Proceedings

of the

25th Annual Northwest Turfgrass Conference

September 22, 23, 24, 1971
Chinook Motel and Tower
Yakima, Washington

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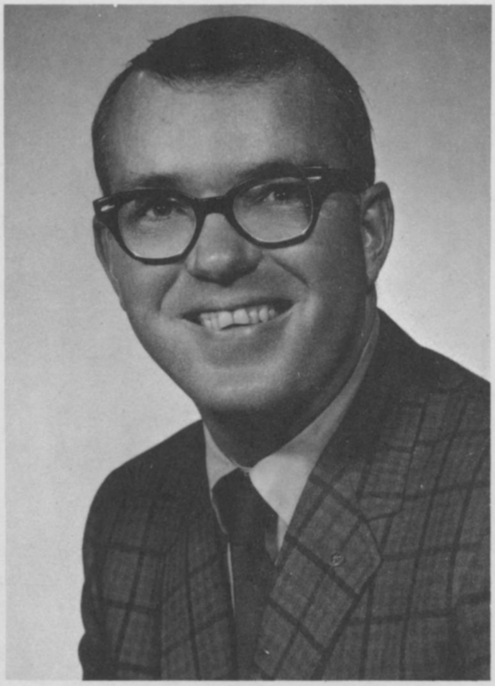
PRESIDENT'S MESSAGE



Welcome to Yakima and the 25th Annual Turfgrass Association Conference.

It has been a pleasure and honor to serve as President of the Association over the past two years. The support of the Board of Directors and membership has been most gratifying and I want to take this opportunity to thank all those who have given of their time and talents to serve on committee assignments. I especially thank the Conference Committee which has worked hard to arrange this Conference which I am sure will be befitting a 25th anniversary. Our thanks, too, to the Chinook Motel for providing such fine facilities.

Over the past 25 years the Northwest Turfgrass Association has developed into a most worthwhile organization and with continued support of the entire membership we will continue to grow and contribute towards development and maintenance of better turfgrass.

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ENVIRONMENTAL QUALITY CONTROL[1]
LET'S DO IT RIGHT

G. L. Culp[2]

The environmental woes of our country are chronicled in a seemingly endless flow of popular magazines, books, and pamphlets addressed to the topics of "ecology" and "the environment". Most of this literature paints the same bleak picture - the earth is doomed unless man revises the trend of ever-increasing pollution. Most of the major news magazines, Sunday supplements, and even fraternal organization periodicals have devoted entire issues to the topic. Full-paged pictures of dead birds, garbage, gas masks, and despoiled landscape call attention to the sad state of our environment.

Needless to say, readers are impressed, or disgusted, which is more nearly the intent. After studying the material, I am less impressed and more disgusted. "Do these people really know what they are talking about," we ask? The answer is frightening and frustrating. The rhetoric spans the gamut of uninformed to authoritative, truth to half-truth to erroneous, and from gross to mild exaggeration. But never, never understatement.

My purpose is to cut through the maze of rhetoric and focus on the major issues which must be resolved and emphasize the pathways for achieving reasonable and attainable solutions. It is impossible to discuss all aspects of our environment in one brief paper. Thus, I will use examples from one problem area, water pollution, to illustrate aspects common to all areas of environmental quality control.

What follows does not deal with the technology of prevention or cure. It deals with conditions which impair the expeditious application of current technology and the devel-

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1/To be presented at the 25th Annual Northwest Turfgrass Conference, Yakima, Washington (September, 1971)

2/Manager, Water and Waste Management Section, Battelle-Northwest, Richland, Washington.

opment of technology needed for the future.

Objectivity and Reasonableness

Perhaps the greatest immediate danger hindering a reasonable and objective approach to environmental quality control is the pronounced tendency of the news media to stress the opinions and proposed programs of sensationalists and emotionalists. This tendency hinders the establishment of proper priorities and reasonable programs. This is a critical point. Many delays are being caused by emotional flak. The apocalyptic predictions and gross exaggerations that catch the eye of the public may eventually lead to "environmental apathy" as the predicted doom fails to materialize.

The more reactive elements of society suggest we sacrifice our present standard of living and reorder our civilization away from competition and material goods. A more realistic and achievable approach is to establish environmental goals which recognize the need for assuring quality living in the context of the expanding technology necessary for sustaining human life. Neither of the extremes of returning the environment to a pristine form nor the development of technology without regard to environmental effects are acceptable approaches. Instead, a policy of adequate control of pollutants discharged from a growing population and associated technological growth must be established and enforced. National, long-term solutions must be adopted rather than the inefficient, and occasionally hazardous, approaches stimulated by emotional appeals.

An illustration of this latter point is the emotional reaction to the phosphate-detergent issue recently seized upon by the press and politicians. Certainly, the phosphate builders used in detergents contribute a significant source of phosphate in our environment and have contributed to accelerated aging (eutrophication) of many bodies of water. The emotional reaction has been to eliminate the phosphate from detergents, including pending legislation to this effect in many states and in the U. S. Congress. Canada and some U. S. communities have already enacted such a ban. It is likely that this approach is not the most efficient available and could lead to increased environmental hazards. The efficiency of a total ban is questionable, because the complete removal of phosphates from detergents will still leave enough (about 50% of current levels) in municipal wastewaters so that a significant phosphorus source remains. Sewage treatment facilities will still have to incorporate phosphate removal if municipal wastewaters are to be eliminated as a significant source of phosphates. The capital and operating costs of such facilities will be marginally affected by the removal of phosphates from detergents. Also, other major phosphate sources such as fertilizers and agricultural runoff will not be affected. It is a fact that several alternative processes exist which could readily remove phosphates from wastewater effluents. Instead of progressing toward the point of reducing process costs for existing phosphate removal techniques, we may now be about to generate a new set of problems by replacing the phosphate in detergents.

The huge sums of money required to retool the detergent industry could have been spent to consummate effective municipal and industrial phosphate removal techniques. To my knowledge, no significant analysis was ever made to determine whether it would be cheaper to produce a phosphate substitute or treat existing effluents. Add to this the costs of assessing the environmental impact of phosphate substitutes, and you may find that the preemptory decision is a costly one; especially when the costs of removing residual phosphate following the conversion to non-phosphate detergents are considered for those areas requiring low phosphate effluents. Obviously, the consumer is the one who has to pay the price, either by product cost or taxes.

The inefficiencies and hazards of emotionally based action illustrated by the detergent controversy emphasize the need to assure that reasonable and objective environmental scientists and engineers have the opportunity to make their voices heard. This will be a most difficult task because preservation of the environment is akin to godliness. As a result, opponents of precipitious action are viewed as having vested interests or as "counterenvironment". Many do represent vested interests, but this does not mean that they should not be heard or be silenced in the public area.

Serious dialogues must take place expeditiously and outside the realm of sensationalism and emotionalism.

Criteria and Standards

Not long ago, after delivering a talk on environmental quality, one of my colleagues was approached by a high school student who said, "I've heard that we only have 35 years before pollution begins to kill people by the millions. You say it isn't really that bad. I don't know what to believe!" In my opinion, providing a satisfactory answer to this worried statement is a prerequisite to establishing long-term public support for adequate pollution control programs.

You can readily understand how this anxiety has developed. In the eyes of the layman, even the "experts" do not agree on the fate of our environment. It is difficult for the public to distinguish between the credentials of an excellent aquatic biologist and a Nobel Prize winner in physics. Nine times out of ten they will believe the Nobel Laureate even though he might not know the difference between a protozoan and a dandelion. Technologists should carefully do their homework or remain silent.

How can an environmental policy be molded to make a suitable impact on the problem? In the water pollution control field the pathway of policy formulation goes something like this -- criteria, standards, implementation. Water quality criteria are defined as "scientific requirements on which a decision or judgement may be based concerning the suitability of water quality to support a designated use."

At this point, technologists can make a most important contribution because they can provide a sound basis for making a decision or judgement. Note that we carefully said, "provide a sound basis," and not "make a decision or judgement". The job is not to set standards but rather to define criteria.

For a given set of conditions, scientists and engineers can determine the temperature at which salmon survive in a water course. They ought not make the policy that determines how much or whether the natural temperature of a body of water will be permitted to be increased.

A water quality standard is defined as "a plan that is established by governmental authority as a program for water pollution prevention and abatement." At this point, the public is added to the picture and then policy is formulated. Also, the technologist becomes just another citizen, albeit a very well-informed one. He can only speculate on the possible social tradeoffs that the public might be willing to make in accepting a certain level of water quality. The scientists and engineers who participated in criteria development must play a very active role in public policy and standards formulation. However, they should not attempt to force their views of social goals upon the public.

Economics

Technologists and planners have often failed to propose environmental quality control programs consistent with the public desire and ability to pay for them. For example, they consistently have underestimated the public's willingness to pay to abate water pollution. The public desire is reflected in the passage (by a 4 to 1 margin) of a statewide bond issue for $1 billion for a pollution abatement program in 1968 in New York, and a $95 million issue (5 to 1) in St. Louis. These margins of victory could only relate to an intense desire for an improved environment. Yet, technologists often continue to propose only minimal programs at lowest costs designed to satisfy immediate legal requirements. If approached properly, the public would, in many cases, approve the implementation of more efficient programs. For example, advanced waste treatment facilities could treat municipal wastewaters to the point that they would be completely eliminated as a source of pollution and would be of such high quality as to be a valuable water resource. The capital and operating cost of such treatment would be only $3/month for a family of four based upon the operating costs of the South Lake Tahoe, California, water reclamation plant. In light of a recent survey in the State of Washington, which indicates that 51% of the public is willing to pay $100/year more for an improved environment, this level of expense appears acceptable. In bond elections for environmental control facilities, why not permit the voters to vote both on the minimal facilities to meet legal requirements and more advanced facilities with the incremental costs and benefits clearly described?

On the other hand, there is a feeling that this willingness to pay for environmental improvement may be short-lived. One possible reason could be found in the visibility of the progress the State of New York has made since passing their $1 billion bond issue. The price tag has been reassessed recently and is now more than four times the amount of the initial request. In addition, the citizens of New York are having difficulty seeing any major improvement of the quality of their environment. The fact that most of the people either were not adequately informed as to what they were buying, or how long it would take may make it difficult to gain their support for the needed supplemental financial programs.

The economics of environmental quality control will in large measure be controlled by three factors: 1) both the public and industry must have a clear idea of what their money is paying for and the public must be apprised of progress gained per dollar spent; 2) the rules under which municipalities and industries operate must be consistent, must reflect some reasonable plan, and must be relatively immune to emotional pressures; and, 3) municipalities and industries must accept the cost of waste disposal both as inevitable and as a pressing social responsibility.

Institutional Arrangements

In addition to failing to determine the limit of the public's willingness to pay for pollution abatement, technologists often have failed to apply new technology as it becomes available. The causes are many. Regulatory agencies are in a negative position: they have little to gain from promoting or approving new, relatively untried technology when approval of continued use of older, proven technology represents no threat to their security. Many practicing engineers cannot afford to fight this policy. Compounding the problem, many practicing engineers do not keep abreast of changing technology and, as a result, are not in a position to promote its application. Furthermore, the anticipation of massive pollution abatement programs has attracted marginally qualified people to the field.

Each of the 50 states has its own regulatory agency which must approve all new wastewater treatment facilities. Thus, the engineering profession is faced with 50 separate standards of acceptable technology. The multiplicity of standards represents a barrier to expeditious application of new technology. An analogy has been made to the likelihood of landing a man on the moon by 1970 and 50 separate agencies have been required to approve the technology and hardware used.

In many cases, the governmental agencies charged with pollution control convey to the public an image of looking out for the public's interest, but in reality they fail to do so. This failure of today's institutions to be responsive to real problems is well illustrated by an article in Sports Illustrated, "My struggle to Help the President", by Robert H. Boyle. The author, a sport fisherman, noted a 30-inch outfall, bearing a 1929 date, from a Penn Central shop discharging large quantities of oil into the Hudson River and began to file complaints in 1964. After fruitlessly pursuing help from the Corps of Engineers, the Department of Justice, and the then Federal Water Pollution Control Administration, five years elapsed before, in 1969, Boyle succeeded in getting the Corps to send the U. S. Attorney citations against Penn Central. A federal grand jury finally indicted Penn Central for 6 of 15 citations considered. The railroad eventually pleaded guilty to four and was fined $4,000. However, according to Boyle, Penn Central had yet to install a satisfactory control device six years after he began his efforts.

It is not difficult to understand the frustration of Mr. Boyle. In the Great Lakes Basin alone, there are over 200 separate entities responsible for resources management. Obviously, the problems encountered in dealing with a plethora of agencies is bad enough, but when these institutions are not responsive the problem is compounded.

Therefore, these institutions must be geared to respond quickly to the action expected of them by the public, and they must do so in a consistent manner. Likewise, in order to accomplish the job, the institutions must be adequately funded and staffed.

Technological Translation

A glaring need exists for applying demonstrated research. Much badly needed technology currently is sitting on the bench waiting to be called into the game. We are talking about demonstrated pilot plant or prototypical technology. And it isn't that the coach has not been cajoled or even informed.

For example, in the water pollution control field, only the Water Quality Office of EPA has a concerted effort to apply this research. The FY 1972 budget request looks pitifully small compared to the $6 billion annual cost of water pollution abatement.

There are several problems in addition to the small budget of WQO. First, industry and municipalities are reluctant to go it alone without federal support, particularly in view of the next consideration. Second, regulatory agencies, as mentioned previously, are often extremely conservative and are not staffed adequately to evaluate modern technology. Third, despite the fact that many new processes appear to be less costly in the pilot phase, everyone is reluctant to be the first to try them on a full scale.

Substantial effort must be expended to move new technology into use far more quickly than is presently the case.

Countermeasures

- Environmental goals must recognize the need for assuring quality living at the same time that technology is expanded.

- Efforts of Federal and State authorities to provide better definition and greater understanding of environmental problems should not be permitted to delay or impair immediate progress toward prevention and cures.

- Sensationalism, emotionalism, and the inclusion of peripheral sociopolitical issues should not be permitted to hinder the establishment of proper priorities and reasonable programs for environmental control.

- Reasonable and objective environmental scientists and engineers must have adequate opportunity to present their technical findings, however divergent their views and alternatives, in the face of crisis and emotionalism. Likewise, a concerted effort must be made to combat and expose exaggerated statements by well or ill-meaning colleagues who are speaking outside the realm of their technical expertise.

- Scientists and engineers must recognize that the formulation of standards is a matter of public policy, and their part is the identification and evaluation of alternatives, not the setting of standards.

- Technologists and planners must propose environmental control programs consistent with the public desire and the ability to pay for them. Because of their failure to do so in the past and the apparent lack of subsequent progress, the willingness of the public to pay may be short-lived. Therefore, the public must know exactly what they are paying for, and be provided with schedules for and reports of progress gained per dollar spent.

- Municipalities and industry must accept the cost of environmental quality control both as inevitable and as a pressing social responsibility.

- Enforcement schedules should reflect logical, reasonable, and consistent standards, should be relatively immune to emotional pressures, and should be equitable for both industries and municipalities.

- Many state regulatory agencies must overcome their failure to promote and approve new waste treatment technology.

- Many practicing engineers must overcome their failure to keep abreast of new technology and endeavor to propose its use, where appropriate.

- The barrier to expeditious application of new technology posed by the multiplicity of regulatory agency standards must be overcome.

- Institutions must be coordinated and geared to respond quickly and consistently to reasonable public demands for action.

- A glaring need exists for applying demonstrated research. Funding for this purpose is inadequate.

ECONOMIZING IN PARK OPERATIONS AND MAINTENANCE [1]

Charles R. Schrader [2]

Every park manager is faced with the responsibility of developing his organization to be both efficient and economical. The control of the cost of the operation is based on three major points:

A) The areas of major expense

B) The means and methods available to reduce costs in these areas

C) The human factors involved in accomplishing these cost reductions.

Areas which are normally considered to be the major expenditures in a park operation are broken down into the following categories:

A) Personnel - In most park departments it consumes approximately 80 to 85% of the total operations budget, and we are defining the operating budget here as excluding equipment of a capital variety and also such major construction projects as those which would be included under Capital Improvement Projects, i. e.: swimming pools, new parks, pocket parks, etc.

B) Equipment - A major source of expenditure in the original outlay for the equipment, amortization and the operational costs, or the leasing costs.

C) Vandalism - At one time a relatively nominal cost

1/Paper presented at the 25th N. W. Turfgrass Conference, Chinook Motel & Tower, Yakima, Washington September 22, 23 and 24, 1971.

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in the consideration of the park budget, it is now a major factor not only in the cost of labor and materials, but also as a loss of man hours available for other projects.

C) Materials - An area that depends on the park director's knowledge of what is new and current on the market and how these new materials can be used in place of the materials which have become too expensive over the years.

E) Methods of Operation - Includes the methods of maintenance which are employed as well as the type of equipment used to implement those methods.

The park manager, in analyzing his organization, must analyze each of these areas individually, and he must analyze them not only from the standpoint of economy, but also on the impact that changes of methods and equipment will have on the production and morale of his crews.

Lets take each of these items a little more in depth.

Personnel - In most cities wages have become a relatively fixed cost. Park managers are not normally a part of the union-management bargaining team. Wages are determined by negotiations between the city or town administration and the local union, or are taken from the wage rates prevailing in the area. Cuts in wages will not produce savings in 90% of the cases, since the lower wages will not attract or hold higher production-level personnel. The only way savings can be made in this area is to operate with the absolute minimum amount of manpower.

Equipment - A fascinating area to all park managers and a no-man's land of claims and counter claims. Still, in all, this is a relatively well reported area covered by the trade journals and equipment manufacturers. Mechanization has done much to provide the tools to lighten the load, increase the productivity, and increase the quality of maintenance of park organizations. The use of machinery is easily justified since the machine, with a single operator, can handle from 5 to 500 times the amount of work done by manpower alone.

Vandalism - A well reported area with many excellent papers and suggestions available for your use.

Materials - The life's blood of the supply industry. Another area well covered by the trade journal and the manufacturers advertising.

Methods of Operation - As the youngsters say today, "This is where it's at". This is the area where major savings can be made by increased production with existing personnel or maintaining current standards with less personnel. It is in this area that the least amount of research and study has been done.

One thing has become startlingly clear over a considerable number of years of observation and working with park personnel. Park personnel take great pride in their work and do their work willingly. If this is true, then where are the savings to be made?

For a start let's look at the average work day. We have 8 hours of work time, which adds up to 40 hours per week - right? Wrong! Let's examine that eight hours a little more closely. First, let's make a few necessary deductions, such as:

1. Job preparation time

2. Travel time to the job

3. Travel time between jobs

4. Rest break (morning)

5. Lunch

6. Rest break (afternoon)

7. Job fatigue

8. Job clean up time

9. Travel time back to the shop

10. Equipment clean up and storage

11. Wash up time

Of that 8 hours there are approximately 6 1/2 hours of actual productive time left. Now, how are you going to get the most efficient use of the time left of that 8 hours? Let's define efficiency as getting the job done quickest, with the least number of men, using the best combination of equipment and materials. To achieve this, there are certain basic steps which must be followed:

A) 1. You must define the job.

2. You must determine the optimum manning and equipment requirements for that job.

3. You must communicate your requirements to the man doing the job.

4. You must decide on how to get to the job and return.

This is called the "Written work order".

B) There is a well known law which says that if a man is assigned a two hour task and given a two hour time limit, he will accomplish the task in two hours. That same law goes on to say that the same man, given a two hour task and an eight hour time limit, will do the same task in eight hours. We are indebted to Mr. Murphy and his very profound thoughts. This means that you must tell this man (or crew) approximately how long it will take him to do the job. This is only fair, because if you don't, he won't know whether to take a 15 minute coffee break or a 50 minute coffee break. Making that decision is your job. It also permits you to determine which jobs and how many jobs your crew will complete today or tomorrow or next week. This is called "job scheduling."

C) After the man has completed the job, he must fill out the following information on the written work order and return it:

1. How many man hours?

2. How many equipment hours?

3. What type of equipment?

4. How much material?

This is called "feed back". It is essential for effective scheduling.

D) Have someone check each job after completion to determine if it was done properly and up to your quality standards. This is called "follow up" and "quality control", which keeps the crew honest.

Without these four steps you do not have control over the job.

If you use different combinations of men, equipment and materials over a period of time, this will give you data in relation to optimum:

1. Crew size

2. Equipment combinations

3. Materials

If you practice this approach, you will be able to effectively schedule your work load in advance a week, a month, or a year. Your subordinate supervisors will have a written work schedule for next week for each crew and another schedule for rainy day jobs. If you do not, I would suggest that you are operating at less than 50% of your productive capacity, even with the best of crews and intentions. (The average city appears to operate from 40% to 45% efficiency.)

The second surprising point is that the information necessary to properly schedule crews is already known by the supervisor, but he usually does not know how to apply it.

Ask any of your foremen how long it will take to mow a particular park with a particular piece of equipment and he can tell you within a few minutes one way or the other. Now, if this information is available, why not figure how many parks you can mow in the six and one-half hours you have available, allowing, of course, for travel time between parks. This information enables you to schedule a full days production for a man or a weeks production, or the entire summer if you have determined what your level of maintenance is going to be. This type of approach can be utilized for all your crews, regardless of the type of work to be done.

Let's look at some of the ways this type of scheduling can help you. First, by a written schedule, you can reduce travel time to a minimum by laying out the best travel route for your equipment to follow in advance. You can also determine the safest route for the equipment to follow. Scheduling gives you a level against which to measure that new piece of equipment or the new operator. Scheduling gives you a precise idea of your man power requirements for the summer, winter, fall or spring work load. This in turn gives you an opportunity to level off your work load by scheduling some of your jobs for slack periods of the year. The end products of scheduling puts you in a good solid position to defend your budget with the Budget Officer or your Park Board. In addition, scheduling puts you in the position of being classified as a "Professional" by those outside of the Parks and Recreation movement. A hard headed business man, if you will. If you were operating your department as a business, this is the position you would have to take.

In answer to the question "How will crews react to scheduling?" - Most crews will follow a schedule with little problem if it is fair and logical.

On the opposite side of the coin, one of the biggest mistakes a supervisor can make is to let a crew schedule their own work. To place the responsibility for management decisions on the crew makes them resentful and insecure, which adds to your labor problems. If these men were qualified to make these types of decisions, they wouldn't need you.

Over the past twenty years or so a whole new science has grown up around this idea of getting the most production for the money spent. Most of you know it quite well as the Industrial Engineering function. Many have claimed that it is too precise to work in maintenance; it's not realistic; it's all stop watch, etc., none of which is true. Los Angeles installed such a system a number of years ago and, in a paper given by Jerry Glenn at a New York conference, stated "The City of Los Angeles, in the first full year of operation after the installation of the Maintenance-Time Measurement system, saved $2.5 million out of a $10 million budget, increased the production by 10% while reducing labor force from 1,400 back to 1,000, and increased their efficiency from 41% to 87%." I submit that those figures are pretty impressive.

Most of us are not in the Los Angeles size class, nor do we have the monetary resources to hire outside consultants to install such a sophisticated measurement system, but, you must develop a method for measuring output, or your production capability will never be known. In order to know your productive capacity, it becomes necessary for you to put a time value on each and every job your crews are required to do. Following this same line of reasoning, you must determine the optimum crew size based on the method you are employing, and further, to investigate other methods which might either reduce crew size or the job time. This means that you must get the following information back from the field:

1. How many man hours?

2. How many equipment hours?

3. How much material?

After doing a job a number of times, a pattern will emerge giving you a good average job time-cost estimate on which to base your scheduling.

How do you determine optimum crew size? By trying different combinations and recording those results. A lot of paper work? You bet, but there is no easy way to do the manager's job properly.

Gentlemen, as park foremen, park supervisors and park executives, it's time we stopped kidding ourselves that park work is different from all other types of business and can be operated off the seat of our pants. It's a business, a science and an art, and it's time we accept the fact that other disciplines are relevant and necessary, and use them accordingly. Business Administration, Industrial Engineering, Public Relations, Landscape Design, Chemistry, Engineering, etc., - the list goes on and on. All are part and parcel of good, modern park management. Our ability to meet the increasing challenge of public service will depend on our increasing knowledge of and ability to use these disciplines in addition to the natural sciences.

SEED TESTING FOR QUALITY—YOUR PROTECTION [1]

By Robert Eschbach [2]

Seed quality is more involved than just testing. It's interesting to see how the opinion of what quality seed is has changed over the years. Articles on seed quality published 10 to 12 years ago, state that four factors should be considered in evaluating seed quality - Pure Seed Percentage (Purity), Germination, whether noxious weeds are present, and the variety of the seed. True, these are important, but over the past 5 to 10 years, that small fraction of a percent of weed seeds and other crop seeds has become more and more vital as factors of quality, as well they should.

Over all, the quality of seed being sold has improved and seed certification is one method of being assured of quality, but it is not to be considered the final word. Certification is primarily an assurance of trueness to variety, and it has been used also as an indication of mechanical quality. Certification does have quality standards, but these are minimum standards. Any lot of seed entered into certification meeting these minimums is entitled to the Blue Tag. Seed of excellent quality also carries the same Blue Tag. So a lot bearing this "Blue Tag" may have just met the minimums or may have passed with honors.

State Seed Laws have been amended to clarify and assure quality. For example, New York State, in an attempt to alert consumers to Annual bluegrass problems, require that Annual bluegrass be listed on the label, either as a noxious weed listing the number of seed present per pound or by a percentage figure as a specific ingredient on the label with its germination as you list items in a lawn mix. To New York,

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1/ Paper presented at the 25th N. W. Turfgrass Conference, Chinook Motel & Tower, Yakima, Washington September 22, 23 and 24, 1971.

2/ Chief, Seed Branch, State Department of Agriculture, Yakima, Washington.

The important thing is that Annual bluegrass and its rate of occurance is on the label. It's the dealers choice where he puts it. We, in Washington State, were petitioned a few years ago to classify Annual bluegrass as a restricted noxious weed, thereby requiring it to be listed on the label. The Hearing Officer, reviewing the testimony, decided after the Hearing, that the request to classify Annual bluegrass as a restricted noxious weed was not substantiated well enough and the request was declined.

This spring here in Washington an Annual Bluegrass Quarantine restricting the planting of seed stock lots in Eastern Washington that contain Annual bluegrass, was adopted. This means that any lot of grass seed planted for seed increase must be free of Annual blue- grass. Contaminate lots are permitted to be planted in nurseries and rogued. This quarantine is to keep our bluegrass seed production area free of Annual bluegrass.

You have seed "Fine-Textured-Coarse Kind" lawn mix labeling. This was an attempt, again, to alert the consumer of a quality lawn mix and which mix is a "cowboy" mix. This program has not done the job as well as hoped, and many problems have arisen, especially with the classification of a "fine-textured" grass. Merion Kentucky Bluegrass is listed as a "fine-textured" grass and many Ryegrasses, with leaf blades narrower than Merion are classified "coarse kinds" in some states--"fine textured" in others. Industry, in cooperation with seed analysts and Seed Control Officials are working on a new idea as to labeling lawn mixes. I would assume that we will have a new lawn seed labeling guide in the next two or three years.

Some states, in an effort to encourage quality lawn mixes, have established "Turf Mixture Certification" programs certifying that the lots used in the turf mixtures were all certified seed. However, this has had its problems as States went, so far as to specify the ingredients and percentage range of each kind allowed and you have about as many supporting this as you have opposing. This program may have prevented some poor mix ratios from being used, but the specific-detail quality was not too greatly improved. We still had that small percentage factor of other crop and weed not telling the total story.

The Seed World Magazine, six years ago, published a paper by Dr. Robert Schery, Director of the Lawn Institute, on lawn weeds. This article points out the importance of that small percentage point of weeds and other crop seeds and how misleading it can be.

Of the approximately 83 weeds listed in "Lawn Book", by Dr. Schery, as important weeds in lawns, only 35 of these important lawn weeds were found in some 765 samples of Kentucky Bluegrass, Bentgrass, Fescue, Ryegrass and Redtop tested by Seed Technology, Marysville, Ohio, and in 950 samples of Bentgrass, Kentucky Bluegrass and Fescue tested by Oregon State University. Their occurance would be reported on the label as either .05% weed seed or .10% other crop seed. This points out that many of our lawn problems are not the cause of seed quality. Crabgrass was one of the weeds listed as serious but it was not found in 1,715 seed samples tested. We now have 35 of the 83 important contaminants of lawns that occur in seeds. Dr. Schery discounted those that disappear naturally and those that are easily controlled with familiar herbicides, ending with 12 lawn contaminants that are serious problems, namely:

Annual bluegrass
Bromes and Chess
Nutsedge
Orchardgrass
Quackgrass
Redtop
Rough bluegrass
Ryegrass
Tall fescue
Timothy
Velvetgrass
Wild onion, Garlic

Please note seven are crop seeds and would be included in small percentage figure of "Other Crop Seeds" on seed analysis tags.

I believe the Eastern Seaboard states, especially Maryland, Virginia and New Jersey have done more than any other one group to initiate quality consciousness in turfgrasses. We, in the west, may not agree with all their ideas, but I feel we must give them credit for being the catalyst for quality marketing.

The Sod Industry of these states have demanded quality seed for production of quality sod. I'm not sure if the driving force was the standards established by officials for Sod Certification, or if the consumer demanded a quality product. I assume a little of both. To meet this demand, testing was asked to be more complete - more detailed.

Seed testing is done in accordance with "Rules for Testing Seeds" as established by the Association of Official Seed Analysts. Basically, it involves examination of a seed sample consisting of about 2,000 to 2,500 seeds. Depending on the size of seed, this will vary. For example, the analyst will check 1/4 of a gram of Bentgrass that runs from 11,000 to 23,800 seeds per gram. Two grams of Fescue, which runs 1,200 seeds per gram, and 1 gram of Kentucky Bluegrass that runs 4,800 seeds per gram.

The seed you buy is labeled with the information your dealer obtained from this small sample of seed. If the original lot was uniform, and the sample was representative, the test on which the label is based will be within reasonable tolerance. For my home lawn, which is a playground for the neighborhood, and is partially covered with a plastic swimming pool, Slip "n" Slide and other lawn destroying devices invented by "Mattel" and "Ideal" toy manufacturers, this test is good enough; but for your greens and nice fairways and for show turfs around Clubhouses, businesses, parks, etc., you need a more complete test and more information. Seed Laws require seed to be labeled to show percent of Pure Seed, Inert Matter, Other Crop Seed and Weed Seed. The professional needs a detailed accounting of Crop Seed and Weed Seed percentage. One of the original advocates of more complete testing for the professional turf industry was, and is, Dale Kern, President of Seed Technology, Marysville, Ohio. In January 1969, Dale introduced in an article in "Weeds, Trees, and Turf", his Turf Analysis Test. Dale points out that a certified Merion Kentucky Bluegrass lot with the following analysis--

Pure Seed	97.85
Other Crop	.10
Inert Matter	2.00
Weed Seed	.05

could mean that the .10% Other Crop Seeds could represent 364 Orchardgrass or 270 Tall Fescue, or 1,250 Timothy, or 45,000 Bentgrass seeds per pound. You get the same astronomical figures for the number of Weed Seeds represented by the .05% - such as, 2,800 Chickweed seeds, 750 Annual Bluegrass seeds per pound. You each use a different seeding rate, but if you use 10 pounds of seed per acre, or 200 pounds, you are planting a lot of problems. Dale Kerns felt that if a larger sample was tested, a more accurate accounting could be made of the seed lot the sample represents. It was found that not only were the other crop and weed seed percentage figure misleading, but a lot of contaminants - Crop and Weed - were not found in the conventional working sample...so the birth of his "Turf Analysis Test" which is the examining of a larger quantity of seed and issuing a special report itemizing the Weed and Other Crop seeds found. At first, this caused strained relations between West Coast producers and East Coast consumers. Seed was sold and labeled here under conventional tests. East Coast customers would retest by Dales "Turf Analysis" and pay our West Coast shipper, based on Dale's test.

Now, we West Coast labs had requests for retests - resamples - retests. Split the samples - send to several labs for referee. Dealers were trying to average tests to obtain fair settlement? About the same time, the Sod Industry of Eastern U. S. was requesting detailed information about lots of seed they were using. So, in an attempt to help alleviate both headaches, we initiated the "Sod Quality" program.

Under this procedure, we test seed that is eligible for certification on about the same basis Dale Kern uses for his Turf Analysis. If it meets our "Sod Quality", we tag the lot with blue "Certified Seed Tags" and a gold "Sod Quality Tags". Each shipment or sale is accompanied with the detailed golf colored Sod Analysis Certificate. The test number is imprinted on the Sod Quality tag to tie both together.

Our office soon had some interesting comparisons that showed the importance of a "Sod Quality or "Turf Analysis Test".

One of our conventional tests of Merion Kentucky Bluegrass shows -

Pure Seed	97.73	
Other crop	.77	(Kentucky bluegrass)
Inert matter	1.50	
Weed seed	-0-	

The Sod Analysis shows the following number of seeds per pound:

162 Shepherds' purse
54 Windgrass
90 Witchgrass
72 Redroot pigweed
18 Lambsquarters
18 Fine-leaved fescue

The official test showed no weeds, the Sod Analysis showed 414 unwanted contaminants per pound. Another conventional test shows .01% Weed seed consisting of 450 Shepherds' purse and 18 sorrel per pound. The Sod Analysis shows, in addition to the above, 54 Tumble mustard, 223 Windgrass, 18 Alfilaria, and 18 Downy chess seeds per pound. A simple case of the larger your sample, the more accurate your results. I'm sure all of you have had problems show that you couldn't explain. By use of seed testing for quality, you can avoid some problems, or at least know what to expect. Don't misunderstand, seed is not the blame for all problems but some seed lots do carry unknown contaminants. The point is that the small percentage figure of Weed Seed and Other Crop Seed on the tag is most important. State Seed Laws only require the percentage of weed seed and other crop--not a detailed listing of what the % consists of.

The Pure live seed index is a simple method of comparing seed lots, and an important aid in evaluation of general quality. When you read an analysis tag with Pure Seed of 92% and a Germination of 85% and another lot will read Pure Seed 95% but a Germination of 80%, which is the better of the two? By use of Pure Live Seed Index, you can easily see which lot will give more seeds that will sprout. Multiply the percent of Pure Seed times the percent of Germination (92% times 85%) 78.20% Pure Live Seed which means 78.20 pounds out of every 100 pounds will grow. 95% times 80% is 76.00% Pure Live Seed, therefore, the first lot with a 92% Pure Seed and 85% Germination is the best buy based only on purity and germination. To get the total story, check the tag for Weed Seed and Other Crop Seed percentages and find out what the percentages represent.

We cannot sit back and say trade standards are adequate, as these standards are for the average market. Your demands and your clients and their needs are above average. We, with the cooperation of the Washington State Seed Council have prepared "Seed Specification Guide" for use in requesting bids. If used properly, this will assure you of obtaining the quality you ask for on purchases but it should not be interpreted to be the minimum standard. Only your needs can say what is the quality you want. Seed testing with standard test and sod analysis test can assist you in obtaining the quality you desire.

AQUATIC WEED CONTROL[1]

R. D. Comes[2]

We have received a number of requests in the past for information on the control of aquatic weeds in the parks, golf courses, and public lands that you manage. I appreciate the opportunity to discuss this complex problem with you today.

At the outset, I would like to emphasize that there is no panacea for the control of aquatic weeds, or even for the control of a given species. Nearly every lake, pond, reservoir or channel differs markedly from all others. These differences must be taken into consideration when planning, and I would like to emphasize the word planning, an aquatic weed control program. The use of the weed-infested water may dictate the type of control program that can be undertaken. Usually water is not permanently confined to a given area, but is instead transient. Therefore, uses that are made of the outflow water from impoundments and the

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1/Cooperative investigations of the Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, and Washington State University, College of Agriculture.

This is a report on the current status of research involving use of certain chemicals that require registration under the Federal Insecticide, Fungicide, and Rodenticide Act. It does not contain recommendations for the use of such chemicals, nor does it imply that the uses discussed have been registered. All uses of these chemicals must be registered by the appropriate State and Federal Agencies before they can be recommended.

2/Research Plant Physiologist, Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, Prosser, Washington.

water in canals or ditches downstream must be considered along with the uses of the water in place.

Aquatic weeds is a very broad term. Perhaps we should define the various categories of aquatic plants before we discuss their control. Usually, aquatic plants are separated into four general categories. These are submersed, emersed, floating, and algae. Submersed plants are adapted to grow with all or most of their vegetative tissue below the water surface. Examples of submersed plants are the pondweeds (Potamogeton spp.), elodea (Elodea spp.), common coontail (Ceratophyllum demersum L.), and milfoil (Myriophyllum spp.). Emersed plants are rooted or anchored in the substratum with most of their leaf and stem tissue above the water surface. The leaves and stems do not lower or rise with fluctuations in the water level. Examples are cattail (Typha spp.), bulrushes or tules (Scirpus spp.) and yellow waterlily (Nuphar polysepalum Engelm.). Floating plants are those that are either free-floating such as the duckweeds (Lemna spp.), or they may be anchored to the substratum and produce most of their leaf and stem tissue above the water surface such as dwarf waterlily (Nymphae tetragona L.). Unlike emersed plants, the leaves of floating plants rise or lower with fluctuations in the water level. Most algae are also submersed and free floating. However, some may be anchored to the substratum, rocks, stumps, etc., by holdfasts. Algae do not have true roots, stems, or leaves, and they are commonly referred to as pond scum.

All or most of you are aware of some of the problems or nuisances created by aquatic plants. They impede water-flow, hinder the use of sprinkler-irrigation equipment, limit the use of many lakes for recreational purposes such as fishing, boating, and water skiing, create undesirable odors in and around lakes and ponds, provide an excellent habitat for mosquitos, and in general, lower aesthetic values. Each year, more people are using our lakes and ponds for recreation and building sites. This trend in usage has made the public acutely aware of aquatic plants and the nuisances they can create. Aquatic plants may cause other problems that are not as conspicuous to the casual or infrequent visitor to a body of water. The decay of dense mats of algae or other submersed vegetation uses up the dissolved oxygen in water and may cause fish to suffocate. Such vegetation also collects silt and organic debris. This in turn, increases the rate at which a lake ages and becomes extinct.

I do not wish to infer that all aquatic plant growth is a nuisance and unwanted. Aquatic vegetation plays a definite role in the development and maintenance of a balanced aquatic community. Algae play an especially important role in the conversion of mineral nutrients, carbon dioxide, and light energy into organic matter which provides energy for other aquatic organisms. Aquatic plants also provide valuable feed for ducks, geese, and other waterfowl. Therefore, attempts to control such plants in ponds and lakes should be limited to nuisance areas, and they should not be completely eliminated from every body of water. In most instances, the primary goal should be to control only the nuisance vegetation and to leave the remainder in the natural state.

Before control measures are considered, it is imperative to identify the species in question. Many of the herbicides registered for aquatic weed control are selective, and attempts to control the problem species may be futile unless they are identified properly.

For years, submersed weeds in irrigation delivery and drainage canals were controlled by draining and drying, chaining, dredging, or hand-cleaning. These methods were inefficient, time-consuming, and expensive. The need for water in our arid regions almost precludes draining and drying an irrigation canal in midsummer. Also, silt and plant debris frequently clog sprinkler systems when canals are chained or dredged to control aquatic weeds.

After approximately 20 years of intensive investigations, we have only two herbicides that will provide adequate control of rooted submersed weeds in flowing water without causing injury to irrigated crops. Certain aromatic solvents (mixtures of cyclic hydrocarbons) have been used extensively for this purpose since 1949. Aromatic solvent that contains 1 to 2 percent of an appropriate emulsifier is usually applied to a canal at a rate of 8 to 10 gallons per cubic foot per second (cfs) of water flow during a 30- to 60-minute period. Such a treatment will control most submersed species for distances of 3 to 6 miles. Density of weed growth, water velocity, and the salt and silt content of the water influence the effectiveness and distance relationship. Subterranean portions of aquatic weeds are not lethally injured by aromatic solvent, and retreatments every 6 to 8 weeks are usually required during the irrigation season.

Recently, some irrigation districts in the Yakima Valley of Washington have controlled submersed aquatics effectively with solvent applied at rates of 4 to 5 gal/cfs of flow every 2 to 4 weeks throughout the irrigation season. Treatments are started early in the irrigation season before dense growth develops. Additional costs for these more frequent treatments are offset by the marked reduction in other operational and maintenance needs such as draglining to remove silt depositions.

Solvent is extremely toxic to fish and other aquatic fauna. It should not be used in water where fishing has priority over agricultural needs. Also, water that contains solvent should not be discharged directly into fishing waters.

Acrolein (acrylaldehyde) has been used for the control of submersed weeds in irrigation channels since about 1960. This compound is an irritating, lachrymatory, volatile, inflammable, and highly reactive liquid. Primarily for these reasons, acrolein has not been used as extensively as solvent. Acrolein frequently is introduced into a channel at a rate of 2 to 3 gals/cfs over a period of 1 to 4 hours. The rate of application and the introduction time depend on water temperature, velocity, and use. The higher concentration is recommended when the water temperature is less than 70° F or when the velocity exceeds 2.5 feet per second. Water that contains more than 15 ppmv of acrolein should not be used for irrigation purposes. Thus, the longer introduction period should be used if the water is not wasted. Acrolein also controls only those portions of the plants above the substratum, and two or more treatments may be needed each season. A single treatment of acrolein may control submersed weeds for a distance of 5 miles in small channels and 20 miles in large canals.

Research by the Agricultural Research Service and Bureau of Reclamation shows that much lower concentrations of acrolein will control submersed weeds in irrigation channels. Six treatments per year with acrolein at 0.1 p.p.m.w. effectively controlled pondweeds for 10 to 20 miles in a canal with a flow of about 2000 cfs. Each treatment was applied over a 48-hour period. In addition, pondweeds were adequately controlled in many of the branch laterals and noticeably suppressed in the main canal for a distance of 50 miles.

Acrolein is highly toxic to fish and other aquatic organisms. However, concentrations of acrolein needed to control submersed aquatic weeds are not toxic to farm animals.

Aquatic weed problems in lakes and ponds cannot be approached in the same manner as those in irrigation channels. Usually, any measures taken to control aquatic weeds in lakes and ponds must not harm fish or fish food organisms.

Three principal methods of controlling undesirable aquatic vegetation in lakes and ponds are environmental control, mechanical control, and chemical control. Cost, effectiveness, ease of application, and safety to desirable plant and animal life will determine the method most suitable for a given situation.

The construction of ponds or reservoirs is increasing each year. Proper construction of such ponds may reduce or prevent many weed problems in future years. Deepening the edges so that no water is less than 2 or 3 feet deep, and installing by-pass systems to prevent drainage water or water high in organic matter from entering the basin reduce the possibility of invasion by rooted aquatic plants. Also, the topsoil and organic materials should be removed prior to filling the basin with water. In large ponds and reservoirs, a periodic drawdown of the water level, 5 feet or more, may reduce the incidence of rooted aquatic plants.

Underwater weed cutters of various sizes are available for mowing vegetation at depths of 6 inches to 6 feet beneath the water surface. These mowers range from portable models that can be mounted on a small motorboat to large, self-propelled barges. Usually 3 to 5 cuttings per year are required to maintain the vegetation below the water surface.

Mowing presents no direct hazard to fish, humans, or wildlife, but the dislodged and decaying vegetation may kill fish if it is not removed from the water. The decaying vegetation may also produce undesirable odors on and around the lake. Small plant segments usually remain after the bulk of detached plant material is removed from water. Such fragments of some species of aquatic plants will form new roots and develop into new plants. These plants may become established in various areas of the lake, or they may be transported in the outflow to new sites. In either case, they furnish new propogating material.

Control of aquatic plants with herbicides is usually less expensive and more effective than mechanical control. Chemicals are now available for controlling most of the important species of aquatic weeds, but all of these compounds have limitations. With the exception of copper sulfate, no herbicides are permitted in potable or livestock water and only acrolein and aromatic solvent are registered for use in water that is to be used immediately after treatment for irrigation water.

Copper sulfate has been used widely during the past 50 years or more for the control of many species of algae. Concentrations ranging from 0.25 to 2.0 p.p.m. in water normally control most of the filamentous algae. However, some genera such as Cladophora and Chara are not controlled with 5 to 10 p.p.m. of copper sulfate. Algae are more difficult to control in cold, alkaline water than in warm, soft water. The concentration of copper sulfate needed to control many algae may be toxic to fish, especially trout, and this compound should not be used in trout waters. Higher aquatic plants are usually not affected by concentrations of copper sulfate needed to control algae.

Recently a copper chelate, copper triethanolamine, has been introduced onto the market for algae control. According to the manufacturer, this compound is not toxic to fish, including trout, at concentrations required for algae control.

Diquat (6,7-dihydrodipyrido[1,2-a:2',1'-c]-pyrazidiinium ion) applied postemergence to weed growth controls a wide spectrum of submersed species and filamentous algae. Concentrations needed for adequate control range from 0.5 to 2.5 p.p.m. Diquat is not toxic to fish and other aquatic fauna at concentrations required for weed control, and its mammalian toxicity is relatively low. Diquat is adsorbed by bottom mud, organic matter, and suspended sediment in a relatively short period of time. Thus, it should not be applied to water containing moderate quantities of suspended sediment. The water should not be used for human or animal consumption, swimming, or irrigation within 10 days after treatment.

Several species of submersed plants, including many Potamogeton species, coontail, and milfoil, can be controlled with the disodium salt of endothall (7-oxabicyclo[2.2.1] heptane-2,3-dicarboxylic acid) at concentrations of 1 to 3 p.p.m. However, endothall is not a highly effective algicide, and it will not control elodea. Endothall has a relatively high mammalian toxicity, but it does not harm fish at concentrations needed for weed control. Fish should not be taken for consumption until 3 days after the treatment was applied; and the water should not be used for livestock water or domestic purposes until 14 days after treatment.

Two derivatives of endothall, the mono(N,N-dimethylalkylamine) salt and the di(N,N-dimethylalkylamine) salt are reported to be about 10 times as active as the disodium salt. They are especially useful against algae. Most algae can be controlled with 0.05 to 0.2 p.p.m., whereas 0.5 to 2.5 p.p.m. are needed to control submersed flowering plants. The two amine derivatives of endothall are very toxic to fish, and they should not be used in excess of 0.3 p.p.m. except for localized treatments. The manufacturer suggests that treatments for submersed weed control should be made by competent commercial applicators. Treated water should not be used for irrigation, livestock watering, or human consumption for 7 to 25 days after application. The specific length of time depends upon the concentration applied.

Yellow waterlily, one of the most troublesome aquatic plants in Washington, has been controlled with formulations of a low volatile ester of 2,4-D [2,4-dichlorophenoxy) acetic acid] at 2 to 4 lb/A or the potassium salt of silvex [2-(2,4,5-trichlorophenoxy)propionic acid] at 0.5 to 2 p.p.m. Avoid the use of silvex in water intended for irrigation, crop spraying, or domestic and animal water supplies. Extreme care should be taken to prevent drift of the herbicide onto desirable vegetation along the shoreline.

Granular or pelleted formulations of 2,4-D at 20 to 30 lb/A are also used to control coontail, watermilfoil, and a few pondweeds.

Granular formulations of low volatile esters of 2,4-D do not appear to be toxic to fish at weed control concentrations.

Water treated with 2,4-D should not be used for irrigation, livestock watering, or domestic purposes.

Preemergence applications of dichlobenil (2,6-dichlorobenzonitrile) at 7 to 15 lb/A control most of the submersed vascular plants, the water lilies, and chara, an attached algae. Treatments are usually applied in late winter or early spring by spreading the granules over the water surface or over the soil after drawdown. Dichlobenil is moderately volatile. Therefore, areas treated after drawdown should be flooded soon after the herbicide is applied. Dichlobenil is not toxic to fish at concentrations needed for weed control, but fish from treated waters should not be used for food or feed until 90 days after application of the herbicide. Moreover, treated water cannot be used for human or animal consumption or for irrigation.

Dichlobenil kills weeds by action through the soil rather than through the water as with most other aquatic herbicides. It is especially well adapted for localized or spot-treatments. Treated areas are clearly defined and untreated areas remain in their natural condition.

Other materials which I have not mentioned are registered and used for the control of submersed and floating aquatic weeds in ponds and lakes. However, to my knowledge, they are not used as extensively as those discussed.

Aquatic herbicides may be available as liquid or granular formulation. Concentrated liquid formulations are usually diluted with water prior to application on or below the water surface. Granules may be applied with various types of centrifugal spreaders or other devices that will deliver a relatively uniform distribution of granules. Postemergence treatments should be applied when the plants are growing luxuriantly, and preferably before the submersed species reach the water surface and cause interference with the application equipment.

When submersed and floating aquatic plants are destroyed by herbicides, they slump to the bottom of the impoundment and decay. As already indicated, decaying vegetation utilizes oxygen dissolved in the water. If a large portion, or all, of a moderate to heavily infested lake is treated at one time, the dissolved oxygen will be depleted below the level needed for the survival of fish. This is further reason for controlling only the vegetation that is creating a nuisance.

TURFGRASS VARIETIES FOR THE FUTURE [1]

By D. K. Taylor [2]

Introduction

Most of our turfgrass species are not native to North America (4). Bentgrasses, Kentucky bluegrass and fescues were introduced starting with the early settlers, and that flow of plants and seeds continues today as many new turfgrass varieties are available each year from Europe. However, government agencies and private breeders in the U. S. and Canada are contributing their share of new varieties in an effort to meet the changing needs of our present turfgrass industry.

Some of those early introductions were so well adapted that they became naturalized and later the source for Rhode Island and Prince Edward Island colonial bent in the East, and Seaside creeping and Astoria and Highland colonial bents in Oregon. During the colonizing period natural selection ensured that the vigorous high seed producing grasses multiplied quickly and dominated the stands. However, within these populations other forms persisted which were vigorous in sod forming characteristics. Selection of this type of plant has led to the collection of vegetative bents available today.

An assessment of current varieties of bluegrass

There are literally hundreds of varieties and strains of turfgrass available. Are any of them superior to those varieties which are being grown at present and how do we find out? Screening trials followed by uniform trials on a regional basis would seem to be a logical approach to this

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1/ Paper presented at the 25th N. W. Turfgrass Conference, Chinook Motel & Tower, Yakima, Washington September 22, 23 and 24, 1971.

2/ Turf Research and Forest Breeding, Research Station, Canada Department of Agriculture, Agassiz, British Columbia.

problem. There are a few examples of this approach but to date turfgrass testing has not had this kind of support. Therefore, we must settle for turfgrass trials at scattered locations and attempt to make sound recommendations from these. One additional step is necessary, trials under actual use, and that is where the use can assist in the evaluation process.

The C.D.A. Research Station at Agassiz, B. C. is one of these testing locations. One of the primary objectives of our recently approved research programs is to screen the many turfgrass varieties available at the present time. We now have two years results on our initial seedings and although these are considered preliminary, these tests have already served to indicate which are the unpromising varieties.

Our plots are replicated (204) and cut at two mowing heights 3/4 and 1 1/2". All plots are irrigated when necessary and nitrogen is supplied at 3-5#/1000 in 1970 and 5-7#/1000 in 1971. Clippings are removed. The testing site has a coastal climate but the temperatures are higher in summer and cooler in winter than at the Coast. Following establishment fungicides have not been employed to control disease.

Fescues (53 varieties.)

A severe epidemic of red thread started in the fall of 1970 and has continued through the late spring weather of 1971. The non-creeping fescues mostly *Festuca rubra* var. *Commutata* have responded particularly well to our temperate climate and low cutting height. In three separate tests, those varieties showing some resistance to red thread had the best average appearance ratings and density. The most promising varieties were Highlight, C26, Wintergreen, Rolax and Koket all superior to Pennlawn. C26 is a very attractive dark green variety of hard fescue which had outstanding density and resistance to red thread. Dawson and S59 were the best of the creeping varieties.

Kentucky bluegrass (60 varieties and mixtures.)

The success of the variety Merion has encouraged the development of other bluegrass varieties with an emphasis on the low growing forms which permit a lower cutting height. At Agassiz, the most promising to date are Nugget, Fylking, Pennstar, Berka and K412. Merion, despite its well known faults, cannot be discarded as yet because of its good resistance to Helminthosporium leaf spot. Nugget is attractive for its low growth, density, dark green color and resistance to leaf spot. However, Nugget has a relatively poor appearance over winter, some susceptibility to red thread and was slow to become established with fall planting.

Sydsport, Arista, Baron and Golf have given above average performance but further testing is required to fully evaluate these varieties. A report from New Jersey (3) indicates that Nassau (P-69) is a moderately low growing selection with good density and vigor. It has moderately good resistance to leaf spot, stripe smut, leaf rust and dollar spot. It will be available following the 1972 harvest. Sodco, a multiline variety, is also promising in the East for its low growing habit, stripe smut resistance and suitability for sod production. Warren's A-34 and A-20 have also found acceptance for specialized situations. A-34 is a vigorous shade tolerant variety which when mowed at 2" will tolerate shade up to 65% of the daylight hours during the tree leafing period. A-20 is one of the best varieties of bluegrass available for disease resistance but unfortunately it does not reproduce true from seed and requires vegetative propagation.

Bluegrass variety mixtures are becoming common in the sod industry in an effort to minimize production problems and to produce a product which will meet the needs of different usages and managements. Limited results at Agassiz indicate that mixtures of Fylking with Pennstar, Nugget or Merion are most attractive. There is evidence that a mixture may give a better disease response than individual varieties. Funk and Ahmed (3) suggest that some of the taller grown bluegrasses such as Park, Delta and Kenblue may have a place in mixtures of varieties for minimum maintenance areas where the cutting height is reasonably high.

Bentgrasses (33 varieties.)

The bents are cut at 1/4" and the varieties are classified as follows: colonial 11, creeping 5, vegetative 7 and velvet 10. Results to date are limited. Among the colonial bents over a two-year period Brabantia and GS-2 were better than N.Z. Browntop, Eko and Holfior which in turn had better ratings than Astoria, Exeter and Highland. GS-2 and Exeter are lighter green than the other varieties.

Kingstown velvet bent is outstanding for its appearance, density and dark green color.

Perennial ryegrass (12 varieties).

Recently the possibilities of using perennial ryegrass on playing fields in the milder sections of the country has been explored. The fine leafed varieties which are now available have made this species even more attractive and compatable with Kentucky bluegrass in mixtures. However, it requires a good level of fertility to form a dense turf.

Of the varieties tested at Agassiz, Manhattan has been outstanding for its dark green color and its density of turf. On a spaced single row basis, Manhattan was as winter hardy as any of the varieties in the test. Although Norlea suffered winter injury in row plantings, it is felt that a severe attack of rust in the previous fall contributed to a weakened condition. Norlea's survival as turf was excellent having a darker green color than all other varieties in early spring. In one period of difficult cutting there was less leaf shredding for Manhattan, Norlea, Brabantia, Stadion and Viris than the remaining varieties.

Pennfine, a recent release from Pennsylvania State University, is a promising variety not yet tested at Agassiz.

Turfgrass varieties of the future

Madison (5) has listed the following criteria for selecting new turfgrasses and perhaps our turfgrasses of the future will have a major share of these characteristics. -

1. Resistance to pests, including disease and insects.

2. Low spreading growth so mowing will produce a minimum of injury.

3. Tolerance of smog, salinity, compaction, heat, cold, traffic (weat), and other environmental adversities.

4. Density.

5. Rapid recovery from injury, which with (4) provides minimum weediness.

6. Good color over a long season.

7. Adaptability to a specific management program. High maintenance grasses that respond to high nitrogen levels with vigorous growth, etc., or low-maintenance grasses tolerant of drying, of low fertility, infrequent mowing, shade, etc.

8. Adaptability to a specific use, as grasses for golf tees with a rapid recovery of runners, etc.

9. Adaptable to a wide range of climates or a specific climatic niche.

Pepin and Funk (6) have added to our knowledge on breeding technique, by demonstrating the practicability of making crosses within Kentucky bluegrass. This species largely reproduces without true sexual reproduction. Using their techniques Kentucky bluegrass breeding programs should produce new varieties having a large number of desirable traits. Beard (1) sees a rapid turnover in bluegrass varieties to those having more resistance to disease, close mowing, heat and cold, with improved rooting and sod quality. Daniel (2) suggests that sodgrowers will continue to use multiline and mixtures of varieties at an increasing rate. He reports that sod growers currently insist on mixing Sodco, already a multiline variety, with other varieties. They are reluctant to grow individual elite varieties.

Beard (1) looks forward to perennial ryegrasses which are slower growing, cold resistant and have better mowing characteristics. He suggests that soon we will have fescues which will have more leaf spot resistance and be strongly creeping. He is not optimistic about the bentgrasses, since the lack of formal breeding programs for this grass may reduce the chance of uncovering any large number of improved varieties.

However, with the growing emphasis on improving our environment and the increasing need for recreation, the future for turfgrass appears bright. There is little doubt that government agencies, Universities, seed companies, and individuals will all make an increasing contribution of improved varieties for the future.

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Summary of Results of Perennial Ryegrass Turf Trials at Agassiz, B.C., July, 1971

Variety	Appearance 1970	Appearance 1971	Appearance 2 yr. $\bar{x}$	Density	Red thread	Winter injury row
	4	4		3	3	1
	1-9	1-9	1-9	1-9	No.	%
Manhattan	2.4	3.0	2.7	2.1	27	30
Brabantia	2.6	3.3	2.9	3.2	19	90
Pelo	2.7	3.3	3.0	3.1	24	75
Barenza	3.0	3.1	3.1	3.2	25	50
Stadion	3.1	3.6	3.3	2.9	14	30
S-23	3.1	3.5	3.3	3.1	16	90
Glasnevin	3.3	3.4	3.3	3.1	15	50
Barlenna	3.4	3.6	3.5	3.1	15	30
Norlea	3.7	3.4	3.5	4.1	10	90*
NK 100	3.3	4.1	3.7	3.7	10	60
E-10	3.7	4.5	4.1	4.3	7	60
Viris	3.9	4.2	4.1	4.3	13	40

Test seeded June 1969. 3 replications, mowed twice weekly at 1½" height. Rating of 1 is best, red thread count of damaged areas per 50 sq. ft.

*Norlea severely weakened by attack of rust in the previous fall.

Summary of Kentucky bluegrass Turf Trials at Agassiz, B.C. - July 1971

Variety	Appearance 1970	Appearance 1971	Color	Density	Spread	Resistance to Leaf spot melting out
(no. observations)	10	5	3	2	1	2
(4 replications)	1-9*	1-9	1-9	1-9	cm.	1-9
Fylking 0217	3.4	3.4	3.4	3.0	67	4.5
Pennstar	3.4	3.6	3.2	3.1	65	3.9
Nugget	3.5	3.0	2.0	2.0	57	2.9
Prato	4.0	4.3	3.9	3.9	50	5.6
Merion	4.1	3.1	3.2	3.1	65	3.3
Primo	4.1	4.2	3.2	4.2	70	5.0
Newport	4.7	4.3	3.0	4.2	68	4.7
Cougar	4.9	4.7	2.7	4.7	62	5.9
Windsor	4.9	4.5	2.6	4.4	67	5.1
Park	5.3	6.5	4.2	6.5	70	6.9
(2 replications)						
Birka	3.3	3.2	2.2	3.3	62	3.5
Sydsport	3.5	3.6	3.0	4.3	70	4.0
Golf	3.7	3.5	2.3	3.9	66	3.5
Baron	3.9	3.3	1.7	3.5	67	3.5
Arista	4.1	4.8	2.5	4.5	48	5.5
Hohenheimer	4.9	5.6	2.5	4.6	56	6.0

* Rating of 1 is best. Test seeded June, 1969

Also tested but not promising to date - Atlas, Delft, Delta, Fusa, Grebalowska, Kenblue, Nike, Nu-dwarf, Pat, Skandia II, Soma 64 and SK-46

Helminthosporium leaf spot, plant density and weeds in plots of Kentucky bluegrass varieties

AGASSIZ, B.C., 1971

Variety	Leaf spot 1-9	Density 1-9	Weeds %
Nugget	2.0	1.7	tr
Merion	3.0	2.5	tr
Fylking	3.5	2.5	tr
Arista	3.5	3.5	5
Common	5.5	5.5	7
Atlas	5.0	6.0	13
S-21	6.5	7.0	25

Plots 4 x 10, 2 replications, seeded Aug. 1970
Rating of 1 is best

Summary of Fine Fescue Turf Trials at Agassiz, B.C. -- July, 1971

Variety	Appearance 1970	Appearance 1971	Color	Density	Spread	Red thread	
(No. observations)	10	5	2	2	1	3	2
	1-9*	1-9	1-9	1-9	cm.	No.	%
(4 replications)							
Highlight	2.8	3.3	3.7	2.5	24	14	24
Dawson	3.3	3.3	2.0	2.3	41	19	33
Pennlawn	3.6	3.8	3.4	2.9	33	23	37
Illahee	4.2	4.4	3.3	4.1	48	20	42
Durlawn	4.7	4.1	2.4	4.0	72	21	45
(2 replications)							
C-26	2.8	2.3	1.7	1.5	24	0	3
Wintergreen	2.8	3.2	3.2	2.1	23	10	20
Rolax	2.9	2.9	2.3	2.0	24	3	15
S 59	3.0	3.7	3.3	3.0	52	20	57
Pennlawn	3.1	3.8	2.8	2.7	33	13	42
Rasengold	3.2	3.9	2.5	3.7	45	11	50
Erika	3.9	3.6	2.3	2.7	22	6	33
Arctared	4.5	3.9	3.5	4.0	40	11	40
(2 replications)							
Koket	2.7	2.7	3.2	2.4	24	5	15
Highlight	2.8	3.1	3.0	2.1	24	11	21
Flevo	3.3	3.9	3.1	2.9	21	17	37
Golfrood	3.3	3.1	3.0	3.0	25	13	27
Jamestown	3.5	3.6	1.5	3.3	24	17	15
Brabantia	3.6	3.3	2.7	2.9	20	7	23
New Zealand	4.0	3.9	2.7	3.3	19	19	43
Barfalla	4.2	3.9	2.9	2.7	22	13	27
Oasis	4.3	3.8	4.4	2.7	23	16	47
Commercial	4.9	5.0	2.7	4.0	66	19	50

* Rating of 1 is best. Test seeded June, 1969.

Also tested but not promising to date - Boreal, Duraturf, Ranier, Reptans, Agio, Barenza, Bargena, Bergere, Cebeco, Dasas, Durar, Echo, Elco, Leo, Liebenziger, Novarubra, N.F.G. T. Roemer, Oberhaunstadter, Rubin Rubina, Ruby Red, Steinacher, S6, Taca, Tjelvar and 42-8.

WEED CONTROL IN NEW TURFGRASS PLANTINGS[1]

R. M. Adamson[2]

There can be little argument that the establishment of turfgrass free of weeds is highly desirable. There may be some dispute, however, as to how this condition can best be achieved. If weeds, either broad-leaved or grassy, invade new grass sowings they may quickly gain a foothold and develop to the point where they choke out the grass. In extreme cases the area may have to be ploughed and cultivated to eliminate the weeds or else all the vegetation killed off with a contact weed spray, and the area resown at great cost and little satisfaction.

Grassy weeds in turf are not easy to control in a spraying program. Where the presence of large numbers of grassy weed seeds is suspected, it may be possible to germinate them by watering, and then apply a weed spray or else cultivate them out before sowing the lawngrass seed. Preliminary sterilization with chemicals such as methyl bromide or Vapam is expensive but well worth while in many cases.

Early Studies with Timing of 2,4-D Applications to Seedling Grass

Control of broad leaf weeds in new lawns has been studied at Saanichton since 1965. At that time the late Dick Turley and I decided to see whether it was possible to spray with 2,4-D without waiting until after the grass had been mown twice, the rough rule-of-thumb criterion we had become accustomed to accept for determining the earliest safe time to spray. The difficulty with deferring applications until after two mowings is that much of the damage caused by prostrate, spreading weeds is already done, as they quickly smother the

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1/Paper presented at 25th N. W. Turfgrass Conference, Yakima, Washington, September 23, 1971.

2/Research Scientist, Canada Department of Agriculture, Saanichton, British Columbia.

young turfgrass seedlings. Although these weeds may be removed successfully by the sprays, the large gaps resulting are often invaded either by new broad leaf weeds, or, worse still, by weedy grasses.

In a 1965 growth room study, fescue, bluegrass and bentgrass plots were sprayed with 2,4-D amine at 2 lb/A at the following stages - before clipping and after one, two or three clippings. There was a temporary twisting and stunting of leaves in a number of the treatments, particularly in bluegrass, but no permanent effect on top growth, nor any effect on root growth or turf density.

In another growth room test all treatments were applied as soon as the seedlings had reached a height of 1 inch. Epinastic responses were observed and there was a temporary reduction in dry matter yields at the first clip. By the second clip, only a 4 lb/A rate reduced yield and a month later regrowth was normal in all plants, with no difference between the three species. In another test with five fescue and five bentgrass varieties, again treated as soon the seedlings were an inch high, 2 and 4 lb/A rates of 2,4-D suppressed early topgrowth, but 4 months after treatments, stands and growth were normal.

In a field study in 1966 2,4-D amine at 1 and 3 lb/A was applied to plots when grass seedlings from a May sowing first reached a height of 1 inch and to others after the first mowing. Regardless of time of application both rates stunted growth and reduced dry matter yield of the first mowing for all species, and of the second mowing for bentgrass, but no reductions of subsequent mowings occurred. The data were thus beginning to indicate that 2,4-D could probably be applied earlier than after the second mowing.

Studies Including Benzonitriles and 2,4-D

In 1967 and 1968 the new benzonitrile herbicide ioxynil was included and compared to 2,4-D in both growth room and field experiments (1). In the growth room 2,4-D caused more injury to Park bluegrass than to Chewings fescue or Highland bentgrass. Ioxynil caused no dry matter loss at 1/2 or 1 lb/A when applied as soon as the seedlings had reached a height of 1 inch, although it did reduce stands significantly. In the field ioxynil at both 1/2 and 1 lb/A gave excellent control of weeds when applied as soon as the grass seedlings from spring sowings reached a height of 1 inch, but less effective control when the applications were delayed until after the first mowing. For a comparable degree of weed control 3 lb/A of 2,4-D amine was required, with greater injury, especially to bluegrass.

In 1968 the effects of 2,4-D and ioxynil upon different varieties of fescues, bluegrasses and bentgrasses were compared in growth room studies, with applications made as soon as the grass seedlings had reached a height of 1 inch. At 1 lb/A, 2,4-D significantly reduced sod density and dry matter yield of 12 bluegrass varieties. Differences in susceptibility were noted, with Arista, Beltsville and Kentucky most tolerant of those tried and Delta least tolerant. Three varieties of bentgrass were adversely affected by the same treatment, with Highland, Exeter and Penncross varying in tolerance from the greatest to the least. Chewings, Illahee and Pennlawn fescues were all affected slightly by 2,4-D at 1 lb/A but the effect was less marked than in the more sensitive bluegrass and bentgrass varieties. Again the greater tolerance of the grasses to ioxynil was marked. There was some early stunting of bentgrasses, but they all recovered fully. On the other hand, 2,4-D injury effects were much more pronounced, especially in the bluegrasses, and much variation in varietal sensitivity was noted. The varieties Prato and Arista, for example, were much more tolerant than Merion or Altra. None of the twelve fescue or twelve bluegrass varieties were adversely affected by rates of up to 2 lb/A. There was, however, little evidence of any severe injury, with the possible exception of Astra at the 2 lb/A rate. The mean dry weight of twelve fescue varieties was reduced 15.8 percent below that of untreated plots at the 2 lb/A rate, but there were no differences between varieties and no severe injury symptoms. These data show the comparative safety of applications of ioxynil at the normal 1/2 or 1 lb/A rates.

The field data for 1968, in which the 1967 treatments were repeated in new spring sowings were in general agreement with results of the previous year. Again the merit of early treatments with ioxynil was demonstrated, with better weed control and establishment of all three species than in plots where 2,4-D was applied. Bromoxynil was included in the 1968 field tests and it also showed promise in broadleaf weed control. Canode and Robacker (2) have found bromoxynil outstanding in controlling broadleaf weeds in bluegrass and fescue seedling grass stands being grown for seed.

In 1969 and 1970 both spring and fall sowings of fescue, bluegrass and bentgrass were made. Treatments included 2,4-D alkanolamine, the sodium salt and octanoic acid ester of ioxynil, and the octanoic ester of bromoxynil from two sources. In both the spring and in the fall treatments were applied to some plots at the 1- to 2-leaf stage, while in others the treatments were deferred. In the spring sowings the later treatments were approximately a week after the first application date, when the grasses were at the 3- to 5-leaf stage and almost ready for the first mowing, while in the fall, with slower growth rates, the second treatments were approximately 3 weeks after the first. All rates were at 1 lb/A.

In general, weed control was good to excellent following ioxynil or bromoxynil applications at the first application date in either spring or fall. The earlier application was consistently more effective than the latter, indicating that most weeds tended to become resistant to the effect of the treatment at a rather early stage. Of the benzonitriles, the sodium salt of ioxynil was favored slightly over the ioxvnil octanoate, with both consistently more effective than bromoxynil. It appears, therefore, that treatments with these herbicides should be made as soon as the spraying equipment can be operated without impairment of the soil surface. No significant damage to any of the grass seedings was observed.

The effect of 2,4-D applications is in contrast to those of the benzonitriles, with the earlier applications being less effective in controlling weeds, and causing more damage to the grass. Spring applications can, however, be applied sooner than has normally been considered possible. Although treatments made when seedlings first reached a height of 1 inch in spring sowings usually recovered and made normal growth, weed control was more effective when the treatment was deferred, even by as little as a week, and injury was reduced. In fall sowings, 2,4-D applications were less effective and injury greater than the same treatments made to spring sowings. In both spring and fall applications, Park bluegrass was injured more severely than Highland bentgrass or Chewings fescue.

In 1971 a further series of spring treatments compared applications of ioxynil sodium salt and ioxynil octanoate at 1/2 lb/A with three bromoxynil octanoate formulations at 1/2 and 1 lb/A. The results further confirm the earlier findings of the greater effectiveness of ioxynil compared to bromoxynil. In general, with the range of weeds present, a 1/2 lb/A application of an ioxynil formulation was approximately equal to 1 lb/A of bromoxynil. At the present time, only the latter has been developed for use as a herbicide for weed control in seedling turfgrass in the United States. There is no benzonitrile formula presently registered for this use in Canada.

Conclusions

A few of the main conclusions regarding the use of 2,4-D and benzonitriles for controlling weeds in seedling turfgrass might be summarized as follows:

(a) 2,4-D amine may be applied to seedling fescue, bluegrass or bentgrass turf after one mowing following spring sowings.

(b) 2,4-D cannot be fall-applied safely and effectively to sowings made the same fall.

(c) Bluegrass seedlings tend to be more sensitive to 2,4-D than bentgrass or fescue seedlings.

(d) There is considerable varietal variation in sensitivity of grass species to 2,4-D, but relatively little to ioxynil.

(e) Ioxynil or bromoxynil formulations can be safely applied to new fescue, bluegrass or bentgrass sowings in either spring or fall at a rate of 1 lb/A at the 1- to 2-leaf stage. The main limitation to early application is the danger of damaging the soil surface with footprints or wheels of the spray equipment.

(f) At equal rates ioxynil is more effective in controlling the majority of common broad leaf weeds than bromoxynil.

(g) The benzonitriles should be applied when weeds are small (preferably not over dime size) as they quickly gain resistance.

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BIOLOGICAL AND MECHANICAL THATCH CONTROL[1]

By Roy L. Goss [2]

Why does one turfgrass area develop heavy thatch while an adjacent area produces little even though management practices appear to be quite similar? Before attempting to answer or solve that problem, perhaps we should give some consideration to the various terms that people use to describe thatch. Some use the term mat, fiber, sod-bound, or thatch synonymously. Fiber and mat, frequently referred to in foreign literature, most closely resemble our description of thatch. Sod-binding should not be confused with thatch, since this is an accumulation of roots and/or rhizomes beneath the soil surface. This most often occurs under pasture-type grasses. Mat, as we may use the term, can be a combination of both thatch (dead) and living stems and roots and stolons. Mat may be only partially decomposed, with much living material, whereas thatch is generally considered as all dead material and only partially decomposed.

The U. S. Golf Association defines thatch as an accumulation of dead, but undecomposed stems and leaves at the soil surface.

CAUSES OF THATCH ACCUMULATION

Perhaps no one can put their finger on one single important cause of thatch development. Thatch appears to be caused from many factors all operating simultaneously. Thatch is nothing more than a residue problem caused by excessive crop growth without harvest. Hence, any amount of production in excess of decay or removal will result in accumulation.

1/ Paper presented at the 25th N. W. Turfgrass Conference, Chinook Motel & Tower, Yakima, Washington September 22, 23 and 24, 1971.

2/ Associate Agronomist, Western Washington Research and Extension Center, Washington State University, Puyallup, Washington.

Smith (4) suggests that some of the newer more vigorous turfgrass varieties of high density have an increased production of roots, stems and rhizomes and may be contributing to the thatch problem. Stoloniferous grasses, such as strong creeping bentgrasses, may contribute more to thatch since the regenerated new growth emanates from the stems. After the new growth has initiated most of the old stems die, and contributes to thatch accumulation. He points out that excessively high mowing, particularly of vigorous vegetative grasses, can cause an increase in thatch formation. Although nitrogen applications may be debatable, Smith indicates that excessive use of nitrogen may increase thatch development. This is logical, since any factor which causes the grass to produce abundant vegetative growth will increase the thatch thickness. On the other hand, an adequate amount of nitrogen must be available for bacterial use in breaking down organic material. Phosphorus and potassium will produce more steminess with perhaps stronger and thicker cell walls which are more resistant to decay. Obviously, then, a balanced nutritional program is the best course to take. Excesses of any one element should be avoided.

Several other causes may be added to this list, such as over or under-watering, soil pH, and soil aeration. Overwatering can cause surface rooting where more decay resistant material is deposited on the surface. Under-watering can result in poor moisture relationships which are required for good bacterial activity which speeds up decomposition. Oxygen, of course, is necessary for all of these reactions and can limit decomposition.

PROBLEMS ASSOCIATED WITH THATCH DEVELOPMENT

It has definitely been established that thatch creates many problems. Many feel that a soft carpet under their feet, caused by thatch, is very good until the problems occur. Some of these problems can be enumerated as follows:

1. Thatch intercepts fertilizers and pesticides, frequently preventing them from reaching the soils. Erratic responses in fertilization programs can be encountered when the materials are contained only in the upper thatch region. Again this contributes to surface rooting because grass roots will grow where the nutrition and moisture conditions are best.

Soil-borne organisms may be difficult to control since many of our chemicals will be contained in the thatch and never reach the soil in suitable concentration.

2. Provides a suitable habitat for insects and diseases. Dense thatch formations increase the difficulty in thorough wetting with insecticides or fungicides for adequate control. Angleworm control becomes extremely difficult since the materials must reach the soil to perform adequately.

3. Lime interference. When lime is applied, thatch will intercept the material and not allow it to reach the soil for faster reaction.

4. When thatch is dry, it tends to shed water, thus increasing the problem of moisture relations.

5. Thatch accumulations interfere with mowing programs. Severe scalping can occur when wheels or rollers sink into soft, loose thatch. Thatch accumulations constantly raise the mower higher off the ground and effectively increases the mowing height.

Observations with thatched bentgrass turf at the Western Washington Research and Extension Center agree with the comment by Dr. Smith in that, green heavily thatched turf seems to turn brown in cold weather quicker than thinner turf and will remain brown for longer periods of time. When bentgrass is cut at 1 1/2 inches in the Pacific Northwest, it has a much more undesirable appearance in all months of the year, particularly in winter, than turf cut at 3/4 inch or less.

THATCH CONTROL

There are two principle methods of thatch control. One is a mechanical program. The other system, biological control, has been talked about considerably, however, only a small amount of work has been done.

Mechanical Methods: As indicated above, high cutting of vigorous creeping turfgrasses, or any grass for that matter, will stimulate the production of thatch. Obviously, one of the best solutions is to reduce mowing height. Bentgrass turf used for lawns in their area of adaptation should be mowed at 3/4 inches or less. Well prepared seedbeds can be mowed at 1/2 inch with considerably less problems than higher cutting. Bluegrass and fescue turf should be mowed at the height that is best adapted for that species. Normally, the bluegrasses, particularly the improved ones, can be mowed at about 1 inch in height except for specialized use on golf tees. Bluegrass longevity is better when cut higher than 1 inch, however, regular mechanical thatch removal should be practiced.

Power raking, verticutting, or any means of removing accumulated dead stems and roots will help to maintain turf with less thatch. These machines will remove dead stems and surface roots and/or any accumulated organic debris. In regard to leaves, some feel that leaves contribute considerably to thatch formation. It is my opinion and observation that leaves contribute little or nothing to this problem. The leaves have less lignified or sclerified tissue and decompose more readily. To prove this, simply observe a pile of moist clippings from a lawn or putting green when weather conditions are warm. Complete decomposition occurs in a very short period of time, which is not true, however, with stems and roots that are more resistant to decay. Skogley and Ledeboer (3) from Rhode Island, conducted considerable studies on the composition of thatch and issued the following statement. "Common statements in the literature that leaves and clippings contribute to the thatch buildup were not substantiated in any studies. Leaf remnants were observed only in the surface layers. At a depth of 1.6 cm, all soft tissues were largely broken down, while only sclerified portions remained in the thatch."

Aerification is another mechanical means of reducing thatch by providing more oxygen to the zone where decay occurs. Aerification will also promote better water and fertilizer penetration.

Biological Control: This term implies decomposition or decay stimulated through microorganisms in the soil. These organisms are responsible for practically all decay whether the material is plowed down or remains on the surface. If debris remains on the surface then all environmental conditions must be optimum for thatch decomposition. This includes air, moisture, temperature, and pH. Microorganisms will not appreciably attack dry turf regardless of the other environmental conditions. Top dressings on turf have proved beneficial in speeding up decomposition. Perhaps the principle resonses to top dressings are:

1. Partial covering of the thatch to maintain better moisture and temperature relationships.

2. Possibly increasing the nutrient supply in the thatch layer.

3. The introduction of a new supply of organisms that may be reduced in old turf from various causes.

Cornman (1) reported that six variables including height of cut, clipping removal, nitrogen supply, liming, annual mechanical slicing, and wetting agents produced no statistically significant differences insofar as organic matter and thatch production were concerned in tests in New York. This was a three-year study on Merion bluegrass.

We should guard against heavy topdressing for thatch control. Heavy topdressings can result in layering and can essentially retard decomposition rather than speed it up. Lighter and more frequent topdressings would be recommended. The greatest problem with topdressings, of course, is the scarcity of good materials and the high costs of application.

Martin and Beard (2) from Michigan State University analyzed the various fractions of thatch and then added various enzymes and nutrient material to study their action on thatch decomposition. Their results indicated that pectinase, cellulase, sucrose, and ferulic acid tended to increase the decomposition of thatch, based upon preliminary studies.

Nitrogen applications should be provided in small quantities frequently rather than large infrequent amounts for thatch decomposition. In this manner microorganisms will receive a steady supply of nitrogen for reproduction without stimulating a large increase of stems and roots.

Tests were initiated at the Western Washington Research and Extension Center in 1971 to study some of the effects listed above on thatch decomposition. Two materials of organic origin with high populations of organisms known to decompose organic material have been applied to a thatchy lawn to study their effects. It is too early at this time to assess any results from these tests. Indications from the manufacturers, however, are encouraging. They have proven quite effective on sugar cane and other residues. Additional studies will be conducted with these innoculated organic materials to study their effects.

It is apparent from the foregoing discussion that all researchers are not in complete agreement with the causes of thatch, however, most will agree that the causes are from multiple factors and not any single one.

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IRRIGATION CENTRAL CONTROLS [1]

Donald A. Hogan [2]

This paper is not intended to be a technical explanation of central control systems, but rather a brief discussion of recent development and availability of central control equipment.

History

There has been marked improvements and trends to more elaborate irrigation system components during the last fifteen years. Prior to 1955 many landscape areas such as residential, estate, commercial buildings, playgrounds, campuses, and in many instances, large parks have had permanent underground systems with automatic remote controls. However, in golf course installations, the majority of which are relatively large areas, it is only in recent years that this sophistication has developed.

Invariably the direction has been towards more complex and elaborate combinations of controls. This has not presented a major problem except in the larger areas, particularly golf courses, where the highest percentage of systems have the timing control units positioned in the field at a number of different locations.

Recent Trends

A number of attempts have been made at centralized control systems in the past, both commercially and privately. However, it is only in recent years, since approximately 1966, that this type of equipment has been developed and produced as a permanent feature of a number of commercial

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1/Paper presented at the 25th N.W. Turfgrass Conference, Chinook Motel & Tower, Yakima, Washington September 22, 23 and 24, 1971.

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lines. It should be noted that when referring to central control systems we mean variable timing index units that are for operating a group of control valves, located at strategic points throughout the area, that have electrical connections back to a central panel. The central panel is for starting the sequencing cycle of the field units at predetermined times. This is an entirely different concept than one where all of the timing devices are grouped at a single point.

Most of the major manufacturers of irrigation automatic control equipment are producing this type of product. At last count there was some half-dozen companies actively, merchandizing central program controllers.

It is suspected that the predominant reason for the boom in availability of these controllers is mainly the effort to offer comparable products to those of competitors. However, there are some decided advantages that will be mentioned in following comments.

Features

Understandably there are differences in the various special products on the market, but for the most part, the basic principles apply to all. Individuals involved in irrigation, be they managers, maintenance, installers or designers can benefit from being informed on what is available. For that reason a brief explanation of some of the functions that are incorporated in present-day equipment will be mentioned.

Basic

1. The most significant feature of all is the ability to set the starting of irrigation to any desired time without having to go out in the field and adjust a number of units. The starting may be accomplished either automatically or manually. One may eliminate watering at a moments notice by placing the master unit switches in the "off" position.

2. The total amount of water applied during an irrigation period can be varied simply by increasing or decreasing the number of repeat cycles signaled from the master. For example, if the standard oper-

ation is based on 3 cycles, the amount applied can be increased or decreased by one-third by going to 4 or 2 cycles respectively.

3. Varying the relative running time of the various valves in the system is accomplished by adjusting the separate stations on the field units to the desired time. Individual stations may be turned off without affecting the other stations on the unit.

Supplemental

In addition to the basic central functions there are a number of different special features that are available from various manufacturers. Some incorporate all while others choose to offer only a few. One must be aware that the wiring configuration must be designed to accommodate the functions desired. Some of these special items are as follows:

1. Return to "off" - Cancellation of a started cycle in a short interval of time.

2. Syringe Cycle - either fixed or variable in timing. Control available at satellite unit as well as master.

3. Pump control start from either master unit, field unit, or both.

4. Indicator "On" light at master for field units as a group or available for each individual field unit.

5. Separate repeat option for certain field controllers.

6. Moisture sensing omit circuit.

7. Master valve control.

8. Lighting protection.

9. Separate power source utilization for field units.

10. Low voltage for signal circuits.

11. Low voltage primary power.

12. Individual clock control for satellite units to program separate from master if desired.

Advantages

There are certain advantages to this approach to automatic irrigation. Some of them are as follows:

1. Initiate water application at any desired time without having to proceed to a number of different locations.

2. Vary the total amount of water applied from a single point.

3. Eliminate irrigation from central location.

4. Provide for syringing of specified areas from single location.

Disadvantages

Generally with a new type of equipment there are some things that are not entirely satisfying. In the case of central programming there is not very many, however, there are a few.

1. Cost of the installation may be higher than non-centralized arrangement.

2. Problems may be experienced due to the extra direct bury wire.

3. Installing a number of the various supplemental features does make the installation more complicated and can multiply maintenance problems.

Recommendations

It is suggested that if you are planning a new or conversion automatic irrigation system, the central control approach be thoroughly investigated. In the event that you elect this type of installation it would be best to integrate only those special features you feel are necessary and whose usefulness will outweigh the added cost and complexity.

WHERE HAVE WE BEEN IN IRRIGATION? [1]

Carl H. Kuhn, P. E. [2]

Over the past fourteen years during which I have had the privilege to be associated with the irrigation field, one impression stands out above all others.....the rapidity with which new concepts have been developed and old ideas discarded. Commensurate with the introduction of new concepts is the seemingly "speed of sound" development of new products brought about by a viable and competetive manufacturing fraternity.

Where else, other than the aero space field, have concepts changed so rapidly in the past decade and a half than in the irrigation field? Do you remember the era around 1955 and 1960 when down-the-middle systems utilizing 200 foot diameter agricultural heads were in vogue? It almost seems ludicrous that those systems were considered a form of automation over the old hose systems since the sprinkler locations were "automatically" pre-established. In the following five years, actual automation of a sort became very popular in the semi-automatic systems where controllers and remote control valves were married to multi-row agricultural head quick-coupling valve systems. Semi-automation permitted us to introduce re-cycling of sprinkler batteries and better control of the rate of precipitation instead of dumping as much as a half inch of water on an area in the period of a mere hour.....a very common fault of the down-the-middle manual systems. During the past eight years, full automation came to the Northwest like a tidal wave and has been enjoying the bulk of the trade since. Of course I am speaking of full automation in the framework of multi-acre golf courses as opposed to small commercial and residential systems where full automation has been popular

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1/Paper presented at the 25th N. W. Turfgrass Conference, Chinook Motel & Tower, Yakima, Washington, September 22, 23, and 24, 1971.

2/Professional Engineer and Irrigation Consultant, C. H. Kuhn and Associates, Mercer Island, Washington.

and practical for many years. We thought we had the epitome in irrigation in the fully automatic system although we recognized certain shortcomings. We didn't have to wait long until Central Controls came into the picture, first quite simple in nature and now available in numerous and even complex forms.

That is not a bad history for fifteen years, is it? Many of these new inovations have spurred manufacturers of ancillary products into testing and developing new and imaginative products. We are moving closer to being able to recreate natural rainfall but there is much room to play. If I had to view this speed of irrigation development from the Golf Course Superintendent's eyes, I just might be somewhat disturbed that the "new" system that I had paid dearly for five years ago is now, although functional, almost obsolete by current modes.

The four legs of the table of irrigation.....competent design, quality materials, quality construction and reliable manufacturer service and follow-up.....are eversomuch more important in this day than in the "good old days". Let us investigate these four legs and see what the past fifteen years advancement in the irrigation field has done to them:

DESIGN If you were to have ten independent designers provide you with a layout of the old "down-the-middle manual system", chances are that you would come up with ten near-alike designs, varying only in the brand of products and the makeup of the pump plant. I am assuming, of course, that each designer would at least take the very basic design criteria into account. Today, those same ten designers would likely provide ten very different designs for a completely automated Central Control irrigation system. Although there might be a trend in general head locations and even pipe locations, great differences would appear in control concepts, wiring schematics, scheduling, product choice and product concept inasmuch as central control designing permits substantially more imagination in creative design than was permitted in the old pipe and quick-coupling valve systems. In addition, central controls and their satellites are manufactured so that no two brands are exactly alike and, in many cases, the methods of cycling, syringing, central controlling, wiring, sequencing are almost foreign to one another. If we are ever to conceive of a professional design utilizing todays full automation concept, we must be knowledgeable in the advantages and disadvantages of each product available, the idiosyncracies of each individual golf course, the highly variable cost factor, your budget, your needs, and numerous other factors. Design is no longer a matter of simple hydraulics but is now a combination of hydraulics and electrical engineering, cost analysis, labor markets and skills and, most important of all, the ability to utilize the complex products on the market to most nearly duplicate natures requirements for turf.

Before I get off of the design kick, let me again emphasize the complete scope of that much maligned word "design". Design is much more than placing concepts on paper; it is also very much inclusive of competent and unbiased field supervision of system installations. I have heard, on recent occasions, statements such as "Who needs supervision.....it's only a sprinkler system?" You might remember that we are no longer dealing with simply pipes and quick coupling valves. We are now in the realm of systems which, for eighteen holes, might include 60,000 to 70,000 feet of pipe, 900 to 1000 rotary pop-up heads, 300 to 1000 automatic valves, several hundred thousand feet of wire, 20 or 30 field satellites and perhaps upwards of 4 central controllers. If nothing else, an installed cost of as much as $150,000 to $200,000 might impress you. Field supervision, field inspection, field surviellance...take your choice, is as much a part of a complete system as the original plans and specifications.

I am not going to belabor the matter of "as-built" drawings as a part of the design package. I will ask you to review the paper presented at Salishan last year by Mr. Gordon, however, since the year 1971 has shown that there is still need to heed that sage advice. When you are fortunate to obtain your as-builts, make doubly certain that they represent the historical compilation of daily, repeat, daily updating. Don't buy something that is made up at the end of the job from someones memory. Insist upon having your "as-built" updated in the field at the end of each working day. When the job is over and for years following, you will hail the day when you decided to do your "as-builts" properly.

MATERIALS Most products of most manufacturers in the irrigation field can be considered to be "quality". There are occasional "busts" in manufacturing but then most manufacturers do an outstanding job of correcting their problems. When I refer to quality materials on a project, I refer to more than the precision, care or inspection of a manufactured product: I refer to choosing the right combination of a multiplicity of products, i.e. pipe, heads, valves, fittings, swing joints, pumps, controllers, etc., that will give you the best system for your course with your topography and your water supply and your budget and your soils and weather. There are, for instance, certain products which should never be used under certain conditions of water quality, water pressure, windage, precipitation requirements, etc., no matter how attractive the price might be or how tantalizing the guarantee might seem. Eliminate them before you draw the first line on your irrigation design.

Take automatic valves as a typical example. They all look about the same with their solenoid configuration and they price out at list price in the same general ball park. But there is much more to these expensive gadgets than the appearance and the brand name. Did you ever concern yourself with the closing speed of various valves so that you eliminated the tendency for your mainlines to "walk" out of the ground? Did you ever worry about the open speed.....the speed which has been known to damage sprinklers or even separate them from the riser? Did you ever worry about debris or sand fines in the water and what this deleterious material would do to the consistant functioning of your valves? If you don't worry about these quality factors now, before you start the design of your irrigation system, you can save that worry for that period of time that usually starts with the first day your warranty runs out. That is the time when you finally realize the cost, inconvenience and sleepless nights that comes free with products that do not meet the conditions of your particular golf course.

I should like to mention sprinklers for just a moment, that is rotary pop-up sprinklers. Aside from placing precipitation adequately, they have three basic mechanical functions.....pop-up, rotate and pop-down. The trouble is that they do not all do these three functions under all conditions of pressure, water quality, installation practices, etc. Some are impact driven, gear driven, cam driven, steel ball driven; there are cast iron bodied, brass bodied, plastic bodied; there are constant speed heads, variable speed heads, etc., etc., etc.. The choices and varieties as many and varied so I strongly urge you to seek competent advice in making your sprinkler selection. If you are going to pre-select your head on the basis of its success on another course, then give your golf course the benefit of the doubt by asking yourself these questions: are our water conditions, water availability, topography, windage, soil conditions, climate, fairway width, etc., alike?

CONSTRUCTION As in every facet of construction, no two irrigation contractors are alike. You will assure yourself of higher quality construction by pre-qualifying contractors; that is selecting three or so contractors who have a good history of workmanship and follow-up and then restricting the bids to this select group. Yes, there will be some hues and cries if you leave someone out but this can be expected. Then, follow up the work with competent field supervision to assure that the plans and specifications are being followed. This program will work well for providing that you have preceeded this action with good design and a set of absolute definitive specifications which spells out all of the hows, whens, whys, wheres of the system construction. Some courses have aided their cause by requiring a two sprinkler season warranty rather than the normal one calendar year warranty. This has been justified on the basis that one calendar year in the Northwest gives 4-6 months test whereas the same system installed in southern California or Arizona would get 10 months operation.

MANUFACTURER FOLLOW-UP I mention this factor not in a derogatory sense but rather in a commendatory sense for those manufacturers who have had a tremendous scheme of follow-up for their products in the ground. A warranty is usually good for one year; you, on the other hand, expect your exotic and complex automatic system to go merrily on its way for many years to come with minimum maintenance and cost payout. In the more simplified systems of 10 to 15 years back, maintenance was minimal since the system components were basically pipe and ag heads. Now, with complex irrigation systems and with more and more products that we in the field are pushing the manufacturer for before the ink has dried on their drawing boards, the likelihood of absolute trouble-free systems diminishes. When you are selecting the exotics of your irrigation system.....the heads, valves and controllers, do some research of your own to determine which manufacturer comes back to bail you out after the warranty has expired.

As you can see, we are now in the Age of Aquarious in irrigation. Nothing is simple any more or, if you will permit me a pun, "The Days of Wine and Hoses" is over. In fifteen years we have gone from simple design and do-it-yourself construction to sophistication of the first order in design and construction. Hydraulics have been replaced with a mix of hydraulics and electronics, backhoes have been replaced in part by pipe-pullers; records of construction have changed from one line pipe diagrams to complex triangulated as-builts. This, then, is where we have been in the past fifteen years.

In closing, may I suggest that you, the Superintendent, will be expected to be responsive to your Board of Directors, your Green Committee or your Irrigation Committee in helping decide what you need and what you can afford in automatic irrigation. If you haven't built a fully automatic central control system on at least one course, you are likely to be at an extreme disadvantage. Your information is likely to be fragmented from conferences such as this, by the man who owns one or from manufacturing sources. If you are considering automation, I strongly urge you to convince your club heirarchy to sponsor an investigative trip for you, one which takes you to an area where you can obtain a maximum overview of modern automation in a few days. Southern Cal is a good example of maximum golf courses per square mile. A trip such as this will fill you in on most of the good points of current design and products and, almost certainly, all of the bad points. You will, in effect, be condensing the past fifteen years into an up-to-date irrigation capsule.

APPLICATION OF FERTILIZER THRUGH IRRIGATION SYSTEMS [1]

John H. Pierce, M. A. [2]

We are all interested in producing and maintaining lush green turf at the least possible cost. To accomplish this let us consider the practice of applying small amounts of fertilizer through the irrigation system at frequent intervals. This practice has recently achieved a degree of sophistication which warrants a special designation and I am sure the word Fertigation fits.

Fertigation has been practiced for some years by growers in the floriculture and nursery industries with relatively simple devices which do not require large amounts of water.(1) Recently, the size of these operations has grown to the need for large amounts of water and along with this need some very sophisticated injectors and proportioners have been developed. I would like to discuss the types of Fertigation equipment available at present, the manner in which the fertilizer is injected and the limitations and problems involved with each type.

The need is for equipment which is extremely accurate, very dependable and not too complicated to maintain. We need accuracy, not only to avoid burning turf, but to apply the minor elements and other growth control chemicals which are needed in very small amounts. Some of the new growth retardants will require carefully controlled application. I have a lawn mower which sometimes starts and it reminds me that dependability is very desirable. As we move toward more frequent Fertigation we need well constructed equipment to resist wear. The newest devices will require an item in the budget for maintenance. Some of the companies which have recently developed rather complicated electronic-mechanical equipment are providing field service with the

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1/ Paper presented at the 25th N. W. Turfgrass Conference, Chinook Motel & Tower, Yakima, Washington, September 22, 23, and 24, 1971.

2/ Environmental botanist, Joe Berger Company, Seattle, Washington.

sale of the fertigation device. This seems to me to be the answer rather than all of us trying to become expert at everything.

To purchase and maintain sophisticated fertigation equipment is costly but I am sure this cost is more than offset by the savings in labor, materials and the improved condition of the turf.

<u>Methods of Injection</u> (2)

There are at least five methods of injection as follows:

1. Gravity mixing.

2. Centrifugal Suction Pump.

3. Diaphragm or Piston pressure pumps.

4. Metering pumps, electric, engine or water motor.

5. Proportioning pumps with automatic flow control.

Gravity mixing, suction and pressure pumps are not accurate enough for the critical needs of turf fertigation. There is too much danger of misapplying the chemicals needed in very small quantities or burning the turf with nitrogen. This type of equipment is in use with field crops and some types of nursery stock where the demands are not that critical. The devices known as "educators", which introduce dissolved or suspended materials into flow lines, are less accurate than pumps and hence not suitable for turf fertigation.

The most widely used proportioner-injector in the floriculture and nursery industries is the Smith Measuremix. (3) This is a precision built water motor connected internally to a piston-type injector. It operates on water power in that water passing through the water motor provides the power to run the injection pump. For every revolution of the water motor there is one stroke of the injector pump and thus the ratio of water to fertilizer solution is always maintained, regardless of changes in water pressure, or the amount of water flow. This provides a safety factor against burning with excess fertilizer. The Smith is accurate to ±4% and relatively simple to maintain but it does have limitations. All the water dispensed by the distribution system goes through the water pump limiting the main line to six inches and a maximum gallonage output of 700 gpm. For most greenhouses, nurseries and some turf areas this is adequate. If you would like to see this equipment in operation I would be glad to tell you the nearest grower using same. Other water motor injectors are listed on the chart.

I would like to discuss three of the newer fertigation devices which are in use here in the west and give you a chart of some others, to assist you in exploring fertigation more extensively yourself.

BIF, (4) offers a complete packaged injection system which consists of a flowmeter, differential pressure signal lines, differential pressure to proportional electric potentiometric signal converter, control box and injection nozzles. The main water line flow creates a variable time duration signal, proportional to the flow, which energizes or de-energizes the electromagnetic clutch on the pump. It can be installed on pipe up to ten inches in diameter with flow rates of 1400 gpm and accuracy of plus or minus 4%. The injection rate is adjustable at the pump and additives can be up to 10 gpm per injection nozzle. This equipment is in use in California.

Hills-McCanna (5) markets custom systems using metering-proportioning pumps with control of the injection rate accomplished by adjusting the stroke length of the reciprocating pump, from zero to 100%. The flow control is achieved by time duration signal as in the BIF above. This equipment provides a multiple-feed pump with up to 16 liquid end assemblies for a wide variety of additives. It is limited by the fact that the main flow passes through a water meter 2" at maximum rate of 160 gpm. This is in use in Idaho.

Milton Roy (6) has custom engineered systems for automatically maintaining a given ratio of one or more additives to mainstream flow up to 1400 gpm. The "Milroyal" type has a patented worm gear and crank drive which converts the high speed rotary motion of the electric motor to low speed reciprocating motion and allows stroke if desired, a signal process monitor downstream to control the accuracy of injection. Two or more pumps can be used together for injection of several chemicals simultaneously. This type of system is in use in Washington.

Increasingly, growers of all kinds of plant material are using tissue analysis as a basis for fertigation. (6) To replace whatever the tissue analysis shows is lacking in the plant material requires equipment for fertigation with the accuracy factors indicated above. This will give you some idea of the changing state of the art of fertigation at the present time. It suggests that it is prudent to have your fertigation system engineered by competent professionals who can meet the needs of your particular fertigation problems, and service your equipment. It is my opinion that we are just beginning to control and manage growth through the use of sophisticated fertigation equipment and we can all profit by becoming more knowledgable about this subject. (2)

For the future, I think the ecological as well as the aesthetic and recreational values of turf will mean that more and more land surface will go into turf. So, it behooves all of us to become more efficient at producing and managing turf. Improved fertigation techniques is one way to accomplish this purpose.

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(3) Joe Berger & Co., Inc., 1218 Western Avenue, Seattle Washington 98101.

(4) Kakar Corp., 909 Kirkland Avenue, Kirkland, Washington 98033

(5) Hills-McCanna, 400 Maple Avenue, Carpenterville, Illinois.

(6) Soil and Plant Laboratory, Box 1648, Bellevue, Washington. 98009

(7) What's ahead in Irrigation, Grounds Maintenance, December, 1970.

(8) Flow measurement and control handbook, Rimbach Publications, 845 Ridge Avenue, Pittsburgh, Pennsylvania 15212.

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FERTIGATION EQUIPMENT

Manufacturer or Distributor	Type	Ratio Control	Main Flow	Remarks
BIF, Kakar Corp. 909 Kirkland Ave. Kirkland, Wa. 98033	Electric Diaphragm Flowmeter Multiplex	Flowmeter Adjustable Automatic to 300 gph	to 1400 gpm 10" pipe	Custom engineered Safety monitor electromagnetic clutch
Ratio-Feeder H. E. Anderson Co. Box 1006 Muskogee, Oklahoma 74401	Water Motor Multiplex	Adjustable Stroke 1:200 to 1:2500	160 gpm 2" pipe	Water meter flow controls main flow.
Smith-Measuremix Joe Berger & Co.,Inc. 1218 Western Ave. Seattle, Wa. 98101	Water Motor Multiplex piston pump	Factory set 1:100 to 1:4000	700 gpm 6" pipe	Main flow thru injector. ready-made unit.
Milton-Roy Co. Soil and Plant Lab Box 1648 Bellevue, Wa. 98009	Flowmeter piston & diaphragm Multiplex	Adjustable stroke to 85 gph per head	1400 gpm	custom engin- eered. safety monitor
Hills-McCanna 400 Maple St. Carpenterville, Ill.	Electric multiplex piston pump	Adjustable stroke 32 gph per head	160 gpm 2" pipe	Main flow thru water meter.
Injectometer Mfg.Co. Box 1044 Clovis, New Mexico 88101	Gas engine electric duplex	Adjustable valve flowmeter gauge	160 gpm 2" pipe	to 245 gph injection accuracy?

1971 WEAR TRIALS ON BLUEGRASS VARIETIES, PULLMAN [1]

By LaVerne Boyd and Alvin G. Law [2]

Wear trials on ten varieties of bluegrass were repeated for a 2-year study of wear performance. The same methods were used as in 1970, except it was conducted for 24 consecutive days. At this time one variety was worn out and a second nearly so. Each wear day consisted of 50 trips across each plot for a total of 1200. Each plot was cut at 2 heights, 1" and 1/2". Some difference in wear ability between the two heights can be found in the evaluation charts. It may also be noted in the recovery readings that some varieties change their positions in their original order of wear performance during the recovery period.

The varieties were comparatively free of disease during the test period. Helminthosporium could be found on Merion and Cougar. Weed encroachment occurred in Delta and South Dakota Certified during the recovery period. The other varieties remained comparatively clean.

A summary of the wear ability of each variety can be determined by the table of averages of the three evaluations.

1/ Paper presented at the 25th N. W. Turfgrass Conference, Chinook Motel & Tower, Yakima, Washington September 22, 23 and 24, 1971.

2/ Sr. Experimental Aide, Agronomy Department, Pullman, Washington. Professor of Agronomy, Department of Agronomy, Pullman, Washington, Washington State University.

TURF WEAR TRIALS 1971
Washington State University

	At end of Wear 1 inch	At end of Wear 1/2 inch		Recovery of 10 days 1 inch	Recovery of 10 days 1/2 inch		30 days 1 inch	30 days 1/2 inch
Merion	7-7-7	7-7-6	Merion	8-8-8	8-7-8	Merion	9-8-9	9-8-9
Nugget	7-7-7	7-7-6	Nugget	7-7-6	7-6-7	Sodco	8-7-8	8-7-7
Sodco	7-7-6	6-6-5	Sodco	6-7-6	6-6-5	Windsor	8-7-8	8-6-7
Windsor	6-6-6	6-6-5	Windsor	6-6-6	6-6-6	Nugget	8-7-7	7-7-7
Pennstar	5-6-5	5-5-5	Fylking	6-6-5	5-4-5	Fylking	8-6-8	7-5-7
Cougar	5-6-4	4-5-4	Cougar	5-7-4	4-6-4	Cougar	7-7-7	6-6-6
Fylking	5-5-4	4-4-4	Pennstar	5-5-5	5-4-5	Pennstar	7-5-7	7-5-7
Newport	4-4-3	3-3-2	Newport	4-5-4	4-5-4	Newport	5-5-5	4-5-4
S.D. Cert.	2-2-2	2-2-2	S.D. Cert.	2-4-2	2-3-3	S.D. Cert.	3-4-3	3-3-3
Delta	1-2-1	1-1-1	Delta	2-3-2	2-2-2	Delta	2-3-2	3-3-3

The above tables show the averages of the 4 reps for each of 3 evaluations, in the order of best performance as indicated. Scale: 1 = poor, 9 = best.

TURF WEAR TRIALS
Washington State University 1971

D = Density; C = Color; U = Uniformity

Evaluation 10 days after wear end

Rep.	I	II	III	IV	V	VI	VII	VIII	IX	AVG.
Wear	D C U	D C U	D C U	D C U	D C U	D C U	D C U	D C U	D C U	D C U
Cougar	6 8 3	5 7 5	5 7 4	5 6 5	5 7 4	6 7 3	4 6 5	4 5 5	4 5 5	4 6 4
Fylking	6 5 4	6 6 5	6 6 6	6 6 6	6 6 5	6 4 4	6 5 5	6 5 6	4 4 5	5 4 5
S.D. Cert.	2 5 2	2 2 2	3 5 4	2 3 2	2 4 2	2 4 2	3 2 4	3 4 4	2 2 2	2 3 3
Newport	3 4 3	4 6 5	5 7 4	5 5 5	4 5 4	3 4 3	4 6 5	4 5 5	4 4 5	4 5 4
Delta	2 3 2	2 3 2	2 3 2	1 2 1	2 3 2	3 3 2	2 3 2	2 3 2	1 1 1	2 2 2
Windsor	6 6 6	6 6 6	7 7 7	7 7 7	6 6 6	6 6 6	6 6 6	7 7 7	6 5 6	6 6 6
Sodco	6 6 6	6 7 5	8 8 8	6 7 6	6 7 6	6 5 6	6 7 5	7 7 6	5 5 5	6 6 5
Penstarr	5 5 5	5 5 4	5 6 5	6 5 6	5 5 5	5 4 5	5 5 4	5 5 5	5 4 5	5 4 5
Merion	8 8 8	8 8 8	8 8 8	8 8 8	8 8 8	8 7 8	8 8 8	8 7 8	8 7 8	8 7 8
Nugget	7 7 7	7 8 7	6 7 5	7 7 7	7 7 6	7 6 7	8 8 8	7 7 7	6 5 6	7 6 7

← 1 inch → (I–V) ← one-half inch → (VI–AVG.)

Evaluation 30 days after wear end

Rep.	I	II	III	IV	V	VI	VII	VIII	IX	AVG.
Cougar	7 8 7	7 7 7	7 7 7	7 6 7	7 7 7	7 7 7	6 6 6	6 5 6	6 5 6	6 6 6
Fylking	8 5 8	8 6 8	8 6 8	8 6 8	8 6 8	8 4 8	6 5 6	7 5 7	7 4 7	7 5 7
S. D. Cert	2 5 2	3 2 3	3 5 4	3 3 3	3 4 3	2 4 2	3 2 3	3 4 3	3 2 3	3 3 3
Newport	4 4 3	6 6 6	6 7 6	5 5 5	5 5 5	4 4 3	4 6 4	5 5 5	3 4 3	4 5 4
Delta	2 3 2	3 3 3	3 3 3	2 2 2	2 3 2	2 3 2	3 3 3	3 3 3	2 1 2	3 3 3
Windsor	8 6 8	8 6 8	8 7 8	7 7 7	8 7 8	8 6 8	8 6 8	8 7 8	6 5 6	8 6 7
Sodco	8 6 8	8 7 8	8 8 8	8 7 8	8 7 8	8 5 8	7 7 7	7 7 7	7 5 7	8 7 8
Pennstar	7 5 7	7 5 7	7 6 7	8 5 8	7 5 7	7 4 7	7 5 7	6 5 6	7 4 7	7 5 7
Merion	9 8 9	9 8 9	9 8 9	9 8 9	9 8 9	9 7 9	9 8 9	9 7 9	9 7 9	9 8 9
Nugget	8 7 7	7 8 7	7 7 7	8 7 8	8 7 7	8 6 8	8 8 8	7 7 7	7 5 7	7 7 7

← 1 inch → (I–V) ← one-half inch → (VI–AVG.)

TURF WEAR TRIALS
Washington State University 1971
Evaluation at Start
Wear started 6-24-71

D - Density; C = Color; U = Uniformity.

No / Reps	I (One inch)	II (One inch)	III (One inch)	IV (One inch)	AVG (One inch)	I (One-half inch)	II (One-half inch)	III (One-half inch)	IV (One-half inch)	AVG (One-half inch)
Wear	D C U	D C U	D C U	D C U	D C U	D C U	D C U	D C U	D C U	D C U
Cougar	6 8 6	7 8 7	7 8 7	7 8 7	7 8 7	5 7 5	6 7 6	6 7 6	6 7 6	6 7 6
Fylking	7 7 8	7 7 8	7 7 8	7 7 8	7 7 8	6 6 7	6 6 7	6 6 7	6 6 7	6 6 7
S.D. Cert.	2 2 2	3 3 3	3 3 3	2 2 2	3 3 3	1 1 1	2 2 2	2 2 2	1 1 1	2 2 2
Newport	4 4 4	5 5 5	5 5 5	5 5 5	5 5 5	3 3 3	4 4 4	4 4 4	4 4 4	4 4 4
Delta	3 3 3	4 4 4	4 4 4	3 3 3	4 4 4	2 2 2	3 3 3	3 3 3	2 2 2	3 3 3
Windsor	4 6 7	5 7 8	6 6 6	6 7 8	5 7 7	3 5 6	4 6 7	5 5 5	5 6 7	4 6 6
Sodco	8 9 7	8 9 8	8 9 7	8 9 7	8 9 7	7 8 6	7 8 7	7 8 6	7 8 6	7 8 6
Pennstar	7 7 9	7 7 9	7 7 9	7 7 9	7 7 9	7 6 9	7 6 8	7 6 8	7 6 8	7 6 8
Merion	6 5 5	7 5 6	7 5 6	8 6 7	7 5 6	5 4 5	6 4 6	6 4 6	7 5 7	6 4 6
Nugget	9 9 9	9 9 9	9 9 9	9 9 9	9 9 9	8 8 9	8 8 9	8 8 9	8 8 9	8 8 9

← One inch → ← One-half inch →

Wear — Evaluation at end of wear period 7-15-71

Wear	I (One inch)	II (One inch)	III (One inch)	IV (One inch)	AVG (One inch)	I (One-half inch)	II (One-half inch)	III (One-half inch)	IV (One-half inch)	AVG (One-half inch)
Cougar	5 8 3	5 7 6	4 4 3	4 4 4	5 6 4	4 7 2	4 7 6	3 3 3	3 4 4	4 5 4
Fylking	6 4 4	5 5 4	5 5 4	4 4 4	5 5 4	5 3 3	5 5 4	4 4 4	3 4 4	4 4 4
S.D. Cert.	1 2 1	1 1 1	2 2 2	2 2 2	2 2 2	1 1 1	2 2 2	2 2 2	1 1 1	2 2 2
Newport	3 4 2	6 6 4	4 4 3	3 3 3	4 4 3	2 3 1	3 5 1	3 3 3	2 2 2	3 3 2
Delta	1 2 1	1 1 1	2 2 2	1 1 1	1 2 1	1 2 1	1 1 1	1 1 1	1 1 1	1 1 1
Windsor	6 6 5	7 6 6	5 5 5	6 6 6	6 6 6	6 6 5	6 6 5	6 6 5	5 5 5	6 6 5
Sodco	6 7 5	7 7 6	6 7 6	7 6 6	7 7 6	6 7 5	7 7 6	5 6 5	5 5 5	6 6 5
Pennstar	5 6 4	5 6 5	5 5 4	6 6 6	5 6 5	5 6 4	5 6 5	4 4 4	6 6 6	5 5 5
Merion	6 7 5	8 7 7	7 6 6	8 8 8	7 7 7	6 6 5	6 6 5	7 6 7	8 8 8	7 7 6
Nugget	5 6 4	8 8 8	6 6 6	8 8 8	7 7 7	5 6 4	8 8 8	6 6 6	7 7 7	7 7 6

TURF DISEASE CONTROL—Progress Report [1]

Charles J. Gould [2]

Fusarium Patch

Fusarium never developed sufficiently in any of our four experimental areas to permit an adequate comparison between the various treatments. However, in general, benomyl (Tersan 1991), Fore, Tersan LSR (similar to Fore), phenylmercuric acetate (PMAS), Calo-clor and a mixture of thiram and PMA (Bromosan-old formulation) appeared to give the best results. Benomyl at 2 oz (per 1000 ft^2) was better than 1 oz; an application every 2 weeks was better than every 4 weeks; an application in 3 gallons of water was about as good as an application in 10 gallons; and combining sulfur with benomyl appeared promising. Some promising results were also obtained with thiabendazole (Mertect 160) but they were not as consistent.

Fore and Tersan LSR usually produced a good, dark, dense turf which remained relatively disease-free until applications were discontinued. Then, if weather conditions were favorable, the *Fusarium* rapidly invaded the previously treated areas, perhaps because the grass was so dense. Benomyl is apparently somewhat more persistent in its action. An alternating program might be worth trying in order to obtain the best features of both compounds.

New fungicidal tests will be started this fall. They will be run on our Farm 5 plots and on putting greens in cooperation with Ron Proctor at the Rainier Golf and Country Club and Ernie Lueckenotte at the Earlington Golf Course.

Several years ago we tested a few of the common bentgrass

1/Paper presented at the 25th N. W. Turfgrass Conference, Chinook Motel & Tower, Yakima, Washington, September 22, 23, and 24, 1971.

2/Plant Pathologist, Washington State University, Western Washington Research and Extension Center, Puyallup, Washington.

varieties without finding one that was adequately resistant to Fusarium nivale. Since then many new varieties have been developed. However, we were too busy with fungicidal and nutritional tests to do more along this line until this spring when we started a large test at our home farm (#1) with eight stolon and 29 seeded varieties. Three more seeded types will go in this fall. The 40 varieties originated in Sweden, Denmark, Germany, Holland, Canada, New Zealand and the U.S.A. You are invited to check the plots at any time.

Ophiobolus Patch

Some Ophiobolus developed in our fungicidal plots at Farm 5 during the last two years. The mercuries, iron sulfate and a 2 oz rate of Mertect appeared to suppress Ophiobolus somewhat but the infestation was not sufficiently uniform to make it a good test.

Corticium Red Thread

Red Thread invaded part of the experimental area at our home farm. Since the infection was not uniform the results should only be considered as indicative. Fore, Mertect, Iron sulfate and the mercury compounds appeared to partially control the disease.

Rhizoctonia Brown Patch

A succession of warm muggy days and nights during the last week in July and early part of August in 1971 gave us the worst outbreak of "Rhizoc" that we have had in at least 15 years. The fungus is very common here but only thrives when night (as well as day) temperatures are over 60° F and the relative humidity remains high both day and night. Therefore, it is rare for us to have more than a very few days of trouble each year in contrast to its seriousness in the eastern U. S.

(This research is in cooperation with R. L. Goss and V. L. Miller)

AGRONOMIC RESEARCH REPORT [1]

Roy L. Goss. [2]

I. Nutritional studies on the control of Ophiobolus Patch disease of turf. By Roy L. Goss and Roy M. Davidson, Jr.

Earlier observations have indicated that nutrition is of prime importance in the control, prevention or remission of Ophiobolus Patch disease in turf. Plots were established in October 1970 to test various materials and combinations for the control of Ophiobolus. The disease was well established on the bentgrass turf which had been previously fumigated with Methyl bromide. The treatments are as follows:

1. Ammonium sulfate at 1 lb. nitrogen/1000 ft^2/application
2. Phosphoric acid at 2 lb. phosphorus/1000 ft^2/year
3. Sulfur at 2 lbs./1000 ft^2/year
4. Phosphorus plus sulfur at the rates indicated singly
5. Lime at 1 ton/Acre
6. Ammonium sulfate plus chlordane
7. Chlordane at 3 lbs. active ingredient/Acre/application
8. Fore at 8 oz/1000 ft^2/application
9. Benlate (Benomyl) 2 oz/1000 ft^2/application

Urea was applied to all plots except the controls, and those receiving ammonium sulfate at the rate of 1 lb. of nitrogen per 1000 ft^2/application. Ammonium sulfate and urea

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1/Paper presented at the 25th N. W. Turfgrass Conference, Chinook Motel & Tower, Yakima, Washington September 22, 23 and 24, 1971.

2/Associate Agronomist, Western Washington Research and Extension Center, Washington State University, Puyallup, Washington.

were applied every three weeks except during January and February. Benlate and Fore were applied once every two weeks for a period of twelve weeks. Chlordane was applied once every three months. Phosphorus was applied every four months. Sulfur was applied in fall and spring. Phosphorus and sulfur applications were separated by at least ten days. Lime was applied initially in August 1970. Ammonium sulfate, lime and urea were broadcast within the appropriate plots and the remaining treatments were applied with a sprayer at the rate of 10 gallons of water per 1000 ft^2.

Plots treated with ammonium sulfate and the combination of ammonium sulfate plus chlordane began rapid healing within two months from the time the treatments were initiated. By April 1971, six out of ten treatments indicated good results. Ammonium sulfate alone, ammonium sulfate plus chlordane and the fungicide, Fore, showed complete healing of all infectious areas. Phosphorus alone indicated about 80% control; sulfur 90%; and phosphorus plus sulfur 90%. It is interesting to point out that chlordane alone produced little or no results in the control of this disease. The fungicide Benlate exhibited only minor effects on the disease as compared to the fungicide Fore. It is suspected at this time that the level of sulfur contained in the fungicide Fore produced the greatest effect in the control of this disease.

Lime produced no effect on the control of the disease which indicates that soil pH appears to have considerable influence on the development of the disease.

II. Putting green nutritional studies.

Principle emphasis in 1971 was placed upon the evaluations of the effects of N, P, K and S on Poa annua plant and seedhead development. A summary of observations indicates that both sulfur and phosphorus are significant in their effects upon seedhead development.

It is obvious from the following table that the highest rates of sulfur produced plots with fewer seedheads. When phosphorus is added to the formula, seedheads increased in some cases but not significantly with higher rates of sulfur. The highest variation in seedhead control occurred in all cases at the higher nitrogen levels, as would be expected.

Treatment N, P, K, S	Mean Rating Color[1]	 Poa annua[2]
20-0-5-0	5	4
20-1.76-5-0	4	4
20-0-5-1.15	8	5
20-1.76-5-1.15	8	9
0-0-0-0	5	3
20-0-5-3.45	9	1
20-1.76-5-3.45	9	2
12-0-5-0	6	5
12-1.76-5-0	6	4
12-0-5-1.15	9	7
12-1.76-5-1.15	8	9
12-0-5-3.45	9	4
12-1.76-5-3.45	9	6
6-0-5-0	7	6
6-1.76-5-0	7	6
6-0-5-1.15	8	5
6-1.76-5-1.15	8	7
6-0-5-3.45	8	2
6-1.76-5-3.45	8	2

[1]Color = 10 = Best, 1 = Poor. [2]Poa annua=10=Most seedheads

High rates of nitrogen, along with standard rates of phosphorus, potassium and high rates of sulfur, produced plots with the best color. At the lower nitrogen levels, phosphorus produced little effects on quality, while influencing *Poa annua* seedhead development considerably.

These studies indicate the importance of sulfur, particularly in putting green nutrition on sandy soils. It also points out that care should be exercised in excessive applications of phosphorus. Under no circumstances should phosphorus exceed 4 lbs. of P_2O_5/1000 ft^2/year (1.76 lbs. P) since this appears to be very adequate for excellent turfgrass nutrition.

III. *Poa annua* pre-emergence studies.

Observations at the end of one year indicate no undesirable reactions from Betasan, Calcium-arsenate, Fore and Benlate in pre-emergence control studies for *Poa annua*. A total of 18 lbs. of calcium-arsenate/1000 ft^2 has been applied to certain plots and a total of 24 lbs. of active ingredient Betasan (Bensulide)/Acre, throughout the past year. Bensulide applications have been made every three months at the rate of 4 lbs. active ingredient per acre. *Poa annua* ratings have been made at the end of the first year. There have been no significant increases nor decreases in the amount of *Poa annua* in these plots, hence, the project will be continued for at least two more years.

IV. Weed control studies.

Plots were established at Green River Golf Course at Auburn, Washington on June 30, for the control of *Veronica filiformis* (Speedwell). Most of the materials applied were new experimental material with the exception of Lasso, Dacthal and Ioxynil/MCPP. Ratings indicated perfect control of Speedwell with both Dacthal (DCPA) and Ioxynil/MCPP. The DCPA was applied at the rate of 12 lbs. active ingredient per acre and the Ioxynil/MCPP at 3/4 lb. active ingredient/Acre each. The experimental materials varied in their effect, some of which proved to by phytotoxic.

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Yakima, Wa. 98901

Yakima Elks Golf & Country Club
Box 187
Selah, Wa. 98901

Yakima Metro Park Dist.
Box 171, Yakima, Wa. 98901

NORTHWEST TURFGRASS
MEMBERSHIP DUES

1. Annual dues, $25.00, payable on or before May 15th each year. Dues are based on annual due date nonprorated.

2. Membership includes registration fee for one person at Annual Turf Conference. Other persons from member organization registration fee $8.00.

3. NO INITIATION FEES ARE CHARGED.

4. Non members may attend the Annual Conference by paying a $15.00 registration fee. For further information on dues, contact the Northwest Turf Treasurer.