Proceedings

of the

Thirty-Fifth Annual
Texas Turfgrass Conference

TEXAS A&M UNIVERSITY

and

THE TEXAS TURFGRASS ASSOCIATION

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P R E F A C E

The Proceedings of the 35th Annual Texas Turfgrass Conference are provided to those who registered at the Conference December 8-10, 1980 at Texas A&M University as a reference to the information presented during the program. Since it was not possible for you to attend all of the educational sessions, the Proceedings will give you an opportunity to review additional information.

We are grateful to the program participants who contributed their time and talent to make the program a success. And, we owe a special debt of gratitude to those speakers who took the extra time and effort to write these Proceedings.

Special appreciation is also extended to Mrs. Barbara Johnigan, my secretary, for her assistance with the preparation and distribution of these Proceedings.

We invite each of you to return to Texas A&M University December 7, 8 and 9, 1981 for the 36th Texas Turfgrass Conference.

Richard L. Duble
Extension Turfgrass Specialist

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STATE OF THE ASSOCIATION ADDRESS
35th Annual Texas Turfgrass Conference
Presented at the General Membership Meeting,
December 8, 1980

by

David J. Dusek*

Several events occurred this year that are unique to 1980. These events are certainly indicative of the era in which we live. As we look back over the past 12 months, we also have to look ahead because each of these events in all probability will continue to significantly effect each of us one way or another both personally and professionally.

1. Gasoline prices for the first year in history maintained a $1.00 plus per gallon. I do not really have to elaborate on the impact fuel costs had on us at home and on the job.

2. Gold prices reached the highest level ever; over $800 plus per ounce.

3. Prime interest rates for the first time in our personal history reached nearly 20 percent.

4. The cost of living reached a record high of 14 percent plus. Yes, inflation has effected every walk of life, personally and professionally.

5. We all experienced the hottest summer in recorded history this year. Some areas in Texas experienced 57 consecutive days over 100° F and 68 total days over 100°.

6. Fifty-two American citizens have been held as captive hostages for one year.

7. Mount St. Helen errupted in Washington State.

8. This year is destined to be remembered for all the politics, campaigning and elections that we all were a part of during the past several months. Ronald Reagan enjoyed a landslide electoral college victory and numerous prominent Democrats were surprisingly ousted by popular vote and replaced by Republican congressmen.

9. Iraq and Iran are at war with each other.

10. The Russians invaded Afghanistan.

11. Roberto Duran gave away a boxing title.

12. A&M beat Texas for the second time in as many years. You talk about uniqueness!

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I have become frustrated during the course of 1980 because the Board of Directors did not accomplish all that I felt we should and needed to accomplish. I am certain these state, national and world events that transpired during this past year have to some degree consumed our personal energies.

During the year on several occassions I spoke of challenging the Board of Directors and Texas Turfgrass Association with a definite plan of action. However, during the last 12 months, I have learned to appreciate, more than ever before, the old addage that anything worth while takes lots of time and energy.

Your Board of Directors embarked upon numerous programs and projects to advance our association and profession during the course of 1980.

1. Membership in the Texas Turfgrass Association increased from 422 paid members in 1979 to 493 paid members in 1980. An increase of 71 new members accounting for a 17 percent growth in one year during a time when we all are having to reduce spending and belong to few organizations speaks very favorably of the Texas Turfgrass Association. I challenge each of you to help continue this trend so that during next year's annual conference we can pride ourselves in even a higher percentage of growth. WE HAVE TIME. WE HAVE TIME TO DO WHAT WE WANT TO DO.

2. Earlier this year your Officers met with Euel Coates, Executive Secretary of the Southern Turfgrass Association, and discussed his organization and basic mode of operation. Later this year the Michigan and Florida Turfgrass Associations were contacted to learn about how they operate. All three of these organizations have successful Associations in terms of membership participation and services. I challenge the new Board of Directors to take this information and make the Texas Turfgrass Association stronger. WE HAVE TIME. YES, WE HAVE TIME TO DO WHAT WE WANT TO DO.

3. The format of the Turf News of Texas was changed significantly during the last 12 months thanks to the insight and efforts of our executive Director Bill McLaughlin. In addition to change this year, a two-year plan was enacted to increase the size and improve the quality of the Turf News of Texas publication. This two-year plan will for the first time put the Association in a position to profit $1,590 in 1982 instead of having to underwrite the newsletter for a total of $3,810 in 1980. I challenge the new Board of Directors to do their part in making this plan of action successful. YES, WE HAVE TIME. WE HAVE TIME TO DO WHAT WE WANT TO DO.

4. This year's Board of Directors realized the need for establishing continuity for Association Directors from one year to the next. We also realized that our Association has to establish a reliable means of financing in place of the often fragmented, temporary, and uncertain ways and means that seldom are predictable from one year to the next.

   A blueprint for determining and programing the growth and development of the Texas Turfgrass Association was developed to establish a

full-time Association office by 1988. We have to face the fact that under our present organizational structure, we are all only part-time employees of the Association. Any effort to promote the development of the Texas Turfgrass Association is closely akin to moonlighting and at most secondary to our full-time profession of earning a living which always comes first. I challenge the new Board of Directors to carefully deliver this seven-year plan and make it a reality. YES, WE HAVE TIME. WE HAVE TIME TO DO WHAT WE WANT TO DO.

5. This year's Citation and Awards committee was challenged to develop an awards program for recognizing the best turf facilities throughout the state and new awards for recognizing outstanding membership contributions and development. I challenge the new Board of Directors to recognize the importance of these and other membership services. YES, WE HAVE TIME. WE HAVE TIME TO DO WHAT WE WANT TO DO.

6. The newly approved turf breeder position was filled at the Texas A&M Research Center in Dallas during this past year. Each of our jobs depends on the dedication and ability of our Turfgrass researchers in developing superior grasses to help meet the serious energy shortages in the years to come. I challenge each of you to support turfgrass research to the utmost of your ability. YES, WE HAVE TIME. WE HAVE TIME TO DO WHAT WE WANT TO DO.

7. During the last year, I became aware of at least 27 statewide Green Industry organizations that interface with the Texas Turfgrass Association. Or let me say it another way. The Texas Turfgrass Association interfaces with at least 27 statewide Green Industry organizations.

   The Texas Turfgrass Association is one of the largest urban agricultural organizations in the State of Texas. It is also one of the better organized and established statewide organizations. Just imagine the benefits we could all experience by the Texas Turfgrass Association organizationally interfacing with other statewide Green Industry organizations under one umbrella. The name of the Texas Turfgrass Association would probably need changing so the new name would be more representative of all constituents. Or, maybe the best approach would be to give a name to the umbrella mothering organization of which the Texas Turfgrass Association and other statewide Green Industry organizations would belong.

   A. Representation in Austin for the entire Green Industry would be clearly and loudly heard through more effective lobbying. Yes, for the first time we would have a voice.

   B. One statewide Green Industry convention would be much more educational and economical than attending several conferences throughout the year. Concurrent sessions could be held to address the needs of all special interest groups.

C. An equipment show, second to none, could be held at the same time or apart from the annual Green Industry convention.

D. Each sister organization could continue with its own organizational structure and Board of Director meetings, but at the same time have representatives that belong to the umbrella organization.

Face it; as an agronomist, golf course superintendent or Parks and Recreation superintendent or director, we have responsibilities other than growing grass like our job titles or professional organization indicates. We are personnel directors, purchasing agents, arborist, horticulturists, irrigators, mechanics, toilet cleaners and on and on. I challenge the newly elected Board of Directors to start the wheel rolling and provide the leadership to begin unifying all statewide Green Industry organizations under one umbrella. YES, WE HAVE TIME. WE HAVE TIME TO DO WHAT WE WANT TO DO.

In summary, as I look back over the past 12 months, I get the feeling that we approached the work load of the Association and membership needs like an Apollo space program without starting with Apollo 1, 2, and 3, and so on. But on the other hand, as I look back, I am reminded of the Sky Lab Space Ship Columbia. Scientists feel endless scientific advancements to include numerous medical cures will probably result once Columbia is launched into space. However, scientists continue to be frustrated because heat resistant ceramic tiles keep dislodging from the outer shell of the space craft.

The Texas Turfgrass Association Officers and Directors have also become frustrated. We also tried to launch our Columbia, but always seem to be refastening tiles that keep falling off. I challenge each of you to challenge yourself and the newly elected Board so that one year soon our Columbia will be airborne with all tiles attached. YES, WE HAVE TIME. WE HAVE TIME TO DO WHAT WE WANT DO DO.

By 2000 we will experience serious water shortages. A period of crisis will exist. Our plans to meet the demands of the year 2000 are beginning to materialize. As Real Professionals, we must plan to:

1. Develop an attitude banner;

2. We will carry the banner high, market ourselves;

3. Work closer daily with fellow professionals;

4. Continue to express the courage of our convictions, whether for one tree of a forest;

5. Fight for right;

6. Think of today, but beyond tomorrow;

7. Consider every idea source;

8. Keep in touch with trends of people;

9. Keep in touch with trends of education;

10. Keep in touch with each other.

All of which will assist us in our plans and goals of quality. John F. Kennedy once said, "We have the opportunity to make this the greatest country in the history of mankind or the last." To paraphrase J.F.K., we have the opportunity to make this the greatest profession in the history of mankind or the last. Isolation will not provide the answer--standing apart will only encourage built-in obsolescence. We must market our profession--and that takes all of us--not one element. We must develop a creative balance in our effort to reach the professional bond of unification, cooperation and togetherness. The health of this profession depends upon this strength. YES, WE HAVE TIME. WE HAVE TIME TO DO WHAT WE WANT TO DO.

TURFGRASS RESEARCH AT TAES DALLAS

by

A. J. Turgeon*

The Texas A&M University Research and Extension Center at Dallas houses personnel of the Texas Agricultural Experiment Station and the Texas Agricultural Extension Service. Their mission is to support the agricultural industry of North Central Texas (blackland prairie) through research and educational programs that are specific to the needs of that industry. With respect to rural agricultural production, the principal crops grown in the Texas blacklands are small grains (wheat, oats, and barley), grain sorghum, and cotton, as well as forages to support beef cattle production. While responsible for individual research projects involving breeding, culture, and pest management, Dallas scientists work cooperatively with scientists at other Centers and the main campus at College Station to maintain coordinated, statewide research efforts on these crops. In this respect, the Dallas Center is similar to each of the other twelve TAMU Research and Extension Centers located throughout the state.

The Dallas Center is unique, however, because of its location in the heavily populated Dallas-Fort Worth Metroplex, and because of its commitment to serve not only rural, but urban agricultural constituencies as well. Approximately one-half of the research effort at Dallas is directed toward urban agriculture, which includes the production and maintenance of turfgrasses and ornamental plants. In the urban agricultural arena, we have assumed not only regional, but state-wide leadership in several facets of landscape-plant research. Included in this are research projects in: selection and breeding of native Texas flora, ornamental plant propagation and production, urban entomology, urban plant pathology, and turfgrass breeding and management.

The purpose of this paper is to characterize the turfgrass research efforts at Dallas, and to explain how these efforts are coordinated with research by other scientists at other facilities within the Texas Agricultural Experiment Station.

DALLAS TURFGRASS RESEARCH

Dr. Phillip Colbaugh is project leader for urban plant pathology, which includes disease-related research on ornamental plants and turfgrasses. His principal turfgrass efforts have been directed toward the etiology of specific diseases, including a Nigrospora-incited disease of St. Augustinegrass, and environmental factors influencing the dynamics, disease-inciting capacity, and control of fungal spore populations. One important facet of these latter efforts is the role of fungal spores, generated from landscape-plant communities, in human allergies.

Dr. Robert Crocker is project leader for urban entomology, which includes insect and other arthropod-related research on ornamental plants and turfgrasses. His principal turfgrass efforts have been directed toward the biology, ecology, and control of specific insects, including Phyllophaga (grubs) and Blissus (chinchbugs) species.

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Dr. Billy Hipp is project leader for soils research, which includes edaphic studies with all agronomic and horticultural crops. His principal turfgrass efforts will be directed toward fertility and irrigation requirements using native and modified soils.

Dr. Milton Engelke is the new project leader with full-time responsibility for turfgrass research at the Dallas Center. He is working to develop improved, energy-efficient turfgrasses for use under the wide variety of climatic, edaphic and cultural conditions that exist in Texas and throughout southern United States. While the breeding project will be comprehensive in scope, primary emphasis will be directed toward improving tall fescue and St. Augustinegrass; secondary emphasis will be placed on creeping bentgrass and zoysiagrass breeding. In cooperation with other scientists, Dr. Engelke will also be conducting research on turfgrass cultural systems at Dallas and at other locations.

TURFGRASS FACILITY DEVELOPMENT

In 1980, a new automatic irrigation system was designed and constructed to support turfgrass field research. This consists of eleven individually controlled, 1/3-acre (60 x 240 feet) blocks with perimeter irrigation, and a twelfth block with 36 individually controlled subblocks, measuring 20 x 20 feet each, for irrigation research. In addition, irrigation lines were installed to support space-plant and shade nurseries.

From the FY80 operating budget, an equipment inventory consisting of four powered mowers, a utility vehicle with sprayer and topdresser accessories, and tillage and cultivation equipment was purchased to support turfgrass field research.

Currently, planning is underway to construct a new greenhouse-headhouse complex; a portion of this will be allocated to turfgrass research. Also, a new turfgrass-forage field-research building is being planned for possible construction in late 1981 or early 1982.

INTRA-TAES COOPERATIVE RESEARCH

While the recently expanded turfgrass research effort at the Dallas Center is impressive compared to turfgrass programs at land-grant institutions throughout the United States, Dallas based scientists are linked to other turfgrass researchers within the Texas A&M University System through their common association with the Texas Agricultural Experiment Station. Therefore, the Dallas turfgrass research activities must be considered as a component of the statewide turfgrass program along with other components based at College Station and El Paso.

Considering the unique talents of Dr. James Beard, turfgrass physiologist and state-wide turfgrass research coordinator, and his staff as well as other cooperating scientists at College Station (Drs. Kirk Brown, Mike Grisham, and Robert Toler) and Dr. Garald Horst, turfgrass physiologist at El Paso, the turfgrass research team within the Texas Agricultural Experiment Station is the finest ever assembed in a single landgrant institution. With the continuing development of productive, cooperative working relationships between these scientists, the results of their investigative work will far exceed those possible from isolated, individual efforts.

It is therefore in the best interests of turfgrass personnel who benefit from this research program that all efforts to stimulate mutually-beneficial co-operation among scientists be undertaken. It is to this goal that the current administration is fully committed.

1980 LAWN PROBLEMS IN TEXAS

By

Dr. James A. McAfee*

The 1980 season, particularly the summer of 1980, proved to be one of the worst the state has seen in many years. The south established all sorts of weather records for heat and drought conditions. This created many agronomic problems for the lawn care industry. Not only was the weather a major problem, but at the same time we had to worry about the economic situation in the country. High interest rates, lay-offs and uncertainties as to what the future held created some uncertainties in some homeowners' minds about the need for lawn care service. This created many problems for the lawn care industries in the year 1980 which could also carry over into the 1981 season. This presentation will cover some of the agronomic problems, and then talk a little about what we can anticipate happening in the 1981 season as a result of the 1980 season.

The first problem I would like to discuss is turfgrass disease problems. Normally you would not expect diseases to be a major problem on warm season grasses with the extreme temperature experienced this past season. However, in numerous lawns, particularly St. Augustine lawns, the disease Rhizoctonia or brown patch was very active during these 100° F plus days. Also, another disease problem that was observed is a new St. Augustine disease called Nigrospora. Presently little is known about this disease problem. Dr. Phil Colbaough, who will discuss this disease later, has found this to be a problem on St. Augustine lawns. On bermudagrass lawns, a considerable amount of helminthosporium activity was noticed. This was not the normal leaf spot activity that you associate with helminthosporium. Instead, the fungi was attacking the plants near the crown tissue and causing rotting of this tissue and eventually death of the plant. Unfortunately, many people were identifying the problem as drought damage instead of active disease problems. One could speculate as to why these diseases were a problem during extreme heat conditions. I believe that one of the main factors involved was that in many cases homeowners were not allowed to water during the morning or afternoon hours and therefore were restricted to watering their lawns during the nighttime only. With the moisture on the plants at night plus the lower nighttime temperatures, I believe the fungus was able to become active during this period. It should be noted that the brown patch observed was attacking primarily the stolons of the St. Augustine and not the sheath as you would normally observe with Rhizoctonia on St. Augustine. Considerable amounts of turf were lost this summer due to the fact that many people misdiagnosed this problem. Again they were calling it drought damage or lack of moisture when in fact they did have an active disease problem. Furthermore we have observed a tremendous amount of brown patch activity on St. Augustine lawns in Texas and particularly in the southern portions of Texas this fall. If this activity continues and we have a mild winter, you can expect to see a considerable amount of damaged turf in the spring of 1981.

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Due to the hot weather and the dry conditions, most homeowners were not able to replenish the soil moisture to the level needed for adequate plant growth. While most customers were aware that extreme weather conditions existed they did not understand just how much water it would take to replenish the soil moisture to the desired point. Due to the lack of soil moisture, lawns in many instances were unable to respond properly to fertilization. Some homeowners requested a supplemental application of fertilizer to obtain the desired green color. During the hot, dry or drought condition, the addition of too much fertilizer can enhance the problem. Some fertilizers used for turf fertilization are actually salts. Applications of high rates of these fertilizers will place an additional stress on the plants during ideal growing conditions and particularly during extreme hot, dry spells such as we encountered this past spring. You can especially run the risk of a burn problem on the lawns when using high rates of soluble fertilizers during these extreme weather conditions.

In several markets, a rationing and/or cut-off of city water occurred. Homeowners were forced to water at certain times of the day. In extreme cases, no watering at all was allowed. Of course this created many problems for the lawn care industry. Customers in some cases felt that without water it would not be necessary to apply any type of chemicals to their lawns. The main thing that these people should have been made aware of is that while the plant may not grow or respond to fertilizer applications, it is very important that their lawns be observed for any other problems such as disease or insects that might be present in the lawn during this period. If an insect or disease problem is present, it could rapidly destroy the lawn and without proper environmental conditions for regrowth, the lawn would not have the capacity to recover from the damage. Low rates of fertilizers are desirable when water is available. However, if water is completely removed from the homeowner, then it would be proper to discontinue fertilizer applications until the lawn does receive moisture.

Insects did not appear to be a major problem throughout the summer of 1980. Considering the type of weather conditions present, you would have expected chinch bugs to be a major problem in the St. Augustine lawns. While some spotted areas in the state did have a chinch bug problem, overall the chinch bug was not a major insect problem during the summer of 1980. As one lawn specialist observed, it is hard to suck plant juices out of brown leaves. Maybe due to the extreme weather conditions, even the insects were not active. However, one should realize that while insect populations were lower, due to the condition of most lawns, it would not take a high level of insects to cause damage to the lawn. This can also be said for other insects such as the white grub. Again it was very important that these lawns be observed for any insect damage due to the fact that the lawns did not have the capacity to recover and produce new plant growth. The one problem that we did observe to be a major problem was the spider mite. Although the spider mite is not an insect, it can cause considerable amounts of damage to the turf, particularly on bermudagrass. The bermudagrass mite was very prevalent on lawns in Texas. Normally, applications of Diazinon would give very effective control. However, we found that in several cases it was taking more than one application of Diazinon to achieve effective control. Kelthane in some cases was used to obtain effective control. We also discovered a mite problem on lawns in Oklahoma City that resembled red spider mite damage instead of the bermudagrass mite damage. Again the hot, dry conditions were ideal for mite activity.

Weeds did become a major problem on lawns due to the extreme thinning or dying back of the turf. Summer annuals such as crabgrass, spotted spurge, and knotweed became a major problem. Even in cases where preemergent crabgrass control materials were applied, crabgrass was still a problem in some lawns. I believe that one of the main factors that contributed to this problem was that with the drought conditions, the clay soils were cracking and causing destruction of the herbicide barrier and therefore allowing for germination of crabgrass seeds. The major problem with summer annuals present in the lawns at this time of the year is that it is not safe to apply herbicides to the lawns because of the extreme heat conditions. You have two problems: 1) the hot weather induces a higher chance of phytoxicity problems from the herbicides on the bermudagrass lawns, and 2) during the hot, dry weather the phenoxy-type herbicides are going to be very ineffective due to the lack of plant growth by weeds. Due to the lawn conditions this fall, I would anticipate winter annuals being a major problem this coming spring.

I have spent most of the time here discussing lawn problems. However, as most of you realize, ornamentals can also be a problem in the lawns. The ornamentals probably suffered as much or if not more than the turf grass did this past year. The extreme weather conditions also stressed the trees, shrubs, and ground cover. A hard winter or hard freeze this winter could cause a considerable amount of damage to these plants. Even if it is a mild winter, there is still a good chance that you will observe damaged plant material next spring. I think the key is to be aware that ornamentals could be highly damaged and indicate to your customers as soon as possible what the problem is. Your lawn specialist should have been making notes about damaged plant material during their last visit to the lawn this fall and again in round one in the spring. If they observe any damaged plant material, they should make a note and notify the customer that there is a problem. If you wait until after the application is made, then more than likely you are going to receive the blame for the problem.

Next, I would like to take a few minutes to discuss what can be expected in the lawn care industry for 1981. There are some things that we can anticipate being a problem as a result of the weather we experienced during the 1980 season. As I have already mentioned that winter kill can be a major problem, 1) heavy weed populations, 2) damage to ornamental plants, 3) damaged turf from insect activity, and 4) disease problems such as brown patch and spring dead spot. What can we do to try and eliminate these from being a major problem for us? I believe that the main thing is to be aware that the potential lies there, and if you do anticipate a problem, that you communicate with your customers at the earliest possible time that these problems could be experienced. List why they are a problem and what the homeowner can do about it and also what you can do about them. I believe that during these times the best solution to your problems is good communication with the customers. If good communications can be established with the customer and they have confidence in you through your communications, then these battles can be won. However, if you do not communicate with the customer, in all likelihood they will have very low confidence in your ability and therefore will eventually cancel as a result of these problems.

HERBICIDE DAMAGE ON ORNAMENTAL PLANTS (1)

By

B. G. Joyner*

Pesticides in general are often misunderstood by the public. The public's knowledge (or lack of knowledge) of pesticides generally comes from popular articles from the news media. These articles are usually generated because of a pesticide misuse or an otherwise problem due to the pesticide. Therefore, the public most often feels that these pesticides are both harmful and unnecessary. Herbicides used to control weeds in a turf area may be viewed similarly. However, most homeowners are concerned and unhappy when weeds infest their lawn. In part, we must share in some of the blame for this lack of understanding about pesticides and their need. We in the lawn care industry also have an obligation to make sure pesticides are used correctly.

The following discussion will concentrate on herbicides that are used in home lawns to control broad-leaf weeds. More specifically the phenoxy or phenoxy-like materials will be discussed. However, one must realize that there are other herbicides, some of which can cause far more damage to woody ornamentals than the phenoxy-like compounds. It is hoped through this discussion, that we can have a better understanding of these materials and their potential to cause damage, and communicate this to those with whom we come in contact.

Since injury from these herbicides can occur, one must be able to recognize the injury and be able to separate this injury from numerous other problems. To do this, a person has to have knowledge of herbicides, the damage they can cause to ornamental plants, how this damage occurs, an understanding of ornamentals and their problems, as well as problems that cause symptoms similar to those caused by herbicides.

Phenoxy-like Herbicides

These herbicides are used to treat turfgrasses in home lawns (as well as other turf areas) to control broad-leaf weeds. The phenoxy-like compounds (also referred to as hormone-type) include 2,4-D (2,4-dichlorophenoxy) and related compounds (2,4-DP, 2,4,5-TP), MCPP (Mecoprop) and dicamba (3,6-dichloro-o-anisic acid). These materials are broken down in the soil by microorganisms. Breakdown is dependent upon favorable soil conditions. Generally, breakdown occurs more rapidly under warm, moist soil conditions. The herbicide broken down most rapidly is 2,4-D, with dicamba being the most persistent in the soil. Residue analysis of the soil from lawns receiving these herbicides for a number of years may indicate a low level of dicamba still existing. However, this low level (0.02 - 0.04 ppm) of dicamba will not cause damage to plants.

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Symptoms of Injury

Symptoms most commonly associated with injury caused by the phenoxy-like herbicides are a result of a growth response, generally abnormal growth. This abnormal growth response may be in the form of parallel veination (leaf), leaf cupping or rolling, and twisting or curling. The parallel veination occurs when the leaf fails to expand properly and the veins are very close together. The leaf margins may be ragged also due to the lack of leaf expansion.
Leaf cupping generally occurs on plants whose leaves have a palmate type of veination (maple, sycamore, red bud, lilac, grape, etc.). The cupping may be either downward or upward, depending upon the plant. Plants whose leaves have a pinnate veination are more apt to have leaf roll as a result of herbicide injury (oak, ligustrum, holly, crape myrtle, photinia, etc.). The roll may be up or down, but in toward the primary vein. Curling and twisting occurs mostly on new shoots, leaf petioles and narrow-leafed plant leaves (pines, spruces, firs, and taxus).

The above symptoms occur most severly when the plant part in question is growing most rapidly (or active growth is occurring). Once leaves are fully expanded, very little damage or injury occurs on those leaves.

Symptoms discussed so far are those typically seen where lawns are treated with herbicide materials and injury occurs. However, if these materials are used incorrectly and at high rates, death of the contacted plant tissue may result. In most cases, extremely high rates must come in contact with the susceptible tissue. These high rates should not be used on home lawns.

The damage that may result because of the phenoxy-like herbicides is hard to ascertain. Often very little if any damage occurs to the overall plant. The severity of damage does depend on the plant, plant health, herbicides and amount, and miscellaneous other facts such as weather and microenvironment. Certain plants are extremely sensitive to these types of herbicides, such as tomatoes (most all vegetables) and grapes. Death of these plants may not occur but they may lose their fruit. Taxus plants appear to be sensitive to dicamba with tip dieback occurring when large amounts of dicamba is taken up by the roots. In most cases, if the plant is healthy when herbicide injury results, recovery will occur.

Reasons for Contact

In diagnosing potentially herbicide-induced problems, one must consider the various ways plant contact can be made. There are basically two ways in which herbicides can come in contact with desirable plant material; foliar contact and root uptake.

Foliar contact is made either by direct contact or drift. Direct contact occurs because of poor spray technique, accidents or on purpose. Contact by drift occurs through movement of spray mist or volatilization. Spraying during undesirable conditions (high winds or temperatures) or with highly volatile materials can result in greater foliar contact.

Root uptake occurs when the herbicide material moves either on the soil surface or in the soil. Surface movement generally results when water washes the

material to an undesirable location. Soil movement can occur downward through the soil or downward and then laterally through the soil. Lack of knowledge about the herbicide (weed and feed perhaps) or location of the roots generally are the reasons for root uptake by soil movement.

Mimicking Symptoms

There are numerous other problems that mimick the symptoms caused by phenoxy-like herbicides. Certain disease problems can cause distorted growth which results in symptoms of cupping, curling and twisting (virus disease, fire blight, and other diseases). Similar symptoms can also be caused by insects (mites, aphids and others) or environmental problems (frost, heat or drought).

Why Plants Fail

There are many reasons why plants fail in the landscape. It is important to consider all the possibilities and not to jump to conclusions. Most problems on woody ornamentals in the home landscape are not caused by herbicides, but are due to poor establishment, care or environmental conditions. In diagnosing problems, we must consider all the possibilities and not just one.

Where problems do occur with herbicides, due to mistakes, one should learn from this mistake. First, admit the problem, then see what plants are affected (and ones that are not), type symptoms expressed and damage occurring. One should also teach others using this experience. Recommend proper plant care to insure plant recovery. Generally fertilization is required, but it depends upon the plant damage and the plant's need for fertilizer. Pruning may help some plants, but should not be recommended for others. Therefore, plant knowledge is necessary before recommendations are made.

Conclusions

Most problems on woody ornamental plants are not caused by herbicides. Most are caused by poor establishment, poor care or environmental factors. Therefore, in diagnosing plant problems, one must consider all possibilities.

Herbicides used to treat the turf area, can cause problems on ornamental plants. To diagnose a herbicide-related problem, one must know the herbicides, what these herbicides can and cannot do, the woody plant in question and other possible problems.

If injury does occur, admit the problem, learn and apply proper plant care.

ROPE-WICK APPLICATOR FOR LAWNS

by

Ricks H. Pluenneke*

It is interesting the way research can essentially feed on itself, sometimes starting far afield from the final product that can be used. In the early 70's while I was on staff at Mississippi State University, Dr. Chester McWhorter of the USDA's Southern Weed Science Laboratory, was developing the recirculating sprayer to control overstory Johnsongrass in field crops with glyphosate (Roundup). I had been doing night interruption studies on soybeans and weeds; particularly cocklebur (Xanthium spp.) to see if we could discourage seed production - and next year's weed problem. Working with the Electrical Engineering Department, I found that a He-Ne laser producing red light at 628nm (15mw) would cut reproduction in cockleburs 500m away with brief night interruptions. There was no heat involved. This was a follow-up on work by Borthwick and others at the Flowering Laboratory in Beltsville, Maryland, and an attempt to put their basic research to use in the field.

I talked about "geometric selectivity" - if the weeds were shaped differently from the desirable plants, taller or wider, we had a way to contact them with a systemic without damaging the crop. Laser technology was a little too far out, so we turned to an old approach. This is the electrical discharge system (EDS) - a two-inch galvanized pipe mounted horizontally on the front of a tractor with a PTO generator behind that would deliver 20,000 volts. Cockleburs, Sesbania and a number of other weeds were killed on contact over the tops of crops - but it did not work on Johnsongrass. After observing the galvanized pipe set-up, Dr. McWhorter remarked, "I think we can do that with chemicals." Allis-Chalmers is now marketing a version of the EDS unit for weed control in sugar beets in the Dakotas.

Dr. J. E. Dale, of the Southern Weed Science Laboratory, conceived of and built the first rope-wick applicator in 1976 at Stoneville, Mississippi. The basic unit was a horizontal PVC pipe on the front of a tractor with caps on its ends so it served as its own herbicide reservoir. Nautical nylon rope ran through rubber grommets along the front edge of the pipe and served as a wick. It was a simple, beautiful approach to apply glyphosate (Roundup) to overhead Johnsongrass. Dr. Dale did a great deal of research on wicks and systemic herbicides that might be used in the units. I say units because he also worked on others and improved designs. The units involve a little more chemistry and design then most of us realize. Rope-wick applicators are having a tremendous impact in row crops, roadside, and probably will in turf and landscape too as we learn more about them.

We now have a number of hand-held units on the market; many are good, some are bad. They should be used to compliment a spraying program - not necessarily replace it.

I have designed the "Wick-It™" - actually there are three models, with simplicity, lightweightness and utility in mind. The original Wick-It™, with two wicks located for scything action against weeds taller than surrounding

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desirable plants; the Wick-It™ "Tee," for prostrate weeds; and the Wick-It™ "Junior," a lightweight model that can be used for scything or for prostrate weeds. All of the units weigh less than a pound and are "invertable," meaning that they can be turned upside-down while loaded for temporary storage or for transport in the field. Some users mount broom holders on their vehicles to carry the units upside-down as they make their daily rounds. If grassy weeds are seen they can be quickly and easily treated, and the unit returned to its holder until needed again.

Glyphosate is the most commonly used herbicide in wick units to control grassy weeds. We are also working with a number of other systemic herbicides including various 2,4-D, Dicamba, MCPP and picloram formulations.

Before buying a unit, be sure it fits your needs. Some units are heavy and others may have a drip rate that is too fast or too slow. Herbicide moves through the wick by capillary action and there will always be a certain amount of drip, but it should not be excessive. Be sure you understand your herbicide before using it. Be sure that operators do not use a hand-held unit like a "machete." It should not be used to try to beat down weeds and will only damage the device. From time to time, residues in the unit and on the wick should be washed off. Scrub the wick with a soft bristled brush to clean it, and be sure not to get the wash water on desirable vegetation. Do not use different herbicides in the same unit. Phenoxy herbicides (2,4-D, etc.) are next to impossible to wash out of the wicks, and a wick applicator in which one is used should be reserved for that use only. As with any applicator, read the instructions carefully and be sure you understand them before using the device.

MINIMIZING "DOWN" TIME ON EQUIPMENT

by

Wallace Menn*

How many times have you had a bearing go "out", a drive-belt break, a steering cable snap, or some other item on a piece of equipment expire; and when you check your parts rooms, find that you had used your last repair item two months earlier? I am afraid that this may happen more often than most of us would care to admit.

For those of you living in a metropolitan area, this may not present too large a problem, since you can easily hop in your vehicle and go to the nearest distributor for the needed part, providing, of course, that they have it in stock.

For those of us living in outlying areas, we have the choice of ordering the part by parcel post, UPS, freight-line, or (in an emergency) by bus. Whichever mode of transportation we choose, chances are we will not receive the part that same day and likely not for several days.

This brings me to the subject of my brief discussion which is minimizing equipment "down-time" through preventive maintenance and through maintaining a good "wear" item inventory. In turf maintenance, keeping equipment operating is essential and often critical in getting the job done.

First it is very helpful, if not vital, that you have your personnel trained in operator maintenance of equipment. This means having them check oil and water levels, air filter, tire pressure and battery water before operation. In our shop, we usually allow the operators to come in 20 to 30 minutes before quitting time, which gives them time to clean and service the equipment before putting it away. I have found that lubricating equipment following use to be better than doing so before use. This eliminates the operator from assuming that someone else has performed the lubrication on a peice of equipment. It is also very beneficial to train the operator to inspect for and report any worn parts or malfunctions that he has noticed while operating a piece of equipment.

The second area where we can minimize "down-time" on equipment is in maintaining a complete inventory of wear items for the various pieces of equipment used at our location. The following is a partial list of wear or consumable parts:

1. Bedknives
2. Blades
3. Oil Filters
4. Air Filters
5. Hydraulic Filters
6. Sparkplugs, Points and Condensors
7. Belts and Chains
8. Aerifier Tynes
9. Inner Tubes

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The above list of parts is made up of items that we know are going to have to be replaced periodically. In addition to this list, there is always the assorted nuts, bolts and washers, o-rings, zerk fittings, tire plugs and patches, etc. that we should keep in stock.

There are other parts that are considered "non-wear" items such as bearings and hydraulic lines which we all know do eventually wear out. My advice on these items is to find a good, reliable, local source and not to necessarily go back to the distributor for these parts. Now, I am certain that a lot of distributors will disagree with this advice; but I am just as certain that as long as you stick with good quality bearings, seals, and hydraulic materials, you will not have any trouble and you will get that piece of equipment back in operation sooner and probably cheaper. Let's face it, everyone that handles a product from the manufacturer to the consumer must make a profit and rightfully so. Thus, by dealing directly with a bearing distributor or with someone who makes hydraulic lines, it is easy to see that the parts might be cheaper.

Also, due to several bearings being common to several uses and to various pieces of equipment, I have found that quantity buying from a bearing distributor can save a considerable amount over a year or two time span.

Remember, the key to minimizing "down-time" on equipment is organizing a good operator-maintenance program and maintaining an adequate "wear" item inventory. If possible, establish a limited inventory of "non-wear" items such as steering cables, hydraulic lines, bearings, etc. and be certain to replenish this inventory as the parts are used.

TOURNAMENT SCHEDULING

by

Steve Barley*

Tournament Date - May 13, 14, 15, 16, 17, 1981

I. COMMUNICATION

- A. Tournament Director and Committee
- B. Pro-Shop Staff
- C. Grounds Staff (Team Effort)

II. ADVANCE PLANNING

- A. Time Table or Conditioning Set Specifications for Course
  - a. Greens
  - b. Tees
  - c. Bunkers
  - d. Fairways
  - e. Roughs
- B. Time Table for Amenities
  - a. Bleachers
  - b. TV Towers
  - c. Concession Stands
  - d. Portable Rest Rooms
  - e. Crowd Control (Ropes)
  - f. Garbage Removal

III. TARGET DATE - May 9, 1981

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*Superintendent, Colonial Country Club, 3735 Colonial Club Circle, Fort Worth, Texas 76109.

Wednesday, Thursday, Friday, Saturday, Sunday

6:00 a.m. - 8:00 p.m.

Split Shift - All Personnel Must Be Off Course - 10:00 a.m.

6:00 a.m. - 10:00 a.m.

JOB	NUMBER OF MEN
Cut Greens (Double Cut)	5
Bunkers (Hand Rake)	6
Drag Dew	2
Change Cups	1
Check Ropes	2

4:00 p.m. - 8:00 p.m.

JOB	NUMBER OF MEN
Cut Fairways	2
Cut Tees	1
Cut Fringes	2
Garbage Detail	4
Clean-up Detail	4
Service Portable Restrooms	1
Water Greens	2

10:00 a.m. - 4:00 p.m.

8 men are on stand-by in shop in case of emergency.

4 man shift take two-hour break for lunch.

April 20, 1981 - 3 weeks:

1. Placement of Bleachers
2. Erection of TV Towers
3. Schedule Security - 8:00 p.m. - 6:00 a.m.

May 4, 1981 - 1 week:

1. Concession Stand Placement
2. Portable Restrooms Placement
3. Garbage Removal Placement

May 9, 1981:

Roping Stakes in Place

May 11, 1981:

Ropes Put Up

Monday, Tuesday - 6:00 a.m. - 6:00 p.m.

Normal Maintenance

1. Hand Rake Bunkers - 6 men
2. Hand Water Greens - 2 men
3. Fungicide Applied, Tuesday Evening
4. Dew Removed From Fairways, Each Morning
5. Garbage Removal and Portable Restrooms Cleaned, Tuesday Evening
6. Cut Fairways, Fringes, and Tees, Tuesday Evening

WORK SCHEDULES

Normal	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
40 HRS	10	6	6	6	8	4	or 4
Pre-Tournament							
44 HRS	10	8	6	8	8	4	or 4
Tournament Week	12	12	12	12	12	12	or 12

1. Normal Work Schedule 40-44 hour week
2. Pre-Tournament Schedule 44-48 hour week
3. Tournament Week 84 + hour week

4.	Post Tournament Schedule	44-48 hour week
	Pre-Tournament Schedule	March 30
	Tournament	May 9
	Post Tournament	May 18
	Normal	June 1

PRE-TOURNAMENT

Golf Course:

1. Sand Bunkers (90 days prior to tournament)
2. Establish Fairway Cut
3. Protect Tees
4. Protect Specific Pin Placements
5. Establish Green Cutting HT May 9, 1981

Amenities:

1. Paint stakes, cross-walk signs, leader boards, garbage cans, bleachers, ticket booths
2. Order any signs to be used on course

PREPARATION FOR USGA CHAMPIONSHIPS

by

James B. Moncrief*

The most elaborate shows on the road today are the USGA Championships held each year in the United States. They are played on some of the best designed and maintained golf courses in the world. Thousands of dollars are involved. Cities where events are held realize more money from the U. S. Open Championship than any of the others.

There are four major and seven minor Championships which are played on different courses each year. Very seldom are the major Championships played in the south; however, we had two played here in 1980, and the U. S. Women's Open at Richland Country Club in Nashville and the Amateur at Country Club of North Carolina at Pinehurst.

Courses for Championships are maintained above the level of maintenance of most golf courses with more emphasis placed on the major Championships than on the minor.

The local sponsor signs contracts to condition their course according to guidelines recommended by the USGA. Under these conditions, it is much easier to provide a golf course similar in maintenance standards that not only gives the members a pride in their golf course, but gives the golfer a challenge. The club sponsoring the Championship likes to present the best playing condition possible. A coordinator for the Open begins organizing all committees a year in advance.

The playing condition of the course is the most important element in the player's view. The player has a chance to perform and display the best skills he or she has been able to learn. A well-maintained golf course will require good play and in turn will help produce an individual who is playing the best golf at that time. Golf courses that are well designed and present a challenge to the golfer are likely to influence a player to want to be in the competition as well as to assure good attendance of galleries. In many instances, this will influence the player to participate in a tournament if he is eligible. To meet these requirements of high standards of maintaining the golf course, a Green Section Agronomist makes periodic visits to the Championship site to aid in any way for the golf course standards to measure up to the requirements set forth.

The courses that sponsor USGA Championships should be maintained in such a way that they can be ready for competition in a very short time. The course to sponsor the U. S. Open Championship starts three to five years in advance to get the course ready. This prevents a crash program just before the Championship. It takes a well-coordinated plan to put on a successful Championship with many committees and much effort. Sometimes there has been poor attendanc because of circumstances involving maintenance of the course. Some of the leading players heard the greens were in poor shape and by-passed the Championship.

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*Director, USGA Green Section, Southeastern Region, P. O. Box 4213, Campus Station, Athens, Georgia 30602.

Maintenance of the grass for the Championship sites is much more refined than it was 15 or 20 years ago. The golf course superintendents, as well as the golfers, are better schooled in the fine points of the game with very keen competition every week.

This discussion will deal with preparation of a course for USGA Championships. We will begin with the greens which are the most important areas of the golf course.

Firm greens on the dry side provide the best test for both approach shots and putts. The more skillful player has an added advantage on firm greens and the soil itself is a key to holding a shot. A poor soil mix will become more compact with overwatering. A proper soil mix will seldom become too wet and will hold a well-played shot without being wet. The skillful player hits the ball higher which is one reason he or she is able to stop the ball quicker on greens with a firm base. Putting extra spin on a ball also comes with greater skill. Professionals say there is nothing worse than seeing an opponent half top or miss a shot, then seeing the ball roll along the ground and stop when it gets to the green because the green was too soft. Consequently, shot making will determine the champion consistently only when he or she can adjust to condition of the courses.

A sound program for using as little water as possible can help produce championship greens. The tendency is to overwater greens and at times the irrigation engineer is the key for long-term health of the turf. Soft greens do not reward a skillful shot over an inferior one.

Irrigation of greens brought on an interesting story in June, 1964, when the U. S. Open Championship was played at Congressional Club near Washington. Two of our staff members were sitting near a green when Arnold Palmer came along. Before he could play, a Congressional assistant jumped up and began to syringe the green lightly. Questioned by one of the spectators, "What is he doing that for?" Another spectator commented, "Arnie is coming up next and he is watering the greens so the shot will hold." Wrong certainly, yet, there is a certain amount of tragedy in the remark. If Palmer had heard it, he would have probably been slightly miffed to think his skill in applying back spin could be mistaken for swamp-like characteristics of a green. The worker was simply cooling the grass to prevent damage from the oppressive heat.

No doubt here was a man who knew something about golf or else how would he know a shot is supposed to hold at the green. Obviously, his ideal putting green was just a shade less damp than a swamp.

Most low handicappers prefer a fast putting surface and have more confidence on a firm green as he or she can rely on back spin to stop the golf ball. If a well-controlled shot is hit to a green, then the player should be rewarded. The greens should not do it for you. Too often the golf course Superintendent comes under heavy pressure to water the greens to hold a shot. This unfortunate advice will frequently be followed even though it is bad for the greens. A sound irrigation program using as little water as possible is beneficial and will help produce championship greens.

The host superintendent is expected to establish a program of protected areas on the greens to be used for cup settings for the Championship. He is to use the front part of the greens for member play.

The greens should be constantly checked for old cup settings which are either sunken or raised and should be repaired. When changing holes, use a slicing technique and blend in edges with a fork-type instrument. There should be replacement of any dead plugs from a nursery or from extreme edges of the greens which are out of play.

When a Championship is televised, a small can of latex base white paint or white shoe polish can be used to paint the soil above the cup lining. The TV camera will show the holes much better if they are painted white. It is not necessary to paint the ones that are not televised. Cup liners should be in good condition so the flagsticks will stand straight in the holes.

Standardization of flagsticks and flags for Championship play is very important to the player who must play a different course every week. The flagsticks should meet the following specifications: Height--8 feet; Material--fiberglass; Diameter--1/2 inch from top to bottom with no taper. The flagstick should be bright solid yellow as striped ones are difficult to see as they blend into the soil when seen from a distance.

The flags should also be a bright solid yellow to make the best target against the green background of a golf course. The USGA has its own logo of the Open Championship.

All ball divots in the greens should be repaired after each group passes through. It is the responsibility of both the player and the caddy to repair divots.

It is preferred that the walking handmowers be used rather than triplex equipment. If riding units are used, the cleanup mowing cut around the perimeter of the green should be made by the walking greensmower. The triplex mower in many instances will provide a poor condition of the putting surface if not properly adjusted and operated. The performance of the triplex depends very much on the mechanic's ability to synchronize all three units.

The height of mowing can vary. Preferably the speed of the greens should be around 9 1/2 feet to 10 1/2 feet for the major championships. In many instances, the greens are faster than this with the height of mowing around 1/8 inch. A lower cut will depend on the ability of the mechanic and superintendent to thin bedknives and adjust them to fit their particular situation.

Frequent light topdressing at 2 to 3 weeks with proper mixture will help to have closely-mowed greens that are firm. Consistent roll of the greens is very important.

The cutting heights can vary according to the type of grass being grown at the tournament site, such as bermuda and non-bermuda. The following is a suggested height and width of cut required and density can sometimes be more important than height.

	Height		Collar Width
	Non-Bermuda	Bermuda	
Putting Green Areas			
Putting Green	5/32" or lower	3/16" or lower	
Collar Off Green	1/2" to 3/4"	1/2" or lower	30-48"
Light Rough Off Collar	2"	1/2" to 1"	4' to 6'
Rough--Heavy	5" to 6"	4"	

Bunkers

Fresh sand should be added to bunkers at least three months before a championship so it will become well settled. If there is inadequate rain to pack it, irrigation water should be used. The range of sand particle size can vary; however, certain ranges have preference over others. Along coastal areas, the sand will blow out of some bunkers, but the correct size particles of sand and proper design will minimize movement. The 30 to 40 mile per hour winds along the Florida coast will move sand out regardless of size. Usually suitable sand particle size will pass through 1/8 inch sieve openings. Silt and fine particles should be removed by washing or screening. This size particle will resist packing. The sand particles that are round-shaped tend to shift under players feet, but angular particles are more stable. There should be no pebbles in the bunkers.

Sand in the face of steep bunkers should be shallow and firm enough to prevent the ball from becoming lost or buried too deeply. There should be a 2-inch lip on the green side of the bunker, whereas on the side toward the tee or the fairways, they should be brought up to the soil surface to prevent bad lies. The ball would become unplayable under the lip away from the green. There should be no lips in fairway bunkers. No player should be able to putt out of a green side bunker and the 2-inch lips will prevent this from happening. Bunkers should be constructed for water to drain out readily and not pond or stand.

There has been considerable discussion about position of rakes. They are not placed in bunkers, but are available to the side. Rakes should have short teeth and should be placed outside the bunkers away from play. Bunkers should be maintained by hand during championship play; however, power rakes can be used for preparing the bunkers each day providing the grooves are the proper size and a handrake is used around the edges.

Teeing Ground

The teeing grounds should be protected for several weeks before a championship to give the grass a chance to become well established. For the par 3s, you can secure several rolls of chicken wire or plastic mesh to cover the areas of the teeing ground that will be used during practice rounds. Establish mowing patterns early enough so they will be well defined by tournament time.

A regular program of vertical mowing and aerifying should be carried out on a scheduled program to minimize thatch. This will prevent the tee from having a spongy turf and also reduce problems that can cause diseases or attract worms. The tees that are used for the Championship should have routing maintenance throughout the year so that there will not be a problem getting them in top playing condition for the Championship. Many tees for major championships are not the ones club members normally use. Much care should be taken to minimize build-up of too much grass on tees not used constantly. The height of mowing tees is usually not over 1/2 inch for both bermuda and non-bermuda tees.

Fairways

The fairway is very important to connect the teeing ground with the greens. It is imperative that all fairways drain well so puddling of irrigation water or rains will not delay the championship play.

Divots in the fairways are usually filled with 50 percent sand and 50 percent soil and tamped down flush with the soil level. This will minimize bad lies for the golfers that follow or the next day especially on short holes that have approach shots where golfers take much turf.

Constant mowing of fairways cannot be over emphasized. Fluffiness in the fairway turf is not at all desirable. There should be firm fairways with tight, dense turf especially if there are firm greens. The players will have difficulty holding a shot to a firm green if the fairways are overwatered or the grass is cut too high.

The mowing height for the Championship should be established several weeks in advance of play to give the turf a chance to make a dense firm turf. Fertilization should be moderate and not over stimulated so there will be many clippings to get rid of. If the height of cut is lowered at the last moment, there could be uneven cut or yellowing or scalping of the grass. Different directions and cross mowings of the fairways should be a routine operation before the Championship. The fairways should be mowed daily during the week of the Championship, usually in the late afternoon when the grass is dry. It will be preferable to mow the fairways when you can if rain is predicted in the area. Sometimes they are mowed early in the morning and again after play in the afternoon as it may rain during the night or the next day and they cannot be mowed again.

Fairway Height of Mowing

	Height		Width
	Non-bermudagrass	Bermudagrass	
Fairway	1/2" to 3/4"	1/2"	25 to 35 yards
Collar of intermediate rough	2"	1 1/2"	4 to 6"
Deep rough	5 to 6"	3 to 4"	Infinity

The playing area is usually roped off to control spectators. This also protects the grass as well as keeping the spectators out of the playing area. It helps to control the crowd to prevent trampling the grass.

If a golfer misses a shot badly and it goes beyond the spectators into an area where the grass has been trampled down, he or she is better off and will probably have a better lie than in the intermediate or deep rough.

Extra Equipment

It is important for the various committees to be prepared for any sudden showers or rains. It is also important to keep the players' schedule as planned and equipment available in the event rain occurs to keep greens as dry as possible. One of the best ways to keep the greens dry or get excess water off following rains is to have squeegees to be used to push water off to one side. The country club should have at least a dozen squeegees available to use during the Championships if necessary.

Certain maintenance equipment is required for championship play and it is important that it is in excellent operating condition before and during the Championship. For best mowing results, all equipment should be sharp, adjusted properly and set at specified mowing height. It is requested that triplex greensmowers be set slightly lower than specified heights of cut and they should be checked daily after each mowing.

The following equipment is necessary for most USGA Championships: 2 mowers for cutting tees, 2 fairway units for mowing fairways, at least 5 single walking greensmowers or 2 triplex greensmowers with a back-up. There should be 1 mower for cutting the secondary or intermediate rough and 2 mowers for cutting the primary or deep rough. There should be 2 sets of cup changing equipment, extra sticks, flags, flagsticks, adequate paint, spray guns and tee markers. Cup changing equipment should be sharp for the Championship to insure a clean cut and an even hole. It would be advisable that all the combs or brushes be removed at least one week before tournament play.

Toilets for contestants should be placed in the middle of the front and back 9 holes inside of the ropes. Water coolers should be provided on all tees at least Tuesday and throughout the Championship.

Tees and greens should be identified as to the hole number, yardage and par on both sides of the signs preferably at the entrance to the tees and exits of the greens. Signs can be on rather tall poles, 7 or 8 feet, and inserted in metal pipes that are flush with the soil for easy removal. Signs should be large enough for easy reading probably 12 to 14 inches high and at least 15 to 16 inches wide. The type of material signs are made from can vary greatly, but good strong lumber should be used to withstand strong winds.

Trees

Newly planted trees should have the braces and wrappings removed as soon as they can withstand the weather. If a depressed area was created around the tree when it was planted, it should be filled in as soon as the trees are

established. All low hanging branches should be removed so the gallery will not have to duck under them, and it will not be unfair to golfer playing underneath the trees.

Personnel

The golf course maintenance crew should be well advised on work hours to conform with the starting and finishing time of the Championship each day. They should also be reminded that their clothing and shoes are important especially those working or walking on the greens. Cowboy boots, heavy cleated or other types of shoes that will create markings on the greens should not be worn.

All control vehicles should be informed about traveling in areas so noise will be minimized while play is in progress, avoiding congested groups of spectators and possible times they should be traveling in certain areas. Moving of equipment during wet conditions should be minimized to prevent rutting and damage to the course.

No course should have a change in the golf course without notifying the USGA officials in charge. Any unusual damage to the course that requires extensive work or changes of the golf course should be known by the proper USGA or club official.

Most courses have practice driving range areas and it is very important that they be maintained similarly to areas on the same course. The practice tees should be mowed daily the same height as the fairways, as they get enormous wear. The higher height of cut will help preserve the grass. Maintenance of these areas should be programmed so they will be topdressed frequently, seeded if necessary, and watered properly at all times.

When country clubs and the ground maintenance group have met all requirements that have been given, then they are ready for championship play. With the grass in a healthy playing condition, there should be minimum problems. I have seen many unusual situations arise and cause a concern during the Championships. After the Championship starts, the superintendent and maintenance crew do well to keep the course mowed and neatly trimmed.

Eleven Championships take a tremendous amount of coordination and communication between the players, the directors, and the local sponsors. The USGA holds its Championships at different clubs each year. Do not forget the member who has sacrificed his golf course for these events. Most of the members are involved and they are quite proud that their course is the host to these important Championships.

SUGGESTED GUIDELINES FOR THE MAINTENANCE OF ATHLETIC FIELDS

by

Dr. Bill Knoop*

There is no magic about the maintenance of athletic fields. Adherence to the tried and true basic turfgrass maintenance principles discussed in this guide will, if followed, produce a superior field that is not only high in its aesthetic value, but also may be a safer field for the conduct of athletic events.

Mowing

Height-of-Cut - Each of the turfgrasses has an ideal height-of-cut. Since most athletic fields are either common bermudagrass or one of the "named" bermudagrass varieties, there are really only two different heights-of-cut to consider. The best cutting height for common bermudagrass is about 1 1/2 inches. All the others, such as Tifway (419), Tifgreen (328) or Texturf-10 should be cut in the 1 to 1 1/2 inch range.

Generally, if these grasses are cut below the recommended height, they will tend to thin out and be less prone to stand up under heavy use. At cutting heights that are very much above the suggested heights, bermudagrass tends to become stemy. All the leaves are produced near the end of the upright stem and the turf becomes very susceptible to scalping.

Mowing Frequency - The failure to mow a turf at proper intervals can be one of the most abused aspects of turfgrass maintenance. Ideally, a field should be cut at point so that no more than 1/3 of the leaf surface is removed at any one mowing. For a common bermudagrass field, this would mean that it should be cut at 1 1/2 inches each time it reaches about 2 to 2 1/4 inches in height. The "named" bermudas should be cut at 1 inch each time they are about about 1 1/2 inches high.

Mowing Equipment - It is generally considered that reel-type mowers offer the best cut in terms of quality followed by rotary and then flail-type mowers. Regardless of the type of mower, it should be kept sharp.

Irrigation

It would be extremely difficult to maintain an athletic field without irrigation. Many athletic fields are constructed on soils that contain high amounts of a clay that shrinks when it is dry and expands when it is wet. During dry periods, many of these fields may develop soil cracks that are several inches across and many inches deep. These non-irrigated fields may not be safe for play.

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*Area Turfgrass Specialist, Texas Agricultural Extension Service, 17360 Coit Road, Dallas, Texas 75252.

The frequency and duration of irrigation is dependent on many environmental factors as well as those limitations imposed by design of the irrigation system. Ideally, the system should be able to provide enough water over a reasonable time period to wet the soil to a depth of 4 - 6 inches. The soil should then be allowed to become nearly dry before the next irrigation. Since many fields are constructed from high clay soils, it may not be possible to get on enough water in one irrigation to wet the soil that deep before water begins to run off the field. When runoff occurs, stop irrigating and let the water soak into the field. It may be necessary to repeat this type of a cycle several times before irrigation is complete.

It is very important to allow the surface of the field to dry out between irrigations and not to irrigate until it is absolutely necessary. The first visual sign that a turf needs water is what is commonly called "footprinting". When the turf plat has a low water content, it does not tend to bounce back after it has been stepped on or driven over. In other words, after you walk or drive across it, you can easily see where you have been. That is the time to irrigate.

If a turf is irrigated too frequently and the surface stays wet for an extended period, it tends to be more susceptible to disease, accumulate thatch and tends to become more shallow rooted.

Aerification

The roots of the turfgrass plant take in oxygen (O_2) and give off carbon dioxide (CO_2). An average soil contains about 45 percent mineral, 5 percent organic matter, 25 percent air. When a soil receives an abnormally high amount of traffic, as do many athletic fields, the amount of air space in the soil is slowly reduced. This results in a gradual thinning of the turf because the soil has been compacted.

The centers of football fields and the areas near the soccer goal are good examples of areas that are prone to soil compaction. Soils vary in their susceptibility for compaction. As the sand content of a given soil increases, it becomes less subject to compaction. Reversely, as the clay content of a soil increases, it becomes more easily compacted. Since most athletic field soils have a fairly high clay content, it becomes very important to consider the turfgrass maintenance procedure designed to counteract soil compaction-aerification, or as it is sometimes called, coring.

This process involves the use of a machine that inserts a hollow metal tine into the soil to a depth of 2 or 3 inches. A core of soil is displaced and discarded on the surface where it will slowly decompose. The hole left by this process will allow greater amounts of carbon dioxide to escape from the root system. These holes also allow freer movement of water, nutrients and pesticides into the soil. Aerification is the only way a soil can be tilled without seriously disturbing the turf.

Every athletic field should be aerified at least once a year. Those that are used more than others and that have a thin turf may need to be aerified once a month during the growing season.

Fertilization

A good fertilizer applied at the right time is an important part of any athletic field maintenance program. For most fields, a 3-1-2 or 4-1-2 ratio of N-P-K will do a good job. The following are a few fertilizer programs that might be considered:

Fertilizer Analysis	Nitrogen Source	Application Dates	lbs. N 1000 ft.	lbs. Fert. 1000 ft.	lb. Fert. Football Field*
15-5-10	soluble	April 15	1.3	8.7	500
		June 1	1.3	8.7	500
		July 15	1.3	8.7	500
		Sept. 1	1.3	8.7	500
		Total	5.2		2000
15-5-10	50 or 100% SCU**	April 15	1.6	10.7	600
		June 15	1.6	10.7	600
		Aug. 15	2.0	13.4	800
		Total	5.2		2000
19-5-9	50% SCU	April 15	1.7	9.0	500
		June 15	1.7	9.0	500
		Aug. 15	1.7	9.0	500
		Total	5.1		1500

* A football field is 57,600 square feet.
** Sulphur Coated Urea.

The above times of application and rates are suggestions. It might be desirable to adjust application dates one way or the other and it might be desirable to use slightly higher or lower rates. These programs are offered as a reasonable place to start.

Pest Control

Weeds - Weeds are a very common problem on many athletic fields. They may be classified or grouped in several ways. Weeds may be classed as grassy types such as crabgrass, goosegrass, dallisgrass, etc. or broadleafs such as henbit, goathead, etc. Another way to group weeds is by their life cycle. They may either be perennial (live more than one year) or summer annuals or winter annuals. The following chart may help in the selection of the proper herbicide:

Weed Type	Chemical	Trade Names
Summer grassy	MSMA, DSMA	Various
Summer broadleafs	2,4-D, MCPP, Dicamba combinations	Trimec, TrexSan
All winter weeds (apply when bermuda is dormant)	Glyphosate	Round-Up, Kleen-Up

Note: Apply all herbicides according to the directions on the label.

Insects - About the only insect that would commonly be a problem on athletic fields is the white grub. If they are going to be a problem, it is usually after August 1. If there are patches of the field that begin to wilt, but do not respond to water, it may be grubs. Dig up a square foot of soil in the wilted area and look for grubs. If there are more than five, treatment with an insecticide such as diazinon or dursban is suggested. It is suggested that a surfactant (wetting agent) be used with the insecticide to facilitate its movement into the soil.

Diseases - A disease on bermudagrass is fairly rare under most conditions. Most diseases of turfgrass require free water or a very high humidity to grow and infect the plant. In most parts of the state, the humidity is fairly low during the bermuda growing season and it would probably take an extended period of rain or the excessive use of irrigation water for a disease to develop. One of the best methods of disease control is the proper use of the irrigation system.

OLSEN FIELD - A Case Study in Baseball Field Maintenance*

Olsen Field, a 5,000 seat capacity baseball stadium at Texas A&M University, is the envy of the Southwest Conference with its beautifully manicured natural turf playing field. The pride and joy of the Aggie baseball team, Olsen Field is beautiful from the standpoint of its appearance, playability, visibility and location. Situated on a corner of the campus surrounded by a large parking area, the stadium is convenient to both players and fans. But, like any sports turf facility, the field requires a rigorous maintenance program to keep the grass and skinned areas of the playing field in top playing condition.

The permanent grass on Olsen Field is Tifway bermudagrass--a variety of bermudagrass developed by Dr. Glenn Burton at Tifton, Georgia for use on golf course fairways and athletic fields. Its inherent dark green color, fine leaf texture and spreading growth habit contribute to its beauty and wear tolerance. It is an excellent grass for high maintenance athletic fields in the southwest.

Tifway forms a dense, fine textured turf that tolerates close mowing, heavy use and hot summer temperatures. It can be used for at least 7 months out of the year--April through October--without overseeding. Like all bermudagrasses, Tifway ceases growth and becomes dormant during the winter months. Where the field is used extensively between January and April, as it is in collegiate and high school baseball, Tifway can be overseeded with one or more of the improved perennial ryegrasses to provide color, uniform surface conditions and wear tolerance during the dormant period. The ryegrasses remain through the spring season and are gradually replaced by Tifway as it recovers in late spring. The transition from ryegrass to Tifway is very smooth and essentially unnoticed by the players and fans. The color, texture, density and playing conditions of the two types of grasses are very similar.

The overseeding operation is conducted in late fall after the baseball season is completed. Where a field is used exclusively for baseball the overseeding operation does not interfere in any way with the use of the field. The cost of overseeding is small compared to the benefits it produces when you consider that the high school and college season is played during the time the ryegrasses are at their best and Tifway at its worst. At Olsen Field, Tom Chandler, head baseball coach, feels that the lush, dark green turf produced by the ryegrasses adds to the interest and excitement of the players and fans.

The Tifway bermudagrass is still very important since it contributes strength, resilience and wear tolerance to the turf even during the dormant period. It also helps fill in the divots and worn areas during the peak of the baseball season--late spring. Without the bermudagrass base, the ryegrasses would not hold up as well throughout the season in the southern states.

The grasses at Olsen Field are very important. But, even with the best grasses the field would not be outstanding without a rigorous turf maintenance program. I have seen other fields with the same grasses that did not have nearly as fine a playing surface as Olsen Field. And, there is nothing unique

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about Olsen Field. Regular mowing with reel mowers, proper cultivation, fertilization, watering and a selective weed control program constitute the "secret" to the excellent turf in Olsen Field. George Toma, grounds supervisor for the Kansas City Chiefs and Royals, commented during a visit to Olsen Field that the turf was as fine as that on the best major league baseball fields in the country.

If you are interested in duplicating the quality of turf as that found on Olsen Field, the program to follow is simple, but demanding. As any turf management specialist will confirm, a good turf requires persistent attention. You cannot develop fine turf that will stand up to heavy use by doing everything right for just a month or two--it requires a year-round maintenance program.

Maintenance of Grass Areas

At Olsen Field the bermudagrass receives only a moderate level of maintenance during summer and early fall. The field is mowed every 5 days at a height of 7/8 inch. Direction of mowing is changed at each mowing. Grass clippings are not removed. Mowing the entire field, nearly three acres of grass, requires about 2 hours per mowing with an 84-inch triplex reel mowing unit.

Water is applied only as needed during the summer to prevent severe wilting of the turf. Ordinarily about 1/2 inch of water is applied every 2 or 3 days. Allowing bermudagrass to suffer slight drought stress is far better than keeping it overwatered. Overwatering leads to shallow rooted turfgrasses and poor footing. Since Tifway bermudagrass is a relatively drought tolerant grass, it maintains good color, resilience and wear tolerance even under moderate drought stress. Thus, if anything, we keep the field on the dryside.

Ideally, sufficient water should be applied to wet the soil 4 to 6 inches deep. At Olsen Field, where water penetration is very low, we apply only 1/2 inch of water per irrigation which wets only the upper 2 or 3 inches of soil. However, when the field is not scheduled for use for several days, we thoroughly wet the field by applying an inch or more of water at one time. By wetting the soil periodically, we can maintain a strong root system and still keep the field playable.

Olsen Field is fertilized during the summer only enought to maintain satisfactory color and density. From late May through mid-October the grass receives only about 3 pounds of nitrogen per 1,000 square feet in 2 applications. It is important not to overfertilize bermudagrass as it increases mowing and watering requirements and reduces its wear tolerance. Slow release nitrogen sources are used throughout the summer months to avoid the burst of growth following each application and to extend the greening response of the fertilizer. Hercules' Nitroform is used on the turf to provide uniform growth and color and to prevent burning the grass during spring and summer months.

In mid-October, prior to overseeding, the field is fertilized with a complete fertilizer with a 3-1-2 or 2-1-1 ratio at a rate of 30 pounds of nitrogen per acre. These fertilizers were recommended through soil test results that show a high level of phosphorus and a medium level of potassium. To increase the density of the cool season grasses, the field is fertilized in early December

with a 2-1-1 fertilizer at 30 pounds of nitrogen per acre. At that time the bermudagrass is dormant and the seedling ryegrasses are just beginning to develop a complete cover.

The field is fertilized again in mid-January and March with a nitrogen source to sustain growth and color during the playing season. Nitroform is applied at 100 pounds per acre per application. When a rapid greening response is needed, a soluble nitrogen source is applied at a rate of 1/2 pound of nitrogen per 1,000 square feet. Foliar applications of iron sulfate are also used for a fast greening response.

Weed control on Olsen Field consists of several applications of MSMA during summer months for control of crabgrass and nutgrass. Two applications in June about 2 weeks apart and another treatment in late August keep the bermudagrass weed-free. If winter broadleaf weeds--chickweed, henbit, clover, etc.--are a problem in the overseeded ryegrasses, Trimec is used in the early spring. Roundup is used during summer months for complete vegetation control on the skinned areas and warning track. Herbicides are an important component of the maintenance program at Olsen Field. They help keep the field free of unsightly and troublesome weeds and help reduce labor requirements onto the skinned areas of the field.

Overseeding with Perennial Ryegrasses

Overseeding the field with perennial ryegrasses takes place in late October after fall baseball practice is completed. In preparation for overseeding the bermudagrass, turf is thinned with a flail or dethatching mower. Clippings and thatch are removed with a turf sweeper and the field is aerified with a coring-type aerifier. Soil cores are dragged with a heavy steel mat, such as that used to drag the skinned area of the infield, to break up the cores. A flail mower may also be used to pulverize the cores.

All of these operations are important in preparing the Tifway bermudagrass turf for overseeding. However, if common bermudagrass forms the permanent turf, close mowing, aerifying and dragging are all that would be necessary to develop a good seedbed for perennial ryegrass. At Olsen Field, we have used Derby, Caravelle, Regal and Pennfine with excellent results. For the 1980-81 season we planted Caravelle on the infield, Regal on the outfield, and Loretta along the sidelines to develop a color contrast between those areas. The sidelines and outfield were planted at a rate of 8 pounds of seed per 1,000 square feet. The infield was planted at 25 pounds per 1,000 square feet. In each of the three areas, a drop-type distributor was used to plant a 4-foot wide border around each of the areas. This border helped us to keep a distinct line between the outfield and sideline areas and to keep the seed off of the skinned area of the infield and the warning track. The area inside of the 4-foot border was planted with a cyclone-type distributor. The outfield and sideline areas were seeded in two directions at right angles to each other. The infield was seeded in four to five directions to insure uniform seed distribution.

After seeding, the infield was topdressed with a medium textured sand to smooth the surface and to help hold the seed in place. The sand was dragged with a homemade carpet drag to smooth the playing surface. A 16-8-8 fertilizer was applied to the entire field after planting at a rate of 200 pounds per acre.

After seeding and fertilizing, the field is watered lightly twice a day for 5 to 7 days. As the seedlings emerge, water frequency is reduced to daily and, eventually, to an as-needed basis. It is very important to keep the soil surface moist, but not wet, during the establishment period--10 days to 2 weeks after planting.

Mowing the ryegrasses begins about 2 weeks after planting at a height of 1/2 inch on the infield and 3/4 inch on the sideline and outfield areas. During late fall and winter, weekly mowing is satisfactory to maintain the ryegrasses. During spring months the ryegrasses require twice-weekly mowing at these heights. At Olsen Field, the infield is mowed with a walking-type greens mower every other day during the playing season to produce fast, uniform playing conditions.

Maintenance of Skinned Areas

The non-grass areas of the baseball field are just as important to the playability and appearance of the field as the grass areas. Most ball field managers would also agree that the skinned areas require more time to maintain than the grass areas. The first requirement for the maintenance of the skinned areas is that they meet specification for whatever league the field is being used.

The composition of the skinned areas should be such that it provides firm footing, but also remains resilient. The surface should be loose and should readily absorb moisture. The skinned areas should slope toward the sidelines or outfield to provide surface drainage. Soil types that are suitable for the skinned areas range from a loam to sandy loam or sandy clay loam. Sand (brick or mason sand) and calcined clay (Turface) may be worked into the skinned areas throughout the season to maintain the loose, firm and resilient nature of the playing surface. Topsoil, sand and calcined clay is stockpiled before the season begins so that it is available as needed. The topsoil is screened and stored in a protected area or covered to keep it dry.

Prior to the season opening at Olsen Field, the skinned areas are scarified to loosen the soil several inches deep. Sand or calcined clay are worked into the top inch or two of soil by hand raking or dragging with a nail drag. The area is smoothed by dragging with a steel mat and carpet drag. Occasionally the skinned areas are rototilled about 4 inches deep to loosen the soil and incorporate sand and calcined clay. This is only necessary when the soil becomes very hard and difficult to work by hand or with a nail drag. If rototilling is required, it is important to allow time for the soil to settle and pack before the season begins.

The grass edges of the infield are edged with a mechanical edger and the sod lifted by hand to keep the edge sharp. This is done several times during the season to keep the edge sharp and to prevent soil build-up along the grass edge.

After each practice session or game, routine maintenance is performed to keep the infield area in good playing condition. First, the grass edge of the infield is swept with a stiff broom to remove soil that was pushed onto the grass. This is essential to prevent soil build-up along the grass edge of the

infield. Next, the area around the bases are hand-raked to replace soil that was moved by players sliding into bases. Then, the skinned areas are dragged with a nail drag followed by a carpet drag to smooth the infield. Regular working of these areas keeps the field in top playing condition and helps avoid major reworking of the infield during the season.

Pitchers Mound and Homeplate Area

Just as the skinned area of the infield requires regular maintenance, a few minutes each day repairing the mound and homeplate area keeps them in good playing condition. Clay or clay loam soil used to build the mound is stock-piled and kept moist for regular repair of the worn part of the mound. A stiff broom is used to sweep the mound after each use to remove any loose material. The worn area is moistened and moist clay is used to fill the hole. The fresh clay is tamped by hand to pack the mound. After repairing the mound, the entire area is raked by hand and dragged with a steel mat or carpet drag. If the clay sticks to the equipment or to cleats, sand and calcined clay may be added to the surface to prevent sticking. The height and slope of the mound are checked regularly to be sure they meet specifications.

The same procedure is followed on the homeplate area--batters box and catchers box. The boxes are swept after each use, fresh clay is added and tamped, the area is raked by hand, dragged with a steel mat, and topdressed with sand and calcined clay and smoothed with a carpet drag. If rain is forecast, the entire infield is covered with a tarp to keep the skinned areas dry. At Olsen Field, Coach Sampson estimates between 3 and 4 man-hours are required after each use to restore the skinned areas to playing condition.

Foul Lines and Other Chalked Areas

Straight, sharp lines help define and dress up the field. At Olsen Field, the lines are cut 2 3/4 inches wide and marked with marble dust. All of the lines are remarked before each game day.

FERTILIZING SHADE TREES

by

Everett E. Janne*

Trees and shrubs growing in well established lawn or turf areas that receive good maintenance and fertility programs seldom have need for extra fertilizer. Sometimes we apply additional fertilizer to young trees to speed up growth or to aid them in competing with the established sod.

Other conditions which may cause conditions where additional fertilizer might be needed is in landscaped areas where the soil has been sculptured in such a way that the soil uniformity has been disturbed or destroyed and you are attempting to grow trees in exposed subsoil, poorly drained areas, or other conditions not conductive to good tree growth.

Recent research has shown that nitrogen fertilizer is about the only nutrient needed under average growing conditions. In fact, a complete fertilizer high in phosphorus as 10-20-10 or 8-12-4 used year after year can cause excessive amounts of phosphorous to accumulate in the surface soil since it is almost insoluble. In alkaline soils this can result in a phosphorous induced iron deficiency.

It is usually best to let the tree be your guide as to its fertilizer needs. Excessive amounts of growth on trees is usually undesirable as it results in weakened structure and makes them more susceptible to storm damage and breakage. A very young tree or sapling may put on 2 to 6 feet of growth under good conditions. A young tree reaching a trunk diameter of 4 to 6 inches may grow as much as 1 to 2 feet under good conditions, whereas an old mature tree may produce only 2 to 3 inches of new growth per year. In fact, the growth rate over a period of 3 to 4 years will give an excellent clue as to the vitality or vigor of a mature tree. Examine the terminal or lateral growth each year by counting back along the bud scars at the base of each year's growth. You can easily determine the rate of growth in this way. If the length is getting less and less each year, it usually indicates a loss of vigor for one reason or another. About 2 to 3 inches each year indicates adequate growth. Loss of vigor can be due to lack of nitrogen, construction damage, soil compaction, poor drainage or change in drainage pattern, insect damage or disease. It may also be due to severe drought conditions as experienced this year.

If your examination indicates poor leaf color, pale leaves, little or no growth, it may be due to low fertility if you have eliminated the other problems listed above.

There are many ways to compute the amount of fertilizer one should use on woody plants. In open areas or orchard areas the formula is to use .1 or .2 pounds of actual nitrogen per inch of trunk diameter or 1 to 2 pounds of a ten percent nitrogen fertilizer such as 10-8-7. If you were using ammonium sulfate which contains 20 percent nitrogen, you would need 1/2 to 1 pound per inch. On trees less than 3 to 4 inches in diameter, use the lesser amount, on larger

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trees, use the larger amount. Using this method, one can get into trouble when fertilizing trees growing in areas with restricted root areas often found in small yards or in street tree plantings. Here I like to use the formula of 2 to 4 pounds of actual nitrogen per 1,000 square feet of soil area. In this case if you were using a fertilizer formula of 10-8-7, you would use 20 pounds to get 2 pounds of actual N. If you use ammonium sulfate, the rate would be 1/2 as much or 10 pounds per application.

Late fall is an excellent time to apply fertilizer and again in the spring just before or as new growth commences. The best method of application in most cases is to broadcast the fertilizer evenly over the area and water it thoroughly. Some tree maintenance people prefer to drill holes and divide the fertilizer evenly in the holes, then refill the holes with a mixture of sand and peat. This requires a lot of labor and is seldom any more effective since nitrogen is soluble and will move into the root zone with rain or irrigation. The hole or punch bar method will also frequently create a polka-dotted effect on the lawn area.

In many areas of Texas where the soil pH is highly alkaline or the irrigation water is alkaline, we encounter a condition known as iron chlorosis. Iron sulfate or copperas and iron chelates can also be used to overcome these conditions. Probably the most effective iron chelate is one called Sequestrene 138. The recommended rate is 20 pounds of the Fe 138 per acre or 2 ounces per 100 square feet. For trees, the label recommends 1/4 to 1/2 pound per tree under 4 inches and 1/2 to 1 pound for those over 4 inches DBH. The Fe 138 was effective used in soil applications in the highly alkaline soil in Fort Stockton, whereas the iron sulfate and the other chelated iron materials had little or no effect when used in the soil. For ease of application, it is recommended to dissolve it in water at the rate of one pound per gallon of water and pour it over the root zone. It is best if the soil is moist and the surface worked up or loosened. Extension publication L-435, Iron Chlorosis, available from your county Extension agent, gives more complete information on overcoming iron chlorosis.

The reason iron is unavailable in alkaline soil is that at the higher pH the iron changes to an insoluble form and is unavailable to the plant root. The Fe 138 is evidently more stable and does not become unavailable as rapidly.

To reduce the pH in beds and tree areas, you can apply 10 to 20 pounds of powdered sulphur per 1,000 square feet of area and work it into the upper 6 inches of soil, then water thoroughly. Soils high in limestone will have to have repeated applications at yearly intervals. The best solution is to use plants that will tolerate the existing pH.

I want to conclude my remarks with a few slides to illustrate some of these points, then we will try to answer any questions you may have if our moderator feels we have the time.

A KEY TO NUTRIENT DEFICIENCIES OF ORNAMENTAL PLANTS

Taken from: The Ohio State University, Cooperative Extension Service Bulletin 650, Fertilizing Landscape and Field Grown Nursery Crops

This key is divided into three sections: (A) Older Leaves First Affected, (B) Youngest Leaves First Affected and (C) Terminal Bud Affected. After one has determined the specific location of the affected tissue, go to the appropriate section, either A, B, or C.

A. OLDER LEAVES AFFECTED FIRST

A1. General chlorosis progressing from light green to yellow; stunting of growth, excessive bud dormancy; necrosis of leaves, followed by abscission in advanced stages--NITROGEN.

A2. Marginal chlorosis or mottled leaf spots which occurs later; tips and margins may become necrotic, brittle and curl upward--MAGNESIUM.

A3. Interveinal chlorosis with early symptoms resembling N deficiency; leaf margins may become necrotic and may roll or curl--MOLYBDENUM.

A4. Leaf margins may become brown or mottled and curl downward--POTASSIUM.

A5. Leaves accumulate anthocyanins causing blue-green or red-purple coloration; lower leaves may turn yellow--PHOSPHORUS.

B. YOUNGEST LEAVES AFFECTED FIRST

B1. Light green color of young foliage, followed by yellowing; tissue between veins lighter colored--SULPHUR.

B2. Distinct yellow or white area between veins; initially veins are green, becoming chlorotic under severe deficiency, followed by abscision--IRON.

B3. Necrotic spots on young chlorotic leaves, with smallest veins remaining green--MANGANESE.

B4. Chlorotic leaves abnormally small; shortened internodes in severe cases, becoming rosetted--ZINC.

B5. Young leaves permanently wilted, becoming chlorotic, then necrotic--COPPER.

C. TERMINAL BUD DIES

C1. Brittle tissue, young or expanded leaves becoming chlorotic or necrotic and cupped under or distorted; terminal and lateral buds and root tips die--BORON.

C2. Growing points damaged or dead; tips and margins of young tissue distorted; leaves may become hard and stiff--CALCIUM.

CHEMICAL CONTROL OF SEEDLING DISEASES IN OVERSEEDED GRASSES

by

M. P. Grisham*

Seedling diseases are an important consideration in the establishment of overseeded grasses, particularly on golf course greens. Uniform stands must exist when a good playing surface is required after dormancy of the underlying turf.

Damping-off is a collective term frequently used to refer to several seedling diseases which may occur independently or collectively. Symptons include seed decay and seedling death prior to emergence, called pre-emergence damping-off or seedling death after emergence, called post-emergence damping-off.

There are at least seven species of fungi which have been described as pathogenic to turfgrass seedlings (1). Perhaps the most important causal agents of damping-off are species of Pythium. Pythium belongs to a group of fungi commonly referred to as "water molds". As the common name indicates, the fungus is favored by high soil moisture. Pythium development is also favored by relatively cool temperature during the season when overseeding is usually done.

Rhizoctonia solani, isolates of which also cause brown patch of turfgrass, and at least two species of Fusarium may also be important pathogens causing damping-off. These two genera of fungi are favored by relatively warm temperatures and lower soil moistures (field capacity or less) compared to temperatures and moistures favoring Pythium.

The fungi that cause damping-off are soil inhabiting fungi that can survive for long periods of time in the soil or hatch without the presence of a living host. They form resistance survival structures and some may grow and reproduce on dead organic matter.

Control of seedling disease should include an integrated approach using good cultural practices and wise use of fungicides. Cultural practices include insuring adequate drainage, applying fertilizers to promote rapid maturity of the plant, the use of resistance varieties, and the use of fresh seed.

Fungicides were tested at the Texas A&M University Turfgrass Field Laboratory for their efficacy to control seedling diseases of overseeded grasses. Two methods of fungicide application were used - seed treatment and preplant application of the fungicides. All fungicides included in the test were tested in preplant application treatments. Seed treatment applications were made using Captan, Thiram, Koban, and Maneb. 'Loretta' ryegrass was used to overseed 'Tifway' bermudagrass. Seed treatments were made 5 days before planting and preplant applications were made one day before planting. Recommended rates were used in both types of application. The efficacy of the

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fungicides was evaluated by determining the average number of emerged plants per 10 cm^2 in each treatment 23 days after planting.

During the time of this experiment there was relatively low disease pressure on the young seedlings. Field and climatic conditions favored rapid growth and development of the ryegrass, exposing them to the pathogens for a shorter period of time.

Table 1 indicates that Captan was among the most effective materials. Captan is currently one of the most widely used and effective materials for seedling disease control. There appears to be other materials, however, which have been developed or are being developed which may provide some alternatives. Cost may however be a significant consideration since Captan is less expensive.

Another observation was the preplant applications were more effective than seed application except for Koban. At the present time, the additional cost of seed treated with Koban is approximately $5 per 100 pounds of seed. Depending on seeding rates, this would represent an additional costs of about the same amount as a single application of most of the other effective fungicides.

The fungicide program will continue to evaluate materials for seedling disease control as well as disease which appear later in the season. I wish to express appreciation for the cooperation of the GAF Corporation, Ciba-Geigy, the Upjohn Company and Rhone-Poulenc Incorporated.

LITERATURE CITED

1. Couch, H.B. 1973. Diseases of Turfgrass. Robert E. Krieger Publishing Co., Huntington, New York. 348 pp.

Table 1. Effect of Fungicide Treatments on the Number of Emerged Overseeded Grass Plants 23 Days After Planting.

FUNGICIDE	METHOD OF APPLICATION	MEAN NUMBER OF PLANTS PER 10 CM^2
Captan	Preplant	46.25A[a]
Chipco 26019	Preplant	46.25A
GAF 865	Preplant	46.25A
Maneb	Preplant	46.25A
Koban	Seed Treatment	45.00AB
Actidione-Thiram	Preplant	45.00AB
Daconil 2787	Preplant	43.75ABC
Actidione RZ	Preplant	41.25ABC
Fore	Preplant	40.00ABC
Captan	Seed Treatment	38.75ABC
Maneb	Seed Treatment	32.50ABC
Koban	Preplant	31.25 BC
Thiram	Preplant	31.25 BC
Thiram	Seed Treatment	30.00 C
Control	-	30.00 C

a. P = 0.10

THE EFFECT OF CULTURAL PRACTICES ON THE SURFACE SPEED OF CLOSELY MOWED GREENS

by

G. K. Stahnke and J. B. Beard*

The cultural practices selected in preparing a green for tournament play can regulate the speed or distance which the ball rolls. Some of the practices involved are mowing, dew removal, watering practices, topdressing, slicing, coring and spiking. Turf managers possess a general idea as to the effects of various cultural practices on ball roll. The exact magnitudes of these cultural practices on ball roll have not been quantitatively established. Thus, this study was initiated to establish the relative response and quantitative effect of various cultural practices on turf surface quality.

Research Procedure

A relatively level, 2,500 feet green was established in late March of 1979. The root zone medium was a masonry sand with an analysis of 0.7% gravel, 1.2% clay, 1.9% silt, and 96.2% sand. The sand itself was composed of 23.4% coarse, 43.2% medium, 18.2% fine, and 3.3% very fine particles. The area was planted with Agrostis palustris cv. 'Penncross' seed at a rate of one pound per 1,000 feet^2. Milorganite was used as a carrier and the surface was mulched with fumigated hay. The green was fertilized with one pound K per 1,000 feet^2 using potassium sulfate. Within two weeks, 90% to 95% of the 'Penncross' creeping bentgrass seed had germinated. Bare spots were overseeded and the weeds were rogued out by hand. The turf was rolled three weeks after planting. Mowing commenced at an 0.5 inch cutting height during the fourth week after planting using a walking-type greensmower. On the first of June, the cutting height was lowered to 5/16 inch, where it was kept until September when the cutting height was lowered again to 0.25 inch.

Even at 5/16 inch, the bentgrass was quite difficult to maintain in the heat and humidity of College Station, Texas. The southwest corner of the green was continually drying out due to winds sweeping across that corner. Frequent hand watering and syringing were implemented; often three syringe cycles per day were required to prevent drying of the green.

The green was sprayed with Diazinon as needed to control insects, along with alternating systemic and contact fungicides to control disease only as needed. The total amount of nitrogen applied to the turf in 1979 was 7.5 pounds N per 1,000 feet^2. No fertilizer was applied during the months of July through August due to high temperatures.

Preliminary feasibility studies were conducted in July of 1979 at Colonial Country Club in Fort Worth, Texas, with the cooperation of Mr. Steve Barley. Based on these findings, a study was established at the TAMU Turfgrass Field Laboratory at College Station, Texas, in late summer of 1979. The study involved a randomized block design of three replications consisting of three treatment plots 13 by 10 feet and three subplots of 3 by 10 feet within each

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of the main plots. There were a total of six treatments applied during the first and second studies: (1) dew present, (2) dew removed, (3) footprinting effects, (4) mowed, (5) unmowed, and (6) double mowed. A study was established in College Station in May of 1980 to assess the effects of topdressing and coring on surface quality.

The techniques used for each of the treatments were:

(1) Dew removal was accomplished by dragging a looped hose across the plot to knock the dew off the leaf surface. The ball was then rolled across these plots and compared to the length of ball roll on the plots with dew.

(2) Footprinting treatments were achieved by means of a 115 pound person wearing spiked shoes who walked across the plot area ten times. This simulated light traffic across the green.

(3) The topdressing treatment consisted of a 0.5 cubic yard per 1,000 feet^2 application of masonry sand over the entire area. The sand was worked in with a drag mat before the tests were run.

(4) Core cultivation was done using a Ryan Greensaire aerifier with 1/2 inch tines. The plot was cored once and the soil plugs removed.

Two instruments were used to measure the length of ball roll. The first was a fixed inclined plane which was developed by Dr. James B. Beard for previous ball roll studies conducted at Michigan State University in 1966. The angle of the plane could be adjusted or leveled by changing the leg heights in the instrument. The USGA's Stimpmeter was the second instrument used to measure ball roll. The balls were rolled from each end of each plot with both of the instruments, and the measured distances averaged.

Results

An overall assessment of the results shown in Table 24 illustrates a striking similarity between the inclined plane developed by J. B. Beard in 1966 and the Stimpmeter technique developed by the United States Golf Association independently. Three series of experiments were conducted using both instruments. No significant differences were found between the two techniques based on the Duncan's multiple range test at an α level of 0.05.

Under the moderate nutritional and growth conditions on this 'Penncross' creeping bentgrass green, the basic practice of daily mowing resulted in a 15% to 16% increase in distance of ball roll as compared to not mowing daily. However, double mowing resulted in a slight decrease in distance of ball roll in three out of five tests. The latter is a surprising observation which has occured on 'Penncross' creeping bentgrass at both test locations in Texas. Under the three test conditions in which double mowing decreased the length of ball roll, the weather conditions were extremely dry and shoot growth was reduced. Double mowing could have removed leaves down to the stem, which could increase the resistance to ball roll. In two tests in which double mowing increased the length of ball roll, the weather conditions were milder. One study in May was conducted several days after a heavy rain with significant leaf growth having occurred (Table 24). It has always been assumed

that double mowing further increased the distance of ball roll on greens. These preliminary results question whether this assumed response is generally applicable and dictates the necessity for more detailed studies concerning the effects of this practice.

In the second study concerning footprinting effects, even very light footprinting stress resulted in an increase in distance of ball roll. Furthermore, over an entire day where 300+ rounds of golf were played, the distance of ball roll increased 26% around the cupping area, even though there is a counter effect that slows ball roll as a result of leaf elongation during the day.

It was also demonstrated that dew removal in early morning caused a 9% to 12% increase in speed of ball roll under conditions of a moderate dew in College Station, Texas.

When the ball roll test was conducted over the coring treatment plots, there was a 7% decrease in the length of ball roll when compared to mowing alone (Table 25). After applying the sand topdressing, the ball was again rolled over these plots, and an 8% increase in length of ball roll occurred compared to the coring alone. This practice increased the green surface quality to the original playing speed existing before the area was cored.

These results are presented as an initial progress report. This phase of the research investigation concerning turfgrass cultural practices as they influence surface quality will be concluded by midsummer of 1980, with subsequent long-term cultural practice studies to be initiated. The investigation is supported by a grant from the Golf Course Superintendents Association of America.

TABLE 24. THE EFFECTS OF MOWING PRACTICES, FOOTPRINTING AND DEW REMOVAL ON THE DISTANCE OF BALL ROLL OVER A CLOSELY MOWED 'PENNCROSS' CREEPING BENTGRASS GREEN

TAMU - College Station, Texas - 1979

Treatment	Inclined Plane		Stimpmeter	
	Distance (inches)	Percent Change	Distance (inches)	Percent Change
Unmowed	91.1		90.1	
Mowed	105.0	+15%	104.5	+16%
Double Mowed	103.4	+14%	102.9	+14%
Before Footprinting	102.4		104.6	
After Footprinting	107.4	+ 5%	106.0	+ 1%
Dew Present	89.8		89.3	
Dew Removed	100.5	+12%	96.9	+ 9%

TABLE 25. THE INFLUENCE OF MOWING PRACTICES, CORING AND TOPDRESSING ON THE DISTANCE OF BALL ROLL

TAMU - College Station, Texas May, 1980

TREATMENT	Stimpmeter		
	Distance (inches)	Percent Change	
		vs. mowed	vs. mowed+coring
Mowed	88.0		
Mowed + Coring	82.1	-7	
Mowed + Coring + Topdressing*	88.6	0	+8
Double Mowed	94.0	+7	

*Topdressing was applied at a rate of 0.5 cubic yard per 1,000 feet^2.

AIR POLLUTION INJURY TO TURFGRASSES: CAUSES, DIAGNOSIS, SPECIES SUSCEPTIBILITY, AND CULTURAL FACTORS AFFECTING

by

J. S. Amthor, J. B. Beard, and F. Fong*

Air pollution injury to plant tissue is of very significant magnitude in the United States (6). While the atmosphere is often contaminated with countless pollutants, few seriously affect plant growth and development. The three major phytotoxic air pollutants in this country are: ozone (O_3), found in most urban and industrial areas; sulfur dioxide (SO_2), also found in most urban and industrial areas; and peroxyacetylnitrate (PAN), which is a major component of California smog. The effects of all three of these air pollutants on turfgrasses have been reported (1, 2, 10, 11, 12, 13).

Injury By Air Pollutants

Plants can be injured by either chronic or acute exposures to phytotoxic air pollutants. Chronic exposures are long-term (days) exposures to low concentrations of an air pollutant. Acute exposures are short-term (hours) exposures to a high concentration of an air pollutant. Most controlled concentration laboratory studies involve acute exposures of a turfgrass to an air pollutant and then scoring (rating) the plants for visible injury. Most field-grown plants, on the contrary, are subject to chronic air pollution exposures.

Results from laboratory studies may be misleading, since the most detrimental effect of air pollution is often invisible. That is, overall plant growth and vigor are often reduced before any injury lesions are visible. This invisible injury makes a turf more susceptible to all stresses, such as insects, disease, drought, heat, weeds, traffic, etc. Invisible injury will also lower the recuperative ability of a turf.

Ozone Injury

Typical symptoms of an acute exposure to ozone include:

(1) Water-soaked appearance (immediate)

(2) Bleaching of terminal ends of leaf blades

(3) Gray to brown necrosis

(4) White bands across the leaf blade

(5) Red or brown stipples on the leaf blade

(6) White to gray flecks on the leaf blade

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In general, warm-season turfgrasses are much less susceptible to injury by air pollutants than are cool-season turfgrasses.

Most studies of species susceptibility to ozone have indicated that the bentgrasses and annual bluegrass are very susceptible to injury, fescues and Kentucky bluegrass are intermediate in susceptibility, and the warm-season grasses are quite resistant (2, 7, 10, 12, 13). In fact, annual bluegrass is so sensitive to ozone injury that it has been used as a bioindicator of smog concentrations for almost 20 years (7).

Sulfur Dioxide Injury

While sulfur dioxide is considered a phytotoxic air pollutant, numerous studies - many with grasses - have shown that plants growing in sulfur deficient soils are actually benefitted by chronic exposures to sulfur dioxide (4, 5).

Plants are very adequate in metabolizing sulfur dioxide and are only injured when exposed to more sulfur dioxide than can be effectively metabolized (8).

Typical symptoms of an acute exposure to sulfur dioxide include:

(1) Water-soaked appearance (immediate)

(2) Necrosis of the terminal ends of the leaf blades

(3) General leaf chlorosis

(4) Tip burn of the leaves

(5) Gray mottling of the leaf blades

Studies have indicated that the bentgrasses and red fescue are very susceptible to SO_2-induced injury. The bluegrasses and ryegrasses are intermediate, while the warm-season turfgrasses (bermudagrass, zoysiagrass, and St. Augustinegrass) are resistant (1, 2, 10).

Cultivar Susceptibility

For all three of the major phytotoxic air pollutants (ozone, sulfur dioxide, and PAN), highly significant cultivar susceptibility differentials exist within most turfgrass species (1, 2, 10, 11, 12, 13). Within the Kentucky bluegrass species, cultivar susceptibility to visible ozone injury might appear as follows (from the most susceptible to the most resistant):

> A-34, Prato, Merion, Park, Windsor, Baron, Glade, Cougar, Pennstar, Nugget, Fylking, and Newport.

Similar ranking of Kentucky bluegrass cultivars, based on susceptibility to acute sulfur dioxide injury, might look like this:

> Prato, Kenblue, Windsor, Park, Cougar, Baron, Common, Nugget, Fylking, Merion, Newport, and Pennstar.

Likewise, though bermudagrass is very resistant to visible ozone injury, the African types (Cynodon transvaalensis) and Tifgreen (C. hybrid) can be injured at moderate ozone levels, while the cultivar Santa Ana is particularly resistant. Within the zoysiagrasses, Emerald is considered more suceptible to ozone injury than is Meyer (12).

While most studies have been conducted in growth chambers or greenhouses under controlled conditions, investigators have monitored out-of-doors, ambient pollution concentrations and observed the effects on variety plots (11, 13). Following stagnation of ambient, phytotoxic California smog (a mixture of ozone and PAN among other pollutants), the following perennial ryegrass cultivars were rated for their relative injury (from most injured to least injured):

> Common, Lamora, Wendy, Ensporta, S-321, Clipper, Manhattan, Yorktown, Derby, Diplomat, Pennfine, and Citation (13).

These results agreed with laboratory fumigation studies, for the most part (12). The differential response between cultivars was very significant.

St. Augustinegrass-SO_2 Interactions

While St. Augustinegrass is very resistant to visible injury following an acute sulfur dioxide exposure, chronic exposures may be injurious. During a five-week exposure to low sulfur dioxide concentrations, the growth of Floratam St. Augustinegrass was inhibited by 15% while there were no injury lesions visible. The growth of Texas Common St. Augustinegrass was slightly inhibited, while the growth of Seville was, to a small degree, promoted in the same study (1). Without being visibly injured, Floratam may be invisibly injured by sulfur dioxide concentrations now being realized in the Beaumont and Houston areas.

Factors That Affect Air Pollution Injury

Several factors have been identified which affect air pollution injury to turfgrasses.

> Genotypic variation is very significant. While some cultivars can be severely injured by air pollution, others are apparently not affected. Turfgrass managers can utilize cultivar selection to avoid significant air pollution injury.
>
> Irrigation also affects air pollution injury. Since air pollutants are gases, they enter a plant primarily through the stomatal complexes. Any cultural factor affecting stomatal aperture will consequently affect air pollution injury. Anything which would tend to close the stomatal complexes - such as moderate drought - would protect a turf from injury. Therefore, if a high concentration of a phytotoxic air pollutant is expected, irrigations should be kept to a minimum. In addition, water droplets on leaf surfaces are excellent sites for sulfur dioxide injury, as sulfur dioxide dissolves completely in water.

Pesticides, including insecticides, herbicides, and fungicides, have been shown to affect a plant's susceptibility to air pollution. Of particular interest to turfgrass managers was the finding that the fungicide benomyl offered significant protection to annual bluegrass from ozone injury (9). Much work is currently being done regarding pesticide-air pollution interactions.

Plant age also affects the response to phytotoxic air pollution. Young tissue, such as seedlings, is generally more injured by ozone than is older tissue.

Fertilization may affect a plant's susceptibility to air pollution injury. Although it has not been well studied, some investigators feel that lush, succulent leaf tissue is more prone to ozone injury (3, 13). Perhaps lighter applications of nitrogen (especially quick-release) would provide some protection against air pollution damage.

Diagnosis

Diagnosis of air pollution injury is not always simple. Since many things, including drought, salt injury, disease injury, fertilizer burn, and insect injury have been confused with air pollution injury, it is important to investigate all the possibilities before assuming injury due to air pollution. For example, from a distance, thrip injury to Kentucky bluegrass is often confused with ozone injury. Closer investigation reveals the difference.

If air pollution injury is suspected, the first measure that should be taken is to look for symptoms of injury on other species in the immediate area. Many trees and garden plants (such as spinach and Pinto beans) are injured by phytotoxic air pollutants much more readily than turfgrasses and should be used as bioindicators of an air pollution (phytotoxic) episode.

Two government agencies, the Texas Air Control Board and The Environmental Protection Agency, can be contacted for more information regarding air pollution as well as help in diagnosing possible air pollution injury. While air pollution injury to turfgrasses can often be significant - it is also often complicated.

Literature Cited

1. Amthor, J. S. 1980. M.S. Thesis. Texas A&M University. 73pp.

2. Brennan, E. and P. M. Halisky. 1970. Phytopathology. 60:1544-1546.

3. Brewer, R. F., F. B. Guillemet, and R. K. Creveling. 1961. Soil Science. 92:298-301.

4. Cowling, D. W., L. H. P. Jones, and D. R. Lockyer. 1973. Nature. 243:479-480.

5. Cowling, D. W. and D. R. Lockyer. 1976. J. Exp. Bot. 27:411-417.

6. Heggestad, H. E. 1977. J. Air Poll. Cont. Assn. 27:844-846.

7. Juhren, M., W. Noble, and F. W. Went. 1957. Plant Physiology. 32:576-586.

8. Malhotra, S. S. and D. Hocking. 1976. New Phytol. 76:227-237.

9. Moyer, J., H. Cole, and N. L. Lacasse. 1974. Plant Dis. Reptr. 58:41-44.

10. Murray, J. J., R. K. Howell, and A. C. Wilton. 1975. Plant Dis. Reptr. 59:852-854.

11. Wilton, A. C., J. J. Murray, H. E. Heggestad, and F. V. Juska. 1972. J. Environ. Quality. 1:112-114.

12. Youngner, V. B. and F. J. Nudge. 1980. Agron. J. 72:169-170.

13. Youngner, V. B. and F. J. Nudge. 1980. Proc. 3rd Intl. Turfgrass Res. Conf. pp. 155-163.

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349 Soil & Crop Sciences Center
July 8, 1981

MEMORANDUM TO: Speakers at 1980 Texas Turfgrass Conference

SUBJECT: Conference Proceedings

The enclosed Proceedings were developed from those of you who were kind enough to provide a copy of your presentation. I very much appreciate your effort.

Sincerely,

Richard L. Duble
Turfgrass Specialist

RLD:bj
Enclosure