the diseased plants survive. Therefore, the perennial character of the pathogen results in large numbers of diseased plants in localized areas.

2. The perennially diseased plants increase the number of teliospores in a given area which in turn increases the number of primary infections via axillary buds on crowns and rhizome nodes in established turf.

Stripe smut is a cosmopolitan organism and some smutted plants can be found in almost any Kentucky bluegrass turf. It is generally accepted that teliospores are soil borne and infect germinating seeds or axillary buds on crown and rhizome nodes. Where the teliospores originated must be left to various forms of speculation. Modern turf production methods do, however, contribute to the dissemination of stripe smut within a given turf and over long distances. Machinery used in maintenance will spread diseased leaves to new areas of the turf. Sod which contains stripe-smutted plants may be shipped great distances, and established new turf areas infested with the disease. And finally, there is some evidence that stripe smut may, to a limited extent, be spread by seed. Stripe-smutted inflorescences have been observed with teliospores in the glumes of individual florets. Dissemination via seed is believed to be insignificant, however, because stripe-smutted plants rarely produce seedheads.

Stripe Smut vs. Flag Smut - Comparative Symptomatology of Kentucky Bluegrass

Stripe and flag smut cannot be separated in the field on the basis of symptoms produced by individual infected plants. Both pathogens produce long, black teliospore masses (sori) between the veins of leaves. On maturity, the teliospores rupture the epidermal cells of the leaves and drop into the soil, the leaves then dry up, split, and shred. Recent investigations indicate, however, that growth characteristics of plants may be different depending on whether the stripe or flag smut pathogen is present. Stripe-smutted plants branch primarily by means of rhizome production. Flag-smutted plants produce mainly tillers and are stunted. There is also some indication the root development is reduced in flag-smutted plants.

Stripe and Smut on Creeping Bentgrass

Symptomatology. Teliospore masses occur in the leaf blade and sheath, and in stolon internodes. Leaf blades contain one to five sori which may extend into the sheath. Appearance of teliospores in leaves is governed by the growth rate of stolons. The leaves of slow growing stolons show teliopsore masses shortly after being formed, whereas rapidly growing stolons may temporarily outgrow the fungus. The rate at which leaves die varies with stolon vigor. Slow growing stolons show necrotic leaves more rapidly than fast growing stolons. Eventually all diseased leaves die; however, the stolons usually are not killed. Following the death of leaves the axillary buds on stolon nodes break dormancy and produce new stolons which are stripe-smutted. The ability of the stripe smut pathogen to survive and grow with developing buds is due to the colonization of stolon nodes by the pathogen.

Recent investigations pertaining to the influence of temperature on growth and development of stripe-smutted creeping bentgrass stolons indicate the development of this disease in creeping bentgrass is optimal during the cool periods of spring and fall. It has also been found that the pathogen is capable of going dormant in stolons during periods of high temperature. The characteristics of stripe smut on creeping bentgrass indicate that it is a potentially important pathogen of this grass.

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THE IMPACT OF DISEASE

Donald H. Scott, Dept. of Botany & Plant Pathology
Purdue University

Pesticide is today a common household word, and thus part of the reason behind the "fungicide controversy." More and more people who know less and less about pesticides are becoming involved in the discussions. Fungicides, herbicides, insecticides, rodenticides, and all the other "cide" chemicals are grouped together under the heading "pesticides." Consequently, many laymen consider all pesticides to be harmful to them and their environment whenever they hear of one case of adverse effects. The problem is compounded by the fact that much of the information reaching the layman is either incorrect or drawn out of context.

The point to be emphasized here is that as professionals in Turfgrass Management you are considered to be experts. None of us want to cause further restrictions to be placed on the uses of pesticides. Mistakes and accidents should be minimized. And,when misused, most of these cases will be due to indescriminate use

and errors by individuals inadequately informed on the uses, precautions and hazards. Therefore, as professionals you must become as competent as possible. It is imperative that your employees are well informed. In short, you must make that extra effort to insure that accidents are held to a minimum.

Plant diseases are a normal part of nature, and they are one of the many checks that help keep the hundreds of thousands of living organisms in balance with each other in undisturbed nature. Cultivated plants are often more susceptible to disease than their wild cousins, especially when large numbers of the same variety are grown together. In short for a turfgrass disease to develop to damaging proportions, three factors are necessary: first, there must be a causal agent. Most causal agents of infectious turfgrass diseases are fungi. Secondly, there must be a susceptible host for the pathogen to attack, and last, the environmental conditions must be just right.

Each disease causing organism has its own set of environmental conditions that dictate whether or not infection will occur. Pathogens are generally more sensitive to environmental conditions than are host plants. Thus, we have brownpatch weather, Pythium weather, and leafspot weather. In addition to affecting both the host and the pathogen, environmental conditions greatly affect the efficiency of fungicides used to control diseases. Weathering by rain, dew and wind, chemical degradation by sunlight, and microbial breakdown all affect the longevity and effectiveness of fungicide spray residue.

With the exception of a few chemicals, most turf fungicides are protectants, which must be applied before infection occurs. Eradicative spray programs, using higher rates and more frequent applications, are applied after disease development has started. In both cases spray programs are designed to reduce the inoculum potential (spores, sclerotia and other propagules capable of infecting plants).

Fewer applications and usually lower dosages of fungicides can be used in a preventive program because the inoculum potential of the causal fungus is relatively low. The probability of a spore or other propagule coming into contact with an unprotected leaf area is much higher when a disease has developed and the inoculum potential is high.

Helminthosporium leafspot is most likely to occur when daytime temperatures are in the 70's, and night time temperatures are above 50°F. While there is some controversy on the point, it appears that a film of water on the leaf surface is necessary for the fungus spores to germinate. Spores of some Helminthosporium species can germinate in a film of water in one hour or less. Cold, wet environmental conditions are necessary for snowmolds to develop. The mycelim of Fusarium nivale can withstand temperatures as low as -20°F. Species of Typhula that cause grey snowmold grow most vigorously at temperatures between 41° and 59°F. Both Typhula and Fusarium can grow at temperatures below freezing.

The environmental conditions affecting the development of brownpatch are more complex. Two stages of fungus development are required for severe outbreaks. Short germ tubes are produced by sclerotia at 64° - 68°F. with high humidity. These germ tubes are short-lived unless the temperature rapidly increases to 73°F. At this temperature the fungus is capable of infecting the grass plants. When temperatures are rapidly cooled to 64°-68°F. by sudden rainstorm or cooling winds, then increase rapidly to 70° - 90° within a few hours, an outbreak of brownpatch is possible if sufficient moisture is available.

Dollarspot is most likely to occur when soil temperatures reach 60° - 80°F. and associated with low soil moisture and sufficient moisture on the leaves from

dew, fog, watering, etc.

Relatively high temperatures are usually associated with outbreaks of Fusarium Blight; however, the environmental conditions are not fully understood. For the past few years, the causal agent of this disease has been considered to be Fusarium roseum f.sp. cerealis or F. tricinctum. However, our work during 1969 indicated that neither of these fungi were isolated until two weeks after the first symptoms of the disease appeared, and then only in very small numbers. It would appear that further work is needed to define the causal agent of Fusarium Blight.

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The following books on turf diseases are suggested:

Turfgrass Diseases

Couch, H. B., 1962. Diseases of Turfgrasses. Reinhold Publishing Corp., New York, N. Y. 289 p.

Hanson, A.A., and F. V. Juska (Editors), 1969. Turfgrass Science. American Society of Agronomy, Inc., Madison, Wisconsin. 715 p.

Sprague, R., 1950. Diseases of Cereals and Grasses in North America. The Ronald Press Co., New York, N. Y. 538 p.

Identification of Fungi

Barrett, H. L., 1960. Illustrated Genera of Imperfect Fungi. Burgess Publishing Co., Minneapolis, Minnesota. 225 p.

PURR-WICK ROOTZONES

In 1970, specifications for a system of construction of a compacted porous rootzone were printed as Midwest Turf leaflet No. 40, January, 1970. Its six pages outline the nine major phases of completing work. It was written for architects, owners and inspectors.

Architects can use it as a base to which they add needed local specs and adaptation. The large bold type is the base ideas. Copies are available to anyone requesting -

MRT Leaflet No. 40 - PURR-WICK ROOTZONE
Dr. W. H. Daniel, Dept. of Agronomy,
Purdue University, Lafayette, Indiana 47907

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PURR-WICK RESEARCH REVIEW 1966-1970

David Ralston, Graduate Research Assistant
Purdue University

Research work pertaining to the Plastic Under sand Reservoir Rootzone method for building athletic rootzones was primarily conducted on the Purdue experimental green with supporting work conducted in controlled climate rooms and the laboratory. The initial goal of the project was to build a rootzone in which compaction could not become the limiting factor - one that would be as compact immediately as it would after ten years or more.

Another objective was to build a system in which efficiency of water use would be at a maximum. The rootzone material needed to be porous enough so that water movement in and through the rootzone would not be limiting; yet, the rootzone needed to store enough water to supply turf needs to avoid droughty conditions.

A detailed laboratory study of the properties of sand was conducted by David Bingaman. He found that much of the information needed for determining the desired water table depth for a uniform sand could be obtained from just the sieve analysis for the sand.

Three areas of plots have been built on the experimental green to study the properties of various sand mixes and various methods of construction. Plastic-lined rootzone plots were built along the North edge of the green in 1966 by David Bingaman. In 1967, thin rootzone plots were constructed along the South edge to study how the depth of material and type of material without plastic barrier would affect water management. The third group of plots was built in the fall of 1969 on the West side of the green to study how the depth and type of sand above plastic sheeting would affect the growth of bentgrass.

Efficiency of water use by the various plots was determined by studying infiltration rate and dry-down rate during the 1968-69 summers. Infiltration rate was measured each year using the standard double ring infiltrometer. The dry-down rate was measured by allowing the plots to wilt after a heavy rain which had saturated all the plots uniformly. The plots were rated each afternoon for wilt susceptibility on a scale of 1 to 9 in which 1 - 2 was normal growth, 3 - 5 showed foot printing, 6 - 8 was blue wilt, and 9 was severe wilt, and that plot was then watered to

prevent complete death.

In addition to visual ratings, the experiment conducted in July, 1969, included moisture content measurements with the surface neutron meter so that the water loss in each plot was measured. The morning dew pattern was found to be a good indicator of moisture availability to roots for the plots without dew in the morning were the ones which showed drought stress in the afternoon.

Since there was no soil in any of the mixes studied, due to its structural instability and great variability, the infiltration rates in the porous sand mixes were adequate in all cases. All were above 3 inches per hour, and most were between 6 and 20 inches per hour. In many cases the hydrophobic nature of the turf and thatch appeared to be the limiting factor for infiltration. This can be easily corrected by aerification to get the water into the porous material below.

A summary of some of the results for the dry-down experiments conducted in August, 1968, and July, 1969, is presented in Table 1.

Table 1 - Results of two Dry-down Experiments

Type of construction	Material	Days from heavy rain to severe wilt	
		August, 1968	July, 1969
Plastic lined	Lake Michigan dune sand		
	a) finer	15*	17*
(PURR-WICK)	b) medium	15	15
	c) medium/finer	15	15
	d) coarser/medium	13	11
	Calcined aggregate		
	100% calcined clay	5	9
	80-20 calcined clay-peat	6	11
	60-20-20 c.c.-sand-peat	15*	17*
	40-40-20 c.c.-sand-peat	15*	17*
	All Dialoam plots	15*	17*
(Thin rootzone)			
No plastic lining	2-1-1 Dialoam-sand-peat	6	9
variable depth	2-1-1 Terra-green-sand-peat		
4, 6,8,10"	3-1 " " " "		
Check plot	Silt loam soil - center of experimental green	6	9

*Indicates total number of days between heavy rains

The 1968 experiment was started following a 2.2 inch rain on August 16, and ran until a heavy rain on the 31st terminated the ratings. The 1969 experiment was initiated after a 2.4 inch rain on July 8 until rain on July 25. Two light rains during the 1969 test period totaling 0.35 inches tended to affect the total length compared to the 1968 readings, but the relative differences within each year are comparable.

Note that the finer fraction of the dune sand made it the entire test period both years compared to the coarser fraction of the sand which showed stress early and severe wilt at the end of 13 and 11 days. This illustrates the difference in water retention after downward drainage stops following a rain. The infiltration rate was slightly lower but still adequate in the finer sand, but the water retentive ability was much better.

The calcined aggregate plots on the North side of the green had considerably different water storage abilities depending on the amount of peat and sand in the mix. The first plots to show wilt, followed rather quickly by severe wilt, were the 100% calcined clay plots. The particle size range of the material is in the coarse and very coarse sand size range, so the results are not surprising.

The 100% diatomaceous earth (Dialoam) plots did not have the drought stress throughout the test periods either year, showing the water storage capacity and movement to be very good. However, this material in high concentrations above plastic showed severe frost heave each winter so it would not be recommended for use alone above plastic. Dialoam at 40% did perform well on the South edge where no plastic was used and only minor frost heave problems were encountered.

Where 20% peat was added to calcined clay, the severe wilt occurred about one or two days later, and where sand was added to calcined clay and peat the plots did not show severe wilt for the 15 and 17 day test periods. The wilt ratings were still in the 1 to 2 range at the end of the test periods for the sand mix plots, each year showing excellent moisture storage capacity.

The variable depth of material plots without plastic lining had a significant difference in moisture content measured by the neutron meter during dry-down, but no real difference in length of time before severe wilt. The 10 inch deep plots were the first to show foot-printing, and the 4 inch deep the last, but they essentially showed severe wilt about the same number of days after the rain, which indicates water around root tips was unavailable in these conditions.

Silt loam soil in the center of the green was used as a check for comparison. It had an infiltration rate of less than one inch per hour, showed wilt after about 4 days, severe wilt after 6 days in the 1968 experiment, and severe wilt after 9 days in the 1969 experiment. The 80 - 20 calcined clay-peat plots on the North side, and the variable depth rootzone plots on the South side, had about the same moisture reserve capacity as the soil check. The sand mixes above plastic had significantly more reserve moisture capacity than soil.

Root depth was considered adequate to excellent for all plots during the 1968 and 1969 growing seasons. The roots were white and actively growing through late winter and spring. They turned brown but did not tend to shorten up or die back during the hot summer months in the rootzone plots on the North and South sides of the green. However, roots in the soil in the center of the green were fewer in number, and tended to be affected more by the hot summer weather, especially in 1968.

Monthly root measurements, as well as photographs, were taken for most plots throughout the growing season. Roots were found down to 6 to 8 inches for most plots throughout the summer, but had a darker brown appearance with fewer root hairs during the summer months.

To better study the factors which affect root development of bentgrass, an experiment was set up in controlled climate rooms in which the type of sand and depth to water table was varied at a cool and hot temperature. Root development at the cool temperature was very slow initially, but continued steadily throughout the 9-week experiment, compared to the rapid growth during the first few weeks at the higher temperature, and then little to no growth after the fifth week. Within each temperature the water table had a significant effect on root development, with the best roots found in the finer sand fraction with the deepest (16") water table.

To summarize the rootzone research, it has been shown that bentgrass can be adequately maintained without the use of soil in the rootzone mix. Through the use of porous materials for rapid water movement to drain lines and plastic sheeting for increased water storage, water use efficiency can be maximized.

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PANEL DISCUSSION ON PURR-WICK

Moderator - David S. Ralston

Introduction

In order to learn from those who have had experience in building and managing PURR-WICK greens and tees, a panel discussion was held consisting of five superintendents. These men had the courage and determination to carry the PURR-WICK idea from the research stage to the most critical test - that of performance under playing conditions. Much of the background for the construction steps recommended in the PURR-WICK leaflet (MRTF Leaflet No. 40) has come from working with these men.

Each member of the panel used slides to discuss his experiences with PURR-WICK, and what modifications were made during the construction to improve the method of building the plastic-lined rootzones. Below is a summary of each presentation with emphasis on the answers to some of the most frequent questions voiced from the audience on PURR-WICK.

Birdie Shelton, L & N Golf Club, Brooks, Kentucky

The first full size PURR-WICK green was built in the fall of 1968 as a practice green at the L & N Golf Club with the cooperation of the Kentuckiana G.C.S.A. The 5000 sq.ft. green was built in about five working days. The final desired surface contour was about 3% slope from back to front. A series of 4 level tiers with a difference in elevation of 6" between each was made. Each tier had a 4" lip of soil on the internal edge so that water could be ponded in the tier. A double layer of 6 mil clear plastic was used to line the green, and a 1½" plastic pipe with slits was used for the drain line in each tier.

The sand used was an Ohio River mortar sand, and 425 tons were used to give a final depth range of 12 to 18 inches within each tier. Four different topmixes were incorporated in the surface 2 inches, which included sand, calcined clay, peat and sponge rubber.

Penncross bentgrass was seeded on one-half, and Evansville was stolonized on the other half of the green. Famco mat was used to cover the green from October 26 until spring. The approximate estimate for materials was $ 2000.00, or 40¢ per square foot, and the total estimate including labor (.20) was about $ 3000.00.

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Bill Story, Carmi Country Club
Carmi, Illinois

A 4000 sq.ft. plastic-lined green was built to replace the existing green on No. 3 hole, 165 yard, par-3. Excavation was started on August 13, 1969, and the green was seeded with Penncross bentgrass on September 4. To greatly reduce the chance of water leakage around the drain pipe where it goes through the plastic sheeting, a bolted plastic flange collar with a gasket was used. The drain pipe was glued into each side of the flange.

The range in sand depth on the green was 12 - 18", and 300 tons of a Wabash River mortar sand was used. The green was open for play October 10, just two months after starting construction. Stability of sand was somewhat of a problem for the first few mowings in the fall, but by spring a root system had developed and the surface was firm and adequate for putting.

Note: (The green was topdressed and rolled twice in April,1970 to smooth the surface. Golfers have commented on the way it holds a shot,and pitting of the surface is not as much of a problem as on some of the soil greens. Water movement into and through the sand rootzone was excellent during the excessively wet spring weather.)

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Morgan Boggs, Perry Park Resort G. C.,
Perry Park, Kentucky

The initial plans and specifications were used for USGA greens. Information from an old time resident, Stan Macanally, led to the location of a sand pit on the property. Test holes were dug at several locations with a back hoe, and samples taken at varying depths to 8'.

After screen tests on the samples, Dave Ralston's, Purdue, results were O.K. on the suitability of the sand for PURR-WICK greens. The final decision was then made to construct all 19 greens to PURR-WICK specs.

Materials used included: 8 mil plastic sheeting on 4 greens, and 6 mil (doubled) on 8 greens across the center of each tier. The 1½" PVC slitted pipe was taped to the plastic sheeting to prevent the pipe from moving when the sand was pushed with a 955 Cat. Traxcavator. Sand was applied lengthwise over the PVC pipe where possible.

Controlled exterior outlets for the PVC pipe were placed over 4" plastic drain tile with gravel fill. Each outlet had a tee installed with a 3" riser nipple, and a pipe plug in the end. 10" diameter chicken feeder tubes were placed over each outlet to ground level.

Plastic water lines were installed leading to each outlet and stubbed off. These will be used for future installation of float valve controls - to supply subsurface irrigation through the slitted PVC pipes - if the need arises. Part circle, pop-up sprinklers were installed around each green to provide irrigation for the perimeter areas. These will also allow recharging of the putting green wick when needed.

The sand depth over the plastic sheeting varies from 12" to 22", and was contoured to the same plans as for the proposed USGA greens. Each green is designed for not less than 3-way surface drainage.

Peatmoss, calcined clay, ureaform and 0-20-20 were tilled into the top 3 inches of the surface with a 90" Sidewinder Tilther. A 3-point lift, tractor mounted Gill Soil Pulverizer was used to re-establish finish grade.

Certified Penncross bent seed was mixed with Milorganite and applied at the rate of 1 lb. seed, and 15 lbs. Milorganite per 1000 sq.ft., lightly raked, and rolled with a hand-roller.

During installation it was necessary to apply some sand to simplify leveling the subgrade on each tier to plus or minus .1 ft. Also, shifting of the plastic sheeting, where the 6 mil was used in double thickness, created quite a problem. Sand was spotted over the double plastic with wheelbarrows and scoops prior to moving the sand on with the Traxcavator. This did not prevent some shifting of the plastic on the plastic sheets. This problem was not encountered with the single thickness 8 mil sheets.

Twelve greens were completed by early winter, leaving 7 more to be built in 1970.

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George Lumpkins, Owensboro Country Club
Owensboro, Kentucky

In the fall of 1969, a 5000 sq.ft. PURR-WICK green was built to replace No. 7 green which had poor drainage conditions, and was subject to frequent loss of turf from Pythium. To form ledges at the edges of the tiers, 4" rigid plastic drain pipes were used instead of soil. Ten mil clear plastic sheets were used under 2" plastic drain pipe with slits for water entry in each tier.

Plastic flange collars were bolted to go through the plastic sheet, and solid pipe was used from the edge of the green to the drain box. Sand depth was 16 - 18", so 400 tons of washed Ohio River sand was used. All sand was spread with the use of a blade on the back of one of the club's tractors which had low pressure flotation tires.

After seeding with Penncross on November 6, 1969, the green was mulched with clean straw which was then sprayed with green dye for better appearance until the seedlings became established.

Estimate of cost	5000 sq.ft.	Per sq.ft.	
400 tons sand	$ 700.00	.14	
Other materials	800.00	.16	
Labor	700.00		.14
TOTAL	$2200.00	.30	.14 = .44 sq.ft.

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A THIN AND A PURR-WICK ROOTZONE

Robert Mueller, Supt., Columbus C. C., Ohio

In October, 1966, the 17th green was reconstructed as a Thin Rootzone (system 7). It utilized all existing soil as a revised contoured base. Then,

slitted plastic pipe was placed into six narrow trenches, 6 inches deep. These were back-filled with coarse sand; then 5" of sand was spread to contour; then 15 cu. yds. of bulk peat, and 3000 lbs. of calcined aggregates were mixed into the top 2" of sand. All this was fertilized, compacted, stolonized and kept moist. Its estimated material cost was 30¢ sq.ft. It has been the favorite putting green of the membership and the easiest to maintain.

When improved surface drainage and new seeding of fairways 1, 2, and 3 was undertaken in the fall of 1969, Dr. Daniel assisted us in developing a PURR-WICK Rootzone for No. 2 green (6000 sq.ft.).

From my experience with PURR-WICK the proper earth moving and leveling equipment not only saves much time but makes the leveling easier. Our 4 tiers allow 36" of change front to back, plus 18" variation left to right.

When installing the plastic sheeting, taping of edges made earlier handling of sand easier. Also, ample vertical edge of plastic, and anchoring to avoid slippage, will minimize force of moving sand. We tried to use coiled, flexible 2" tubing (slit by coping saw), but much prefer more uniform pipe (straight). For exterior drain to pit rigid solid pipe would have been much simpler to install than cold, coiled PVC.

Plans for 6000 sq.ft. required 500 tons of sand; however, 640 tons were delivered. This increased storage capacity for reserve water, so isn't wasted - in some places sand is a full 24" deep.

Thin Penncross sod was taken from 2 greens of our 9-hole course. It was Greens-aired just before, and topdressed heavily after placing. Sodding was completed the last of October, '69.

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THE PURR-WICK SYSTEM - OUR EXPERIENCES

Charles H. Tadge, Supt. Mayfield C. C.,
Cleveland, Ohio

Our experience with the PURR-WICK system has been limited to the building of a ladies tee for our 18th hole.

About October 15, 1969, we began preparing the base of the tee which was to be 20 ft. wide by 30 ft. long. The base was excavated 6 inches below the existing terrain. Rough excavation was accomplished with a front endloader, and then finished by hand to be as level as possible. The soil removed was placed around the edges to be used in the bank contouring. Strips of 1/8" masonite 14 inches wide were used as forms on the sides, with soil against the outside and wood stakes on the inside. The top edges of the masonite were leveled with a transit-level.

Next, two layers of 4 mil polyethylene were placed on the base, and up the sides to the top of the masonite. This would form a waterproof liner to provide the reservoir of water desired for this technique.

A pop-up sprinkler was installed in the center of the tee with a manual shutoff in front of the tee. The drain lines of $1\frac{1}{4}$" PVC-DWV pipe were placed on the plastic base. The pipe had slits sawed on the sides at 6" intervals for water entry. It was laid out in a 3-row gridiron pattern, draining off the front corner of the tee into a covered access pit. In this pit, made of corrugated metal drain pipe, the fittings for water level control were placed. The drain pipe and the water line were the only two holes in our plastic-lined reservoir. These holes were sealed with roofing mastic inside and out. The drain pipes were covered with a few inches of coarse sand to prevent fine sands from clogging the slits in the plastic pipes.

The area was then filled with a washed mason sand purchased locally. The sand seemed very well suited for the PURR-WICK system since a mechanical analysis showed only 11% to be 1.00 mm. and larger, and only 14% to be less than 0.25 mm. The sand was dumped from trucks into one end, and worked by hand over the rest of the area since it was too small to use powered equipment. Our labor costs were high because of extensive handwork.

The sand was then watered and tamped until level with the top of the 14 inch masonite forms. At the same time, the soil pushed in around the sides against the outside of the masonite. Then, when all soil and sand were in place, the masonite was removed. Next, about 24 cu. ft. of peat was roto-tilled into the top 3 inches of the sand. After preparing the side banks and firming the sand area, the tee was sodded with Warren's A-20 bluegrass on November 14, 1969. The side banks were sodded with common Kentucky bluegrass.

Costs for 600 sq.ft. tee

	Materials	Irrigation	Sod	
Plastic liner	$ 14.00			
Masonite	15.00			
Plastic drain pipes & fittings	30.00			
50 tons mason sand	210.00			
24 cu. ft. peat	32.00			
Irrigation equipment		$ 70.00		
Sod			$31.00+	
Labor, 100 man hours $2.40				$240.00
Total cost - $ 642.00				
Cost per sq. ft.	.50	.12	.05	.40 =
	- - - - - - - -		$ 1.07	

PLANNING NEW TURF FACILITIES

William E. Maddox, Maddox Construction Co.,
Batavia, Illinois

A new golf course is like a new coin. On one fact people see the design of the Architect. On the other face, they see the handiwork of the Superintendent who has tried to get the course in play - usually under very trying conditions - to meet an impossible deadline set by the owner. Inbetween these two faces lies the center of the coin which represents the work of the contractor. I'll leave it to you to judge whether any part can be separated from the coin, or as to which has the most value.

I am the fourth generation of a family Company that built the first golf course west of the Allegheny Mountains in 1890. I have helped build courses in

14 states, in islands, Mexico and Canada. Our problems begin with the contract negotiations. If things go well the next step is to inspect the site. At times communications are very poor. Usually the superintendent is in on all negotiations. Please keep yourselves informed on the future of your golf course, then you won't be surprised as to the final outcome of the layout. Many times the course is affected adversely by the budget - something that we as contractors can't help.

We built a new course for the Playboy Club of Lake Geneva, Wisconsin. I first heard of this project five years ago. The first time I went up to look at it with my Dad and brother, Chuck, it was an abandoned sheep pasture. Some men had tried to start a ski lodge on one of the highest hills. The rope tows had been placed on the hills facing south and west. Consequently, the snows melted very rapidly and they were out of business.

All the ropes had been cut by vandals and hung in crazy loops and curls from the pulleys. The windows and doors were smashed on the ski lodge. The parking lot, which had been built on the only flat place, a 45 ft. deep peat bog was slipping into the black, mushy depths. The Playboy Club had just purchased the property and was determined to make it into a first-class resort.

We didn't build the first 18 because we had too many commitments. The second course,that was designed by Pete Dye and Jack Nicklaus as a consultant, was built by us in 1968-69. It is an old Scotch course of about 6500 yards with many tough holes set in the Kettle Moraine Hills.

Tremendous cuts and fills were required; yet, the whole finished course is to appear rustic and natural. The areas for greens were cleared down to Moraine gravel; then 14" of sand was placed; then 2" of peat was roto-tilled, plus fertilizer, into top of sand; then firmed and planted to Penncross.

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EXCHANGE RESINS AS A SOURCE OF NITROGEN FOR TURFGRASSES

Melvin J. Robey, Physical Plant,
Purdue University

One of the more serious problems on old and new putting greens is soil compaction. Soil compaction makes management difficult because it restricts the movement of water and air into the rootzone, thus retarding the growth of the grass plants.

One method being developed at Purdue, to reduce the problem of compaction, is the construction of thin rootzones. Mixtures of sand, peat and calcined clay are placed over frequent shallow tile lines. No soil is included. These materials are compacted during construction. These materials have good water-holding capacity, excellent internal drainage, and large pore space at maximum compaction.

Maintaining an adequate fertility level is difficult because of three factors:

1. Not having soil in the mixture causes a low cation exchange capacity in the mixture.
2. The large pore space allows the water to move through the soil readily
3. The excellent internal drain allows all of the nutrients to be leached.

An intensive fertilizer program is needed to compensate for the nutrients removed from the rootzone by leaching. The use of ion exchange resins may reduce this problem by increasing the exchange capacity of the rootzones.

Since there are ways of adding cation exchange capacity by the use of peat and calcined clays, the application of anion resins is of more importance. Without any way of holding the anions in the thin rootzone, or soils for that matter, the anions will be leached beyond the roots.

Work being done at Purdue has shown that the anion resins are capable of storing and releasing nitrates over a long period of time; thus, being similar to the organic nitrogen fertilizer being used today. The release of the nitrogen from the anion resins is not dependent on the soil temperature and micro-organisms, but is an exchange reaction similar to that occurring on a clay colloid.

It has been demonstrated that the anion exchange resins in the rootzones can be regenerated by surface application of an inorganic fertilizer such as ammonium nitrate. The addition of an anion exchange capacity would reduce the loss of nitrate-nitrogen from the rootzone and help cut down on losses. One cubic foot of anion exchange resin mixed into 1000 sq.ft. of area is capable of holding more than one pound of nitrate nitrogen.

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PURDUE STADIUM MAINTENANCE PROGRAM

Melvin J. Robey, Physical Plant
Purdue University

The Physical Plants' first two years of construction and maintenance on the Stadium was initiated to correct the following problems:

1. Less than ample drainage
2. Inadequate irrigation system
3. Poor stand of grass
4. Soil compaction
5. Low soil fertility

Poor Drainage

Although tile lines were placed every 30' at a 45° angle under field, plus around the perimeter, the rate at which water moved through the soil into the tile lines was not satisfactory. The center of the field was stripped of sod and regraded forming a 12 inch crown above sidelines.

Narrow vertical trenches were first dug over all existing tile lines. The vertical trenches were refilled with pea gravel to within 4 inches of the surface; then filled with a medium sand. This "capping" was to increase the water-holding capacity in the rootzone area. To save on hauling of materials the width of the

slit trenches should be as narrow as possible (2 - 3 inches).

Inadequate Irrigation System

Up to 1968 the field was watered with traveling sprinklers, which had to be moved periodically by hand.

During the summer of 1968 an automatic irrigation system was installed. PVC solvent weld pipe was used for the 3 parallel lines through the playing field. Sixteen rotary and 2 part-circle pop-up sprinklers, with vinyl covers, were installed. Artificial turf was glued to the top of each sprinkler head to increase resiliency.

Soil Compaction

Soil compaction is the most serious problem which is encountered in athletic field maintenance programs. If the maintenance program is not set up to control soil compaction, other work and money spent will have been wasted.

To reduce soil compaction, the football field was aerated 4 to 6 times a year with a Greens-aire. Prior to the aerating after the football season, a topdressing material was spread 1/4 to 1/2 inch over the entire field. Equal parts by volume of sand, peat, calcined clay and crushed corncobs were used when preparing the mixture.

After aerating, the field was dragged to break up the soil cores, fill in the aeration holes, and better level the field.

Listed below are eight reasons for topdressing athletic fields:

1. Protect crowns of grass from football cleats
2. Level the surface of the playing field
3. Increase water infiltration and percolation rates
4. Increase resiliency of playing surface, thus minimizing player injuries.
5. Improve soil structure
6. Increase water-holding capacity of the soil
7. Build up the nutrient level of the soil
8. Increase cation exchange capacity of the soil

Topdressing followed by aerating is essential in reducing soil compaction. Aerating opens holes in the soil. Dragging the field permits many holes to be filled with the porous topdressing which assures an adequate oxygen supply reaching the roots.

Poor Stand of Grass

This condition was corrected by sodding the center of the football field. The bluegrass sod used was a mixture of Merion, Newport, Delta and Park. The entire playing field has subsequently been seeded with this same bluegrass mixture.

Low Soil Fertility

A fertilizer program was set up which would work in conjunction with the other maintenance procedures. A heavier rate of nitrogen has to be used when high rates of organic material are used in topdressing the field. Two pounds of nitrogen as 33% NH_4NO_3 per 1000 sq.ft. will be applied in late March each year.

This forces early spring growth; yet, the majority of the nitrogen is assimilated by the micro-organisms as they decompose the organic matter applied in the top-dressing mixture.

In May, 8 lbs. of 31%N as IBDU/1000 sq.ft. will be applied to the playing field. This source of nitrogen will last through the summer and into early fall. 200 lbs. of potash will be applied during the year. No phosphorus will be used since a calcium arsenate program is being used to control annual grasses.

Two years of construction and improvement has solved the problems listed (more vigorous grasses and soil warming could be further improvements).

A program of aerification, topdressing, and fertilization is the minimum maintenance an athletic field should receive. If manpower and money is available, then a more intensive maintenance program should be initiated.

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THREE ATHLETIC TURF CARE PROGRAMS

W. H. Daniel, Turf Specialist, Purdue University

Athletic turf needs to be the best possible. The outlines below expand to match budgets, supplies and technology. Program starts before players suit-out and fall practice starts (assume August 10 in Indianapolis).

Economy

A. Fertilize to force grass growth and recovery.
Consider 50 - 100 lbs. N inside track oval
Example, Urea 45% at 100 - 200 lbs.
16-4-8 at 300 - 500 lbs.

B. Start watering if at all possible - as needed.
Consider travel ing types with automatic cutoff - turf (more efficient) or lawn (less expensive) type

C. Mow often at 2" height - as high as practical rather than as low as possible. Keep more leaf for more wear and cushion, and new energy within plants.

D. In early season spread the wear - warm up on sidelines.
Save the center of the field. Keep moving around. Use extra lines at edges, etc.

E. Overseed lightly before each home game - 5 lbs. in knapsack seeder - onto thin areas. Use blend of better bluegrasses.

F. Fertilize again by mid-season - to force growth as soil cools.

G. Mulch worn areas with 2000 lbs. crushed corncobs immediately after last use of field in fall. (Alternate 2 - 3 cu. yds. of bulk peat)
They improve structure and infiltration.

H. Fertilize in (late winter) - use soluble N to force grass early.
(early spring)

I. Kill weeds and knotweed, before they compete with grass, as soon as school is out (June 1 - 15)

J. Mow often, but HIGH all summer.
Build reserves of energy.

Medium

All points of economy, plus

A. Use better nitrogen sources

B. Water to keep turf from wilting all summer and fall.

C. Mow 2" until second home game, then 1.5" as weather cools

D. Spread the wear - use practice fields

E. Overseed before each home game.
Put 3" deep plugs into divot areas

F. Fertilize again by mid-season
Roll lightly after each game as needed

G. Mulch thin areas with corncobs as play ceases.

H. Fertilize to force early spring growth
Prevent crabgrass and foxtail in center half

I. Kill weeds and knotweed as needed before they compete.

J. Mow high - 2"+ all summer
Water only when wilt shows - if in doubt don't water
Aerify once in mid-summer - 4 - 5 times over in 1 day to thoroughly loosen soil; then roll as needed.

Best

All points of Economy and Medium, plus

1. Assure adequate drainage
   a. Vertical trench - 5 yards apart - above tile lines first
      then between as needed
   b. Vertical slits by shovel in wet spots
   c. Vertical grooves - from sideline to sideline annually -
      1. With topdressing of calcined aggregates - 5 tons annually
      2. Prefer doing this in early summer

2. Prevent crabgrass, etc., with pre-emergence material April 10 - May 10
   a. Mow grass twice before applying pre-emerge

3. Protect from disease
   a. Spray about 4 times a year to reduce leaf diseases

4. Topdress in early fall to bury crown of plant
   a. Cleats only down to leaf - not pull out crown
   b. Encourage short cleats on shoes of players

Note: In an emergency on practice fields spreading dry topdressing of peat, sand, and/or calcined clay (which absorbs water rapidly) can help reduce surface wetness. Then, light rolling can also help playability.

5. Keep the turf growing and knitting.
   Consider using large particle sizes of IBDU, a controlled N source, which permits uniform release of N, especially in fall use period.

6. Dress it up. Spray damaged or worn areas with green paints, etc.

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UNIFORMITY IN IRRIGATION

Gayle Hilton, Buckner Sprinkler Company
Fresno, California

Turf managers should have a good understanding of application rates, uniformity, and the limitations of sprinkler irrigation. Spacing, coverage and overlap may seem quite simple; however, there are a number of misconceptions.

First let's take a look at a typical spacing of three sprinklers. You will note various areas are getting water from one, two or three sprinklers. Therefore, it is assumed that the areas are getting one, two or three units of moisture.

Looking at the side view of a sprinkler operating, we should see an even curtain of water falling to the ground. As the sprinkler starts to turn, you will observe the farther the water lands from the sprinkler, the greater the area to be covered. Test tubes set at even intervals from the sprinkler provide a profile of the pattern. The high point is under the sprinkler and diminishing toward the outer edges.

In actual operation, wind, operating pressures and other factors will vary the profile. There are many combinations and factors.

Let's look at a sprinkler pattern with two sprinklers overlapping about 70% of the diameter (70 ft. apart if the diameter was 100 ft.) You will note the area which is being hit by two sprinklers would receive a total amount of moisture equal to the single coverage close to each sprinkler. This is how we obtain uniform coverage. By adding a third sprinkler in an equilateral triangular spacing you achieve the same uniform coverage between all three sprinklers.

With single row fairway spacing the sprinklers are spaced very close together to give the maximum fairway width. This would be 90 ft. if the sprinkler diameter was 200 ft. By the use of the contouring method you will note that the contour lines are basically parallel with the fairway. Also, the amount of water uniformly diminishes from the fairway center line to the edges. There is overwatering in an approximate 45 ft. path down the center, and only about a 120 ft. well-watered fairway.

The two row system would have the sprinklers at approximately 80 ft. in triangular spacing (only about 10 ft. closer than the single row). The contouring now discloses uniform watering throughout the central area and out about

30 ft. on each side of the sprinklers. This will give a uniform watered fairway of 150 ft.

The cost for a double row is only about 5 to 8% more expensive than the single row.

In summary -

Never space sprinklers farther than recommendations
Analyze coverage by the total units of moisture from each sprinkler
The two row will always give more uniform coverage than a single row system.

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IRRIGATION AND ATHLETICS

Paul Bando, Sprinkler Irrigation Supply Company
Glen Ellyn, Illinois

Does anyone know how many major league baseball teams are converting to artificial turf this year? Quoting a recent article in The Chicago Daily News - "The phony turf will be installed at St. Louis, San Francisco and the new stadiums in Pittsburgh, Philadelphia and Cincinnati."

At this time three schools in the "Big Ten" have artificial turf -- University of Michigan, Michigan State University, and the University of Wisconsin. These installations should be of concern to us because professional and collegiate advocates of artificial turf are claimining fewer injuries, more economy of maintenance, and more consistent playing conditions.

I also read in the Chicago Tribune last fall that football fields in the Chicago area are being used as much as 7 - 9 times a week. With this much use the only way turf could exist would be to install artificial turf at a cost of $ 300,000. The paradox is that when I call on architects who design high school athletic fields there is seldom enough money budgeted for irrigation. If irrigation has been included, it is the first thing eliminated if costs run too high.

To provide an adequate turf athletic area, I feel that some type of irrigation system must be present. The three main types of athletic irrigation systems are portable aluminum pipe, traveling sprinklers, or pop-up sprinklers with manual or automatic control valves.

Athletic fields normally receive heavy use during daylight and early evening hours which necessitates night irrigation. Night irrigation lends itself to automatic time control. With an automatic system you will have better conservation of water, more uniformity of precipitation rates, better control of application rates, better use of your personnel, more effective use of fertilizer and seed, and less resodding.

The following is equipment which should be used for automatic irrigation systems: pop-up type sprinklers with rubber covers, pipe (which could be PVC, polyethlene, copper or steel), automatic zone control valves, an automatic timer, a back flow preventer, and possibly a booster pump.

To have an automatic system which functions properly some minimum requirements are - relatively clean water, 50 GPM volume, and flow pressure 40 PSI (or 60 static). If you don't have enough pressure use a booster pump rated at existing GPM. Also necessary is 1½" iron pipe thread water service located adjacent to the athletic field, and electricity.

Important factors to consider when designing a baseball irrigation system are: never put pop-up sprinklers in base path, try to keep sprinklers out of infield, and use part circles in grass behind the base paths. This is to maintain proper irrigation rates on grass and dirt areas. Put the quick coupling valves behind the pitcher mound for watering the infield.

When designing an irrigation system for a football field, the automatic valves and vacuum breaker should be kept out of the playing area. Sprinklers should be spaced with one row 2 feet upwind of the center of the field, and one row to the outside of the hash marks.

If high pressure and volumes are available I would suggest installing sprinklers around the perimeter of the field using part circle sprinklers.

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BINAR - A TWO WIRE AUTOMATIC IRRIGATION SYSTEM

Ted Woehrle, Supt., Oakland Hills C. C.,
Birmingham, Michigan

The BINAR system is basically an electrically controlled hydraulic irrigation system. Two wires are used for transmitting electrical pulses throughout one entire zone of irrigation. Attached to these same two wires are the decoders which are found at each individual sprinkler or station. The greens are divided into two stations.

Regular house current is used as the source of power for the 8 controllers, which are grouped into three areas. A third wire runs between all field controllers and the central control at the maintenance shop. It is also hooked to the "rain omit" devices which is used to shut off the system if rain should come.

From each controller pulses are sent out by two wires as direct current at low voltage, wattage and amperage. These are received by the decoder which in turn sends the signal to the three-way solenoid, which is connected to the individual sprinklers with hydraulic tubing. This requires three short lengths of tubing for each sprinkler. So, now we have individual sprinkler control varying from 0 minutes to 60 minutes.

There is a clock at each controller to tell the zone to start watering. Once a program is set in the field and the clock is set for a given time, the sprinkler will begin to operate at that time, and follow the set program within that controller. Sprinklers can also be operated from the controller manually, or turned on while at tne green by a control there.

"Central Control" - is relatively new. A central controller can tell the field controllers to water only greens, only tees, a combination of tees and

greens, half the fairways, all the fairways, syringe, and any combination of the above, or turn off the system.

One other item is the "percent dial," which can increase or decrease the time without changing each individual time. Say that possible rain is predicted and suddenly it is called off after you have already programmed the system. All you do is dial an increase designated by percent, such as 150%, and the times will all increase 50%.

Our central controller is portable. It can be taken any place where there is a telephone jack and a source of electricity. By setting a program on the controller and plugging it into the two receptacles, we can now operate the irrigation system from our home or place of business by simply dialing a telephone number, and having the program sent over the wires to the device back at the maintenance shop. It is then transferred out to the controllers in the field and the system has been activated to follow instructions.

Many other devices are available. Others will be coming soon. Stop to think for one second. Ninety percent of all irrigation engineers whoever lived are now alive, and new discoveries and inventions are being made every day. Turf irrigation is full of magical things patiently waiting for someone to discover and apply them to our needs.

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SERVIGING MODERN EQUIPMENT

Joseph B. Kelly, Riley Lawn & Equipment Corporation
Indianapolis, Indiana

Of this panel one is in management, one in sales, and one in parts and service department. To service modern turf equipment we must have modern servicing equipment and tools. We must keep informed as to what is new and what servicing techniques are required. In the past three years, the Riley Corporation has arranged for almost one hundred customers to attend the Jacobsen Service School at Racine, Wisconsin. It has been beneficial for we may rely on the phrase - "The equipment is as good as the service behind it."

A list of tools and shop equipment a golf course should have in a modern shop includes: a completely equipped tool cabinet, air wrenches, steam cleaner, air compressor, hydraulic testing equipment, battery charger, battery tester, tire gauges, water pressure gauges, special wrenches and dies, grinding wheel, bedknife grinder, reel mower grinder, drill press, wheel pullers, etc. Also, a file cabinet, owner's manuals, and bookcase for references and publications.

A file card should be kept on each piece of equipment. Information should be kept on purchase date, supplier, model and serial number, oil change record, lubrication record, all replacement parts installed, and the cost and date of installation. If we replace the same belt several times a season on a particular machine, we know to check belt alignment, pulleys, tension and for foreign matter such as grease or oil that could cause belt deterioration. This record is very valuable, but must be kept on a day to day basis. A knowledgeable golf pro once said a look at the superintendent's building and equipment can determine the condition of the golf course. If the shop is shabby and the equipment dirty and inoperable - rest assured the course is in the same condition.

Train your operators and make them responsible. Someone should be assigned to the duty of putting malfunctioning equipment on the "Red Line" or taking it out of service. Be sure the operator listens for tell-tale signals such as a knock or other strange noise from an engine, pump or mowing unit. If it does not sound right, stop the equipment and investigate before irrepairable damage is done.

Order factory parts and specify method of shipment. Use part number and model number when ordering. Make sure you know of component changes in new equipment that resembles the old model you already have. For instance, a new greens mower has solid state ignition - this unit, if inoperable, is replaced as a unit.

Mr. Jim Whitcomb will lead the discussion on Safety in servicing modern equipment.

Your new hydraulic equipment is often kept inside when not in use. Make sure you can move it out quickly in case of fire or other emergency.

Grinding wheels are dangerous - do not tighten them until they crack - do not use a soft wheel where a hard wheel is required. Each grinding wheel is speed rated - make sure the wheel you are using is within the safety limits. Stand out of line of the rotating wheel when it is first started and remain there for the first minute of operation. If it is going to blow this is a likely time. Do not use washers, but use the flanges that come with the grinder. Do not try to use washers to make a wheel fit a machine for which it was not intended. Wear goggles at all times while grinding and keep the machine clean.

Make sure fire extinguishers are full and are serviced with the proper chemical. Know what extinguisher to use on each type of fire emergency. Do not clean parts with a flammable cleaner. Check for proper ventilation when pouring gasoline, and do not fuel power equipment when engine is running, nor over-flow gasoline.

Follow your operator's manual for recommended lubricants. Modern equipment sometimes has more check points, such as hydraulic reservoir, power steering, etc. Also, know where to use air-grease gun as opposed to hand-grease gun, and learn how to use both. Do not use white gas because engine does not run properly on regular gas. If it does not operate right on recommended fuel, repair it or take it to the service shop. Keep fuel in clean containers - underwriters approved. Strain hydraulic fluid through cheescloth if you are concerned about foreign matter. About white gas - one customer cracked the deck around the motor base on a rotary trim mower and replaced three decks before he learned that white gas, which caused excessive heat, was the cause of the breakage.

Check and adjust bedknives on new equipment every thirty minutes. Reel should be just touching bedknife. Drive tractor with fairway mowers at a speed of 4 - 6 MPH. Blitzer mowing speed at 6 - 8 MPH. Do not operate reels except in grass as the grass lubricates and prevents heat distortion of reel blades, and holds down excessive wear.

Check tire pressures twice daily on all pneumatic tired equipment. At the end of the day equipment should be washed off, and belts, nuts and bolts, chains, etc., should be checked for tightness. Wear proper clothing, safety helmet, safety shoes and watch for excessive speeds when transporting equipment or personnel.

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SUCCESS WITH ZOYSIA

Edward Boyd, Supt., Evansville C. C.,
Evansville, Indiana

Zoysia was introduced to our golf course in the early 1950's when Mr. Ernie Schneider was Superintendent. As a crew man, I can remember plugging from a small nursery until I thought my right foot and arms would fall off. We put those plugs into the tees and collars of the green. The tees were then blue-grass, and it wasn't long until the Zoysia was taking over, and our members became aware of the change and liked how they played. Several types of the newer Bermudas were also introduced which made our members aware of the common Bermuda on the course. In the hot and droughty periods these grasses always stood out, and held a ball into perfect position for a golf shot.

About 1956 was a beginning of a new era for the Evansville Country Club. Our players wanted close clipped fairways and would not settle for less, and by this time Zoysia had really come into its own. Homeowners had put it in their lawns with great success, and it was withstanding all the rigid tests on the golf course while producing an excellent playing turf with a very minimum of maintenance. Our members were sold, and so a Zoysia program was to be set up and go for Meyer zoysia from tee through fairway.

The Zoysia was planted sy sprigging, plugging, strip-sodding, and also several areas were solid sodded. These materials were either from our nursery, or purchased from the large sod farms. For ten years we have had two acres of Zoysia in the nursery, which has been stripped off several times, then nursed back to full coverage. Now we have 2 acres of tees, and acres of fairways, plus clubhouse areas in Zoysia.

Now for maintenance, we are not equipped to dethatch anything other than our greens, so we burn our Zoysia thatch off with fire any time after March 1. Tees are sometimes burned, then raked and burned again. Burning the thatch seems to bring the grass out of its dormancy even sooner than unburned. We aerate as soon as the ground is firm enough for equipment to run. This is done with a West Point aerator with 3/4 inch spoons, tractor-drawn, and a mat tied behind the machine to break up the cores in spring and fall. We get our watering system ready to go at this time so we can begin our fertilization program of 6 pounds actual nitrogen per 1,000 sq.ft. per year.

I start my program in early April with a complete fertilizer such as 12-4-8, at 370 lbs. per acre to get the turf growing. Another application in May is followed up in June with an application of 33.5% N as ammonium nitrate at a rate of 130 lbs. per acre. In July and August, I use a liquid fertilizer, and at this time I also add a surfactant as in normal seasons - by this time the water is having trouble penetrating. Then in September, I put on another application of the 12-4-8. Our soils are low in potash, so we are building potash up also. We lime when the soil samples call for it. This rather heavy fertilization program has helped get coverage, so that our front 9 fairways are about 90% Zoysia and Bermuda.

We have a 7-gang Toro Parkmaster with 8 blade reels for mowing fairways, and this machine does an excellent job for us. We cut our fairways at 1/2 inch in the spring,and as it gets hot and dry we may raise the mowers to 3/4 inch. We mow fairways constantly when need be, and never under 3 times a week. The tees are kept at 1/2 inch at all times.

When we get full coverage with our Zoysia and Bermuda, I will then go to a fall pre-emergence for Poa annua. So far our Zoysia has always come through the winters with no signs of damage. The tees are used year round, and they have not showed any signs of damage.

So far insects have not been a problem in our Zoysia, but I have been called by many homeowners who have been very heavily damaged by what is known as the billbug. The adults, which are called snout beetles, vary in color, from light olive-yellow to brown and black, and are from 1/4 to 1/2 inches long. The larvae or grubs are short, thick-bodied, curved and legless.

Injury is caused by the bug eating off the roots and crowns at ground level. The damage shows in circular patterns of maybe 3 to 4 inches, and as large as 3 and 4 feet. These circles start showing signs of wilt and could be mistaken for dry spots. A quick check can be made by pulling on the turf as if you were picking a chicken. If the billbug is present, he has sheared the roots and the turf will pull right off. I have seen many beautiful Zoysia lawns literally wiped out by this pest in our area in the last two years. They have used several different insecticides, such as chlordane, lead arsenate, and dieldrin, both liquid and granules with very little success. This year I will recommend the product known as Diazinon, both as a liquid or granules.

I would prefer the granules for easier application as any of these materials have to be washed in. The lawns that have billbug are mostly the older ones, and have quite a thatch buildup. I would urge any of you that have Zoysia to keep a close check on it for this insect and to keep thatch down.

The Evansville Country Club has come a long way since the Zoysia program was started. We know we still have a long way to go, and I hope to accelerate the program this year. Our members are extremely happy with the condition of our Zoysia turf.

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SLOW STARTING INTO SOD GROWING

Wm. J. Huber, Huber Ranch Sod Nursery,
Schneider, Indiana

Huber Ranch Sod Nursery is located on Route 41, in Schneider, Indiana, about 50 miles south of Chicago. In 1966, I took over the family farm. It consists of 800 acres of level, black, sandy loam soil, and is very adaptable to sod production. Up until this time, I had been working in trucking, and had little to do with farming. For this reason, I knew I had a lot to learn, but I also felt that the best way to get into the sod business was to build a balanced operation, and work into the sod business slowly.

For the first few months I talked to a lot of people. Dr. Daniel's encouragement and assistance was most helpful, and continues to be so. I read what I could, and started to buy equipment to plant crops in the spring. Since it had been basically a cattle farm, most of the field work had been done by custom operators, and all of the equipment was worn out.

I bought the needed equipment, and two weeks before planting time, my

only hired man left with just a couple days notice. I was able to get another man and started planting on time, but neither of us had enough experience to cope with the many problems, and it was very late when we finished planting. One of the main problems was drainage, so that was given a lot of time that year, with surveys, ditch cleaning, new ditches, and a new big volume drainage pump.

In order to properly market our corn crop, I felt that it was necessary to install a grain dryer and improve our storage facilities. Then it seemed important to start feeding cattle in the fall in order to get a return from our cattle lots. I had to work on our silos and set up an automatic unloader. About this time, a man approached me on a hog feeding partnership that looked good, and one in which I could learn a great deal about livestock. I then built a building and we started in business with about 700 pigs.

While these other projects were going on, I had purchased equipment and supplies for getting our first 40 acre sod field planted, including a volume gun sprinkling system. Things got so hectic with the weather and all, that I just couldn't get the ground ready in time, felt it best to concentrate on everything else, and lost a whole year on getting into sod production.

We started our first bunch of cattle that fall, and in the middle of corn picking, the belt broke on the 65 ft. elevator going to the grain dryer, and all of the buckets fell down inside the elevator. It took three days to get that mess squared away.

That winter I was able to hire a good farm manager. With him and the other man we worked with the cattle and hogs, and made plans for the year ahead. I joined the Sod Growers Association of Mid-America, and continued to learn what I could through turf conferences and reading.

My partner in the hog business, because of bad health, decided to quit after one cycle, so I bought him out and went on on my own. This was another capital requirement that I hadn't counted on, but it is one that gives us a good cash flow, because I buy and sell 250 hogs every 3 to 4 weeks all year round. It also gives us a good return on winter labor, plus feeding our own corn.

Things started to run a lot more smoothly that season, and we got 50 acres of sod seeded. Then, in the middle of August, all 165 head of cattle broke out of our feed lot just 30 days before they were scheduled to go to market, and when the corn was the tallest. We used an airplane, horses and a dog, and after a week and a lot of trampled down corn, we had most of them back. We didn't get the last couple back 'til the middle of December.

That winter we dug a $ 3500.00 well and only got 100 gal. per minute, so had to cap it,and now rely on water from the ditch and our 7 acre lake. We were fortunate to have a big drainage ditch along the entire length of the farm.

In August of 1968, we were finally able to harvest our first roll of nursery sod. It is interesting here to note that this first roll of sod came after a capital investment of $ 225,128.65 and a few grey hairs. That fall we moved a small amount of sod all by hand. We also put in another 50 acres of sod which brought us up to 100 acres in production.

By the spring of 1969, we had decided on a pallet system, using a towable fork-lift. I then hired our third steady man and set up a small trucking firm to handle our trailer loads. After two weeks of agonizing delays, I bought our

own semi-tractor and trailer. It became evident that we had to have our own semi along with our straight truck to properly schedule our deliveries, at least to get started. At this point our capital investment had reached $ 255,000.00.

Throughout the season our reception was very good, and our peak labor loads were handled by the use of high school boys, and a fourth full-time man. In the fall we planted 85 acres of new sod,and reseeded the 25 acres that we had moved in the spring. This now put us at 185 acres in sod production. We had to add 4 new wheel move irrigation lines to handle the new seedings, plus the established sod. By the end of the year, we had cleared out almost all of our available sod, and wound up a profitable year. Our gross sales during 1969, including livestock and grain, totaled $ 335,000.00.

During 1970 we will use at least one more towable fork-lift, working with cardboard pallets; depend more heavily on a new trucking firm as our load requirements increase and level out; start using an increasing number of migrant workers, and plan on increasing our sod acreage by 85 acres each of the next two years. Our livestock program should remain at its present level of 350 cattle and 3000 hogs yearly. All of our expansion will be in sod production,but in an orderly fashion so as to maintain its solid foundation and steady growth.

There are many roads to take in getting into the sod business - my story is an example of only one. I feel that our diversification will be a big help in the years to come. No matter what the road, the capital requirements are bound to be higher than planned. It is important not to expand faster than your market as this will tend to depress quality and prices, something we are all fighting against.

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VEGETATIVE PLANTING OF GRASSES

A. Linkogel, Link's Nursery, Inc.,
St. Louis, Missouri

I might give you a little background of myself. Back in the early 30's I was asked to take over as superintendent of a private golf course in the St. Louis area. I knew very little about golf course turf, being raised on a farm, and working a little with a landscape architect. I took this job with the agreement I would attend every turf conference to learn what I could about turf. I also worked very closely with Dr. John Montieth, who was then in charge of the U.S.G.A. Green Section, and O. J. Noer of the Milwaukee Sewerage Commission, whom most of you knew.

One of the first things I did was to lay out a turf experiment area at the suggestion of Dr. Montieth to experiment with some of the newer grasses that he thought might have possibilities in the St. Louis area. You know back in the early 30's we had very few chemicals, weed controllers, etc., and did not know too much about fertilizers. So, some of the first grasses he sent were some of the Zoysias and Bermudas, along with some fescues and bluegrasses, etc.

After several years of testing, we lost most of our Bermudas, except the U-3 strain of Bermuda. So, to further our test we planted a U-3 Bermuda tee on this course. After having it in play several years, we planted about 1 acre

into one of the fairways. Our Club members and members from other clubs were so enthused about this turf I was asked to introduce it into our present bluegrass fairway without interrupting play, so we started a series of testing different methods of introducing it into fairways.

This testing was done on the golf course, and I had some property next to the golf course of my own where I did most of the testing of grasses. Our first step was to cut the bluegrass as short as possible. Then we took a West Point Aerifier and aerified it 5 or 6 times; then took a manure spreader, spread the stolons; then aerified a couple of times. Then took a tandem disk, kept the disks pretty straight to try and push the stolons into the ground, rolled; then watered. We got a good catch of our stolons planted in June, and by September had a complete coverage, but it was very inconvenient for the golfers.

The following year this club came up with the idea of planting one-half of the fairway at a time, so the golfers could pick up their ball, and drop on the unplanted side. This also was very inconvenient for the golfers, although this club planted all 18 fairways within the next two years with this method.

I finally came up with a sprigging machine that seemed to be the best method of vegetative planting into old fairways, and with little interference with the golfers. It was made to fit on any 3-point hitch tractor, a coulter to slice a slit into sod with a shoe following to open up slit. A roller in rear with the man's weight to compress slit back into place. The man would hand-feed stolons into slit from a drum mounted on machine to hold stolons.

The Pray Planter was made for planting in loose soil. It had a shovel that would cut a furrow, and a power hopper which automatically shredded the sod and fed the stolons into the furrow. My machine was mounted under the Pray machine, so we had an automatic planter. This was a lot faster, did a good job, and two men could plant about 4 acres per day.

All of the private country clubs had changed to U-3 Bermuda. This worked out very well, but after 4 to 5 years spring deadspot became a problem, so the clubs became a little discouraged with Bermuda, and started to think about Zoysia on fairways.

We tried the same method of Bermuda planting with Zoysia, and here we ran into a little trouble. We found out that sprigging Zoysia was quite a bit different than Bermuda. Bermuda we could sprig a whole fairway and then apply water. With Zoysia, unless you would sprig small areas and then apply water, it worked fairly well, but not getting water to the stolons for as much as one hour you lost a lot of sprigs. So, we discarded sprigging Zoysia into fairway turf.

Plugs worked out much better, but there was the labor cost involved. With the shortage in labor this was prohibitive, so after checking different plugging machines they were also too slow, the thought came to me to revamp our sprigging machine, so we could plant plugs. This has worked very well. We have a coulter to cut a slice through the sod, a winged shoe to open up the slit so that the plug can be set into slit, a roller in the rear with the man's weight to compress it back smooth. This still left us with the problem of cutting the plugs for planting. We dice with the power slicers, as deep as possible, then undercut to get a mass of plugs and pieces.

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VEGETATIVE PLANTING OF GRASSES - 1970

Ben Warren, Warren's Turf Nursery
Palos Park, Illinois

We have been involved in vegetative planting of turfgrasses for some years, but until recently this method has been confined to creeping bent and Zoysia. Since we have undertaken the propagation of sexual bluegrasses, this method of planting has become a dominant part of our nursery operation.

For several years we have been offering the service to golf courses of planting new greens with a hydro-mulcher. This method consists of mixing stolons and a wood fiber mulch together in a water tank, and spraying this slurry on the green. There are several advantages in this method over the traditional methods such as:

1. The possibility of dehydration during planting is eliminated.
2. There is no foot or vehicular traffic on the finished surface
3. Uniform distribution is more easily obtained.
4. Considerable labor is saved; two men can plant an 8,000 ft. green in 30 minutes.

This way of stolonizing greens has been very well accepted.

Much effort has been expended in evaluating different methods of establishing our A-10 and A-20 bluegrasses which are both too highly sexual to permit increase from seed. Some of the machinery tried are manure spreaders, the Prey planter, and the Bowie Hydro-mulcher, which utilize shredded material - two different designs of vegetative planters both of which utilized tillers or sprigs, and the Beck plug planter.

The plug planter is the machine that has done the most satisfactory job, and four machines designed on the same principle as Beck production machine are at work in our nurseries. These are tractor-drawn machines which plant 9 rows, 9 inches apart, and drop plugs at 9 inch intervals. Rolled or slab sod is fed against a revolving cylinder on which stub knives are attached at intervals. Each pinches off a plug about 1 inch by 2 inch. These machines utilize about 300 yds. of sod to plant one acre, and a 5-man crew can plant between 10 and 15 acres per day.

We have a much broader choice of herbicides at planting time and the several weeks after planting. Also, the planting season is much extended. Mid-summer and late fall plantings are made with much more success than we have ever had with seed.

We do not have enough experience to make an accurate comparison of time required to develop a mature crop by this method vs. seeding. Some plantings have compared very favorably, while others have lagged behind seedings.

Vegetative planting of bluegrasses has been limited to planting our own fields in the past, except for a limited experimental plugging of WARREN'S A-20 into old turf. The results indicate that this grass, when spotted into common or Merion bluegrass, takes over in a reasonable length of time. One golf course, which is under construction, is committed to establishing the fairways and tees with A-20 by this method this year. This planting will be on bare soil and will be done either by plugging or hydro-mulching.

(See Editor's notes page 73).

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KENTUCKY BLUEGRASS - BREEDING AND CYTOLOGY

Terrance P. Riordan, Graduate Research Assistant
Purdue University

The purpose of this project was to select Kentucky bluegrass types whose characteristics would meet the necessary requirements of a roadside turf. The requirements considered most important were low growth habit in order to reduce mowing frequency, increased rhizome spread for long-term maintenance of sloping areas, and resistance to disease and weed infestation. This project was begun at Purdue in 1961, and since 1965 some 12,000 individual bluegrass seedlings have been rated and observed as space plants for leaf color, winter survival and panicle characteristics, as well as the more important characteristics mentioned earlier.

Three plantings were made in order to select bluegrass types for roadsides, and to determine the mode of reproduction, i.e., whether sexual or apomictic. The third planting in 1969 was composed of the second generation of the superior grasses from 1966 and 1967, thus allowing study of reproduction in consecutive generations.

Selected plants of all three plantings had increased rhizome spread when compared to the total population.

	Rhizome spread (1 most - 9 least)	
	Total pop.	Sel. plants
	avg.	avg.
Exp. 1	4.32	2.52
Exp. 2	4.98	3.27
Exp. 3	4.22	3.43

Improvement was larger in the first two experiments, but the improvement in experiment three was important since this planting consisted of only superior plants from experiments one and two.

Little decrease in leaf height was accomplished through selection due to the main emphasis on rhizome spread. These characters are negatively correlated so that no increase in leaf height is considered satisfactory.

	Leaf height (cm.)	
	Total pop.	Sel. plants
Exp. 1	13.4	13.5
Exp. 2	24.3	24.5
Exp. 3	12.1	11.1

The decrease in height, though small, in experiment three gives promise that continued selection for increased rhizome spread and decreased leaf height will be successful.

The other characteristics measured were not considered as important as height and spread; therefore, little selection pressure was put on them. It was felt that if a plant had good spread and low height, future breeding would find the dark color, the disease resistance, and the seed production.

All selections in these experiments were rated for uniformity (apomixis) either by measuring the variability of the selection, or by a visual rating. Some plants were uniform for two generations, some were very variable for both generations, and a few were uniform one generation and variable the other. This will

allow the determination of reproduction so that uniform (apomictic) grasses can be put in a roadside test, and the variable (sexual) grasses can be used for further selection.

In addition to visual study of the mode of reproduction, chromosome counts were made of a few sexual and apomictic selections. This testing is necessary for future hybridization work, and also can give an indication whether the apomictic process is affected by a large number of chromosomes.

Sexuals			Apomicts		
Entry	Avg.	Range	Entry	Avg.	Range
A-17-5	63.0	57 - 69	A-4	53.7	51 - 61
16B-8	51.5	46 - 58	B-16	68.2	67 - 71
A-13-34	40.2	37 - 44			

This work is limited and no conclusive results can be drawn. It appears that some of the sexuals (A-13-34) have low chromosome numbers, and that some apomicts (B-16) have higher numbers, but the overlap leaves the hypothesis in question at this time.

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REGULATING TURF GROWTH

John Thorne, Graduate Research Assistant
Purdue University

Chemical growth regulators have a big future in Turf Management! That statement is premature, but it is time to look at the potentials.

There are well-known growth regulators in use for encompassing weed control. Drouth reduction, seedhead reduction or prevention, and frequency of mowing reduction are being actively sought.

For many turf areas partial control of seedheads or leaf extension for a few weeks may be all that is desired. Improved chemicals that completely restrict excess growth have long been sought for industrial sites, fences, ditch banks, etc.

Research began this spring on the potentials of several floral inhibitors. Among these currently being tested from industry are -

Po-San of Mallinckrodt
Maintain CF-125 - U. S. Borax
MBR 6033 of 3-M Company
TD-1361 of Pennwalt

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EXPANDING HORIZONS FOR EQUIPMENT

Roger J. Thomas, Jacobsen Manufacturing Corporation
Racine, Wisconsin

The need for bigger, faster and better equipment has been emphasized in the last few years because of high labor costs, and a definite shortage of labor in the field of turf maintenance. Growth in all the various markets has been fantastic! Golf courses alone have increased from 4,800 in 1945 to 10,000 here in the United States. Parks and recreation areas have almost doubled in the past ten years. Now, labor costs have risen from 9% to 22% in four years, according to Golfdom magazine. Grounds maintenance indicates operating costs have risen yearly 65%! These costs will probably be rising at a rate of approximately 5% per year, so improved technology for management and equipment are necessary to keep costs somewhere in sight.

What can we do about these rising costs? Well, we have to take a good long look at:

1. The conditions under which we must work, such as the areas to be maintained, precisely the degree of maintenance required, and the amount of travel between jobs.

2. We must repeatedly analyze our schedules to see if some work can be automated, or improved by changing.

3. We must analyze our equipment and possibly purchase new, modern machinery to take advantage of the technological improvements coming out every year.

Since equipment is becoming wider, bigger access areas will be needed, and of course a good study of all existing equipment in the field is necessary.

What can we look forward to in the future? Well, it all starts in someone's engineering department. In discussing this element with our competitors, we came to the conclusion that there are among four companies, nearly 150 engineers working especially to solve the problems we are discussing today. Testing procedures have to be stepped up faster than ever before. We simply cannot wait for five or ten years while testing a product. Chains, bearings, belts and batteries all must be involved in the tests. Possibly the whole area of power must be analyzed and improved.

The field of hydraulics is becoming so large that all of us here today are going to be required to make a special effort to get extensive training just to learn how to handle the equipment.

We must think in terms of wider areas for equipment to pass, and riding equipment everywhere. Yes, even on the green! Ten years ago this was a forbidden practice to ride any vehicle on the green, or in a trap, or over tees. Now, everyone wants to ride everywhere, and obviously the tire companies have a real challenge to provide better flotation for equipment. For you, this means more storage space required for equipment. Since bigger equipment is being developed that is wider in all respects, better start planning for 18 to 36 ft. doorways.

In discussing the subject of trends in irrigation among those people in the business, there seemed to be three general areas on which there was agreement:

1. There appears to be a definite move toward automation in new installations, and many places are now converting from manual systems.

2. There is much discussion about the need for sprinkler heads with individual control valves, and special units such as two-speed sprinkler heads.

3. Most every company, however, had admitted that the most work being done was toward solving that never-ending problem of precipitation uniformity.

Who knows - we may be shooting liquid fertilizer right through our regular irrigation system in years to come. I imagine some of you find this difficult to believe, but I never thought I would live to see the day that there would be crop-dusting at golf courses, and helicopters performing over fairways and greens. And, how far away are we from an all night golf course which is completely covered so you can play "come rain or come shine?"

In the future there are bound to be ways for easier removal of thatch, and possibly some form of control would do away with all the unusual dethatching machines. There's got to be an easier method of not only the slicing of turf, but the pickup of dead material. Faster ways to spike are now available by the use of a complete riding unit that can be taken on the green. It is faster now so we can spike more often and obtain better results with less work.

Yes, there will be inventions, gadgets, gimmicks, or systems to change the technique of performing a job, or change the job itself. Many will work, but a few won't. For example, a recirculating shield attachment to mowers is being tested on a number of courses. The theory is that the clippings are recirculated and cut up so small that they will not be seen and will decompose much faster. This device could be helpful in the future to control thatch.

The entire field of material handling is being reviewed by every company involved in the turf business. Just look what the sod growers have done in terms of material handling with sod harvesting equipment! I am told by businesses producing sod harvesters there still is no general agreement on whether the sod should be palletized,flat, or in rolls. And,in each section of the country the practices are far from standardized.

The entire field of aerating must be studied. Who can say five to ten years from now what the thinking will be with regard to hole punching, slicing, renovating, sub-airing, subsoil feeding, and watering, as well as vertical mowing, spiking, cross-mowing, etc. Seeders and spreaders do leave a lot of room for improvement. We must be able to handle barren turf with machines that will plant grass and get a quick recovery in an area without resodding.

We know, too, that it is most important as manufacturers to improve our services.

1. As equipment becomes more sophisticated in terms of repair and service, manufacturers will have to provide more training.

2. Because of the variety of parts, we are going to have to work more closely with our distributors to avoid shortages.
3. We must analyze existing equipment and utilize some of the same parts for new equipment so that part stocks do not become uncontrollable.
4. We must continue to develop products which pass along to you the service of reducing maintenance costs either through a labor-saving or a quality product approach.

Yes, remember how simple life used to be - well, those days are gone forever. We are now entering the era known as the "surging seventies" and by no means will this be a smooth upward climb, but it will be a series of movements. You will be required to provide superior turf because you are the experts. You can expect help from a multitude of irrigation, mowing, aeration, fertilizer and chemical products.

Each of us here must accept the responsibility to train new people coming into the field, and, most of all, we must set aside our reluctance to change. We must try new equipment, and new methods in order to evaluate them and make progress. Progress is often measured in terms of change, so expect change as part of progress.

If we will all attempt to look forward for the next five to ten years by anticipating our needs, by making suggestions for product improvement or new products to manufacturers, by requesting information from the universities, and by helping others solve their problems there will be waiting for us the most exciting and rewarding period of our lifetime. Yes, bigger, better and broader horizons are in our future if we will only work and plan to achieve them.

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FISHERIES MANAGEMENT - SMALL IMPOUNDMENTS

Gary Doxtater, Aquatic Control,
Seymour, Indiana

One of the goals of research on the aquatic habitat has been to determine the factors which could be managed in order to sustain "balanced" good fishing. In so doing, factors such as growth, reproduction, natural mortality, fishing pressure and others must all work together at a desired optimum in order to obtain this "balanced goal."

Regretfully, there is still much to be learned concerning the aquatic habitat. The aquatic environment is a very complex system. In turn, the management of a man-made system, towards a goal determined by man's desires, is surely a complex procedure,and in fact, an almost impossible feat. Nevertheless, today we utilize the research of the past, modified by the daily advances,and do our "own thing" we call fisheries management.

Probably one of the biggest problems in fisheries management is man - not the fish. We can predict to a great degree what fish will do, but man - never. It seems clear that man has an instinctive desire to contribute his something to the fragile aquatic, and inevitably his contribution is in the form of carp minnows, shad, bullheads, green sunfish, or other species of fish contamination -- application of barnlot "scraps," a gallon of magic weed kill yourself aquatic weed planting kit, a flock of 50 ducks on a 1-acre pond, and on and on. Needless to say,if we can control man's influence on a given situation, we have half the battle won, and can put to use the scientific procedures of fisheries management.

So, we have the aquatic system as being very complex; thus, very susceptible to man's influence. When we set up a pond system, we should keep it simple, and once the system has been initiated do not interrupt the expected evolution with a "maybe this will work" pseudo-fish management procedure.

The small impoundment or pond can provide some excellent fishing opportunities. However, because of it's small size it is extremely vulnerable to drastic, devastating changes due to man's activities. They can, however, with proper control, contribute to the total recreational aspect of an area.

The primary principles that should be discussed are the effects of basic fertility on the fishing potential. For example a 1-acre lake will only support so many pounds of fish - the same as one acre of land is capable of producing only so many bushels of a crop. In water, the crop is the fish. The controlling factor of production is the quality of the soils and watershed that feeds the pond. We greatly increase production when added nutrition is tailored to the needs of the lake.

Table 1. Carrying Capacity and Annual Harvest for Various Types of 1-acre Ponds.*

Watershed type	Largemouth Bass Carrying Capacity	Annual harvest	Bluegill Carrying Capacity	Annual Harvest
Poor	10 - 25 lbs.	10 lbs.	50 - 75 lbs.	50 lbs.
Average	25 - 50 "	25 "	100 -200 "	100 "
Rich	50 -125 "	50 "	200 -400 "	200 "

*Adopted in part from Illinois Conservation Department.

As a general rule -- "remove 4 lbs. of bluegills for every 1 lb. of bass caught." If this were done, the life and the quality of fishing of the pond would be extended greatly. If this harvest of bluegills is not met, the pond will shortly become over-populated, and because of the large numbers of fish, stunting will begin. Inevitably, the bluegills will take over and eliminate the bass production by eating their eggs and fry. When this happens, drastic measures must be taken. There are only two choices:

One, a total eradication and restocking program may be done (especially if there are "rough fish" present). This involves the use of an approved fish toxicant and restocking after the water clears. Good fishing may again be expected usually within three years.

The second alternative is a rather new procedure and will probably be considered one of the major break-throughs in fisheries management in many years. This newly approved chemical can be applied to "thin" down the smaller bluegills without harming the larger bluegills, or bass population. It is a very precise and delicate procedure. However, it is being done in several states with great success. The advantage to this procedure is that no fishing time is lost, and no additional stocking is needed. However, it would probably have to be repeated after several years.

Generally speaking, the fish population of a small pond can best be managed by encouraging the 1:4 lbs. bass-bluegill harvest. Certainly, there are other "do's" and "do not's".

1. Do not stock "creek" fish of any kind
2. Do not fertilize without the advice of a fisheries biologist
3. Keep algae and weeds controlled as they protect the bluegills and tie up valuable nutrients which are needed in fish production.
4. Use only chemicals which are approved for aquatic application
5. Keep muskrats under control
6. Do not screen the spillway
7. Do not experiment - get technical advice

We have touched on a few of the basic principles of pond management. However, it should be pointed out that due to the complexity of the aquatic habitat, "cookbook" management is not possible. What seems to work on one pond won't necessarily work on another. We use general principles, but they many times have to be modified to fit the pond's own individual "personality." This illustrates the real meat of the paper -- that technical assistance should be otained to diagnose and advise you on your pond problems.

There are numerous sources of information available to you. Most State Fish and Wildlife Biologists can provide you with advice on your problems, and should be the first to be contacted on any problem. If they cannot assist, they will be able to advise you where to obtain further help.

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SOME ROADSIDE COMMENTS

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Prior to the development of this Interstate System, the management of the turfed roadsides was a relative minor,and often times a nuisance function of the Maintenance Superintendent of the Highway Department. This attitude was due largely to the conditions prevailing with respect to narrow rights-of-way, guardrail, steep cuts, and fill slopes; and in general roadsides that were most difficult to maintain. With the design of the modern highway with its divided lanes, median strips, and broad rights-of-way, turf areas and their management became a very important function of the Highway Department.

In 1969, the Interstate System alone in Indiana consists of 605 miles of the highest type roadway. This Interstate System averages approximately 18 acres of turfed area per mile of roadway. Also in 1969, contracts were awarded for construction of new highways within the system involving 873,560 sq. yds. of sod, and 5,417 acres of mulch seeding. These areas in the next two years will be the responsibility of the Maintenance Division. Therefore, the entire Interstate System being maintained presently consists of 10,890 acres. This Interstate System, coupled with 10,731 miles of State System with an estimated average of 6 acres of turf area per mile, reflects a total acres of roadside area on the entire State System to be 75,276 acres.

Our average frequency of mowing is approximately 4 cycles per year. Therefore, the State Highway Department mows approximately 301,104 acres annually.

Until 1963 the mowing of the rights-of-way of this State System was performed by State Forces entirely. However, in 1963 the State Highway Commission embarked on a program of mowing portions of this system with private contractual services. This program has expanded each year since 1963, and presently the bulk of the Interstate System is being mowed by these contractual services.

On February 24, 1970, bids were received for portions of the Interstate and State Systems involving 2,124 miles. These bids reflected a total cost of approximately $ 1,000,000.00.

In conclusion, the treatment of the roadside along the State Highway System can often times constitute a controversial area in which the Landscape Architect must decide the treatment and management of these broad rights-of-way areas. There are attitudes that mowing can be restricted by the establishment of landscaping and establishment of unmowed areas which would revert to natural and native vegetation.

This concept can be applied in many areas. However, generally these broad rights-of-way we believe should be kept as corridors of open turfed areas, thus adding to the safety features of a modern highway system, and simply described these rights-of-ways that were designed for safety purposes, if these turfed areas are neglected then, after a number of years of native vegetation, such as trees, will encroach on this established right-of-way, thus adding a hazardous condition to an otherwise safe highway. With this safety thought in mind, it would appear that the Highway Department is faced with the continued maintenance of broad turfed areas either by mechanical or chemical methods.

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Editor's Notes. The preceding articles illustrate the developing nature of vegetative handling of grasses.

Readers may be interested that R. P. Dye Enterprises, 12076 Bellefontaine Road, St. Louis, Missouri, 63138, has developed a bench powered sod dicer. An hydraulic cylinder forces sharpened knives through the turf. The turf is revolved 90%, then diced again, giving - for example - 25 squares per square foot. Such a machine permits pre-harvesting of sod, placing it onto plastic sheeting until actual orders are received; then dicing, boxing and shipping can be accomplished promptly.

In contrast, W. H. Daniel, developed vertical sharpened knives which replace the hollow tines of the Greens-aire. By going north and south, then east and west dicing the sod into 2" cubes is achieved. When plugs are needed they are undercut without further damage to the surface.

In contrast, A. A. Linkogel and others have used the power Aero-blades to dice through the sod to secure cubes ready for planting upon undercutting.

Ideally the nursery should be completely harvested. Ideally the spacing in the new area can vary from 1 to 10 feet apart. Eventually Zoysia and Bermudas will fill in.

A new public course, Alvamar Hills Golf Course, Lawrence, Kansas, planted Zoysia in 1967. A 2-acre nursery was sprigged in July of '66. Planting started from the nursery in June of '67. The sod was cut, shredded through an ensilage grinder, then spread with a manure spreader, then immediately disked in and watered. Automatic irrigation, plus heavy fertilization, proved very useful. One acre of stolons planted 20 acres of fairway.

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