Proceedings

of the

26th Annual Northwest Turfgrass Conference

September 26, 27, 28, & 29, 1972
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Welcome to Ocean Shores

It's been a real pleasure to serve as President of the Northwest Turfgrass Association, but it's even more of a pleasure to become more closely acquainted with people such as Roy Goss and Chuck Gould who put forth an unbelievable amount of energy and time to make our organization what it is today. Until one serves on the Board of Directors and sees what really goes on, I don't think you will fully understand what I mean. My whole-hearted thanks goes out to the members of the Board for their support and to all the committee for their work.

You remember what I said in my acceptance talk in Yakima last year about "let's all get involved and make our organization bigger and better". I know the Board is limited to so many members and so many committees, but why is it every year - year after year - we have the same men doing all the work and carrying all the load? How is it that 75% or so of our members can set back and do nothing year after year and then reap the benefits? I am sure it's not just laziness, but possibly an unsureness of where to start and what to do. Dear member, I dare you to ask, and challenge you to put forth a little effort and give a little of your time for the future of our organization.

Northwest Turfgrass Association

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Functions of Surfactants, Spreader-Stickers and Emulsifiers[1]

Robert W. Moen[2]

Before any discussion on the function of surfactants, spreader-stickers and emulsifiers is begun, perhaps the best way to proceed would be to have some description as to how pesticidal formulations are put together. The latter can be of three types---gaseous, liquids or solids. The first does not need much discussion on formulation except to mention that most fumigants start as liquids and that in some cases it is only necessary to add some agent or inhibitor to stabilize the chemical and keep it the "active form".

Chemicals that are useful in controlling unwanted vegetation, animals, insects, or micro organisms exist for the most part as either liquids or solids at ordinary temperatures. The challenge to the agricultural chemist is to take the materials and put them into a form that makes it easy for the applicator to use. Consider that it only takes 1 to 2 lb of 2,4-D to control the weeds on an acre, or that 1/4 lb of Aldrin will control grasshoppers on that same acre. How do you distribute that small amount of chemical uniformly over the acre? You can solubilize it in something in which it will dissolve, or if no suitable solvent is available you can mix it with an "inert" solid material like a clay or like material, grind it very fine and either dust it over the acre or make the dust easily mixable with the cheapest liquid available - water; these are the wettable powders. Likewise, if it can be safely melted, without decomposition or explosion, it can be sprayed as a liquid onto and into an absorbent granule together with suitable adjuvants to yield a granular pesticide. Sometimes a solvent is used to lower the melting temperature of the active ingredient so that lower

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[1]Paper presented at the 26th annual Northwest Turfgrass Conference, Ocean Shores, Washington, Sept. 26-29, 1972.

[2]Charles H. Lilly Company, 109 S. E. Alder Street, Portland, Oregon 97214

temperatures can be used to effect the impregnation.

Previously, a reference was made about making the finely ground dust "easily mixable with---water". This calls for the use of a surfactant, the use of which makes the powder very easily wetted with water. The surfactant or wetting agent has the property of making water solutions or suspensions of powders able to wet surfaces on which they are sprayed.

Surfactants, or surface active agents, have the property of changing the skin effect that exists in all liquids. This skin effect is called surface tension. Whenever proper surfactants are added to water this surface tension is materially reduced. It is this reduction in the surface tension that allows the water mixtures to evenly wet the surfaces on which they are sprayed. If no surfactant is used or if insufficient surfactant is used the effect will be that the spray is visible in many cases as distinct droplets standing on the surfaces on which they are sprayed. Many things can affect this wettability.

When liquid formulations are considered we have to find a solvent system which will hold in solution a satisfactory amount of toxicant. Economic considerations usually dictate that this must be at least one and one-half lbs active ingredient per gallon and many formulations are available with amounts up to eight pounds of active ingredient per gallon. It should be pointed out that spray strengths of toxicant dissolved in solvent can be used, and have been at time, numerous spraying in years past of 5% DDT solution to control mosquitoes and at approximately 10% strength to control spruce budworm. This year malathion at 95% strength was used in wheat growing areas to control grasshoppers.

Most applicators do not have the equipment necessary to do ultra low volume spraying, and it is for them that emulsifiable concentrates are made. Emulsifiable, emulsive and miscible all mean the same thing--a material that forms an emulsion when mixed with water. Now an emulsion is only a blend of two or more liquids which are not mutally soluble; a suspension of droplets of one liquid in another. There are two ways of making an emulsion. One is the brute force method of providing enough violent agitation to break the droplets down into smaller and smaller size; the other is to add a material known as an emulsifier to liquid and it does the job with a minimum of brute force. Now, the emulsifier imparts surface activity to mixture; it reduces the surface tension or skin effect between the liquids and they mix easily to yield a characteristic opaque mixture; i.e. they turn milky.

Spreader-stickers are exactly what the name implies; they make the spray solution wet the surface and they then form a film to stick the spray onto the surface. Wettable powders generally speaking, are the only sprays which will benefit from the addition of a spreader-sticker. If the spray deposit is a powder subject to erosion from leaf surfaces by action of rainfall or high winds the use of spreader-stickers can be beneficial.

There are certain restrictions put on solvents, emulsifiers and other surfactants. They cannot exhibit any tendency to harm the surfaces onto which they are sprayed. Injury is called phytotoxicity. Pesticides are subject to this evaluation even if they exhibit excellent control of insects, weeds or fungi; phytotoxic properties will keep them out of the market. Emulsifiers, spreaders and spreader-stickers are also subject to Food and Drug Administration approval if they are used on any crop that could conceivably enter the human food chain. To my knowledge all manufacturers of these type materials comply by selecting their raw materials from a list of "approved" ingredients.

Pesticides are used to control unwanted biological forms, and affect these forms by contacting them or having them contact the pesticide, in the cases of migrating insects or by providing an environment unsuitable for the growth of the organism, soil poisons, fumigants, fungicidal deposits on leaves or in the soil. Ideally, only an amount suitable to do the job should be used, but in practice excesses are used. It simply isn't economic to hunt for and treat only the weeds in a turf area so the whole area is "shorgunned" as it were. In the case of plant diseases, it's an impossibility to "rifle" the pest; you've got to protect everything in sight.

Weed control with 2,4-D, amine or low volatile type material is contact in nature; if you didn't contact the weed you won't kill it. Spraying weeds whose leaves are waxy or covered with fine hairs can be ineffective if the spray doesn't spread out on the leaf. Usually this calls for a surfactant or wetting agent. Excessive amounts of wetting agent allow too much run off so that a killing amount may not be left on the leaf. Use only that amount that gives visible drop flattening and spray only to runoff. It is probably better to have too little wetting agent than too much, since as the water evaporates out of the spray mixture the spreader stays behind and increases in strength until it eventually is high enough to allow the solution to wet the surface, and after that happens, the transfer of toxicant from the solution to the plant can begin. Insects like aphids for example take very small amounts of poison to kill them. Their waxy like outer surface prevents water solution from wetting them and they shed the solution like "water off a duck's back". A small amount of surfactant allows wetting to take place and control can occur, but only if the solution contacts the aphid.

It has been said that of the effects of the use of any economic poison nine-tenths can be credited to the proper application and one-tenth to the chemical used. Good equipment is essential to good results.

Read the labels carefully. I cannot emphasize this too much. Remember also, that all chemicals are poisonous to some degree; therefore, avoid exposure as much as possible. The life you save will be your own.

Recent Growth in Golf[1]

Buddie A. Johnson[2]

Golf continues to be one of the fastest growing sports in America. As more and more people have additional hours of leisure time to expend, this trend will continue.

Recent statistics released by the National Golf Foundation show how golf has grown in recent years. In 1945, just after the conclusion of World War II, the nations courses numbered 4808. By 1960, the figure had reached 6,385. The big golf boom of the 1960's is given credence by the rapid climb in the number of new golf facilities during that decade. By the end of 1970, we had a grand total of 10,188 golf courses.

During that period of rapid growth, Pacific Northwest States also climbed toward higher plateaus. The following figures indicate the startling expansion of these states:

	1960	1971	Increase
Idaho	37	59	22
Oregon	66	130	64
Washington	106	197	91

The National Golf Foundation uses a figure of 25,000 persons per 18-hole public golf course in determining feasibility for new golf courses. Of course, this figure must be moderated up or down, according to any given area and particular circumstances. Including private courses, in parentheses, the figures per population for Northwest States read:

Idaho (14)	18,338
Oregon (34)	23,142
Washington (65)	23,552

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[1]Paper presented at the 26th Annual Northwest Turfgrass Conference, Ocean Shores, Washington, Sept. 26-29, 1972.

[2]National Golf Foundation, 833 Curlew Road, Livermore, California 94550.

When one deducts the number of private courses from this average, the number of golf courses per 25,000 population becomes less favorable and would indicate the need for more golf facilities in the next decade to meet the needs of an expanding populace.

WHERE THESE GOLF COURSES WILL BE BUILT

As most everyone in the golf business knows, there have been major trends developing recently in golf course development. These trends are discussed below and show major changes being experienced by the entire industry as it becomes oriented to different types of golf facilities.

The Recreational-Residential Sub-Division - Perhaps this is the most dramatic change in the recent history of golf course development. On a national scale NGF studies are indicating that nearly half of all new golf courses under construction or in the planning stages will be connected with a real estate venture. With the rocketing costs of golf course construction this trend is natural. And land developers are recognizing that properly designed and constructed golf courses materially increase adjacent property values and substantially aid in the sale of home sites, condominiums and apartments.

Golf course home sites usually range in price from \$6,000 to \$15,000 depending on their size and proximity to the course. Waterfront sites are often priced at \$25,000 or more.

In retirement oriented Florida, 75% of the golf courses now under construction are associated with home sites and high rise condominiums. Arizona is running about 58% and California is over 60%. In the northwest, the situation is similar:

	Courses planned or under construction	Real Estate development
Idaho	23	15
Oregon	29	14
Washington	45	30

Experienced land developers are generally accepting the fact that an expertly designed and built golf course should be ready for play before the real estate sales are begun. The new golf courses are usually operated as daily fee facilities by the developers during the first few years of operation, but usually convert to non-equity private clubs after 5 years. In some instances, conflict and bitterness have surfaced because of broken promises by real estate developers and unfulfilled desires of homeowners.

As the number of recreational-residential complexes increases, developers will be pressed toward greater quality in their golf courses. In California, so many of these developments now dot the state that buyers are choosing those projects that offer excellent facilities and good management. Many of the poorly planned and constructed projects are now floundering, some in bankruptcy, and others plainly facing a much longer sell-out period than previously planned.

These projects will continue to flourish in the present decade. Those connected with such developments, however, should be prepared to face stern regulations now designed by planning commissions and zoning departments to ensure quality and proper growth in a given area. We are all sufficiently aware of the attendant environmental problems involved in development oriented golf courses.

<u>The Municipal Golf Course</u> - Perhaps the greatest crisis in golf course planning and construction lies in the realm of municipal golf. Presently, 45% of the nations 12 million golfers play on 13% of the nations golf courses! As concrete and asphalt continues to widen our metropolitan areas, golf courses are being forced to relocate or go out of business. Municipal governments are the only major owners of usable land within our cities and will be the only hope of the urban golfer for more courses.

Many cities are already caught with their "plans down". The city of Huntington Beach, California is a good example. Fifteen years ago, ample land was available within city limits for recreational purposes, but rapid increases in population density quickly dissolved that situation. Recently city officials attempted to find an area large enough for construction of a municipal golf course and were shocked to learn that the only site available was a mushroom growing and packaging enterprise near the city's center. The only thing that prohibited the purchase of this site for a golf facility was the price tag - $3.2 million.

Many cities are fast approaching this same situation. All cities with a population over 25,000 should make a survey of land needs for the next 25 years and make necessary purchases to insure that land will be available for the recreational needs of its citizens. Even though development costs of golf courses are rising rapidly (costs now range from $400,000 to over $1 million for golf courses) the major consideration for the future will be land.

Shorter Golf Courses - The Par-3 and Executive golf courses are becoming common-place. Related not only to land costs, investors are finding an expanding market for the short golf course. The reasons are obvious:

*A small area is required for this type of facility. Short courses require from 10 to 80 acres, depending on the type of project, as compared to 120-plus acres for a regulation 18-hole course.

*Shorter courses require a smaller outlay of cash for construction. A regulation course will cost $25,000 per hole and up, while short courses are often built for $5,000 to $10,000 per hole.

*Owners pay less for maintenance of the short course. One man can maintain a 9-hole par-3 course of 1,000 yards. Outlay for maintenance equipment is proportionately less.

*Shorter playing time is required, making it possible to reach a market not available to the regulation course where two hours or more are required to play a 9-hole regulation course. The impromptu player will be in abundance in areas of high density.

*The shorter playing time gives the short course operator more playing hours, especially if the course is lighted.

*Older golfers and women find the shorter course attractive with the need to strain for distance eliminated.

*The shorter course is easier for beginners and they will learn the game more quickly and enjoyably.

The shorter course not only includes the par-3 course, but we are finding an increasing number of Executive courses, a compromise between the par-3 and regulation course. This type of facility offers the same amenities of the par-3 with the added attraction of a few par-4 holes where the golfer can use a wood from the tee. The Executive course is especially popular with the real estate developer who wants the amenity of a golf course and a higher density of residential homesites.

All of these present trends in golf courses have key ramifications for golf course superintendents and professionals. Not only will different types of maintenance programs be needed, but a divergence will be more and more evident in the areas of responsibility. The superintendent will more frequently be responsible for areas other than the golf course and the golf professional will become more or less a golf director.

These changes will not all be welcome but as the song states, "The times, they are a-changing." No where will this be more evident than in the golf industry. Let's be ready for it.

An in-Depth Look at Ophiobolus Graminis[1]

R. James Cook[2]

INTRODUCTION

Ophiobolus graminis Sacc. (=Gaeumannomyces graminis (Sacc.) Arx & Olivier) holds the distinction of being among the first-recognized and most intensively-studied of all soilborne plant parasitic fungi. Its discovery, description, and name date back to Saccardo, in 1875, who found the fungus causing a basal culm rot on a species of Agropyron in northern Italy (18). Originally, he proposed the name Rhaphidophora graminis, but in 1881, he renamed it Ophiobolus graminis (19). Walker (26) has reviewed the earlier records and suggests that this fungus may have been recognized as early as 1852. In 1890 Prillieux and Delacroix (17) reported a serious disease of wheat in France which they described as caused by Saccardo's fungus, O. graminis. Since then, this fungus has had major impact on the culture of grasses and cereal grains all over the world, and on the science of plant pathology.

At first, Ophiobolus graminis was known primarily for its ability to kill wheat and barley. Farmers in England and Europe undoubtedly learned the hard lesson early that these grain crop could not be safely grown consecutively in the same field for more than two years. Names such as "black foot rot", "white heads disease", and more commonly "take-all" came into use for the disease that developed in monoculture wheat. In the USA, the disease is believed to have been a problem already in colonial times (24). It was recorded in the Pacific Northwest on wheat in 1901, by Cordley (7), at Albany, Oregon. Sprague (24) believed the fungus to be native in the Northwest since he found it on grasses in virgin soils in the coast range of Oregon, and

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[1]Paper presented at the 26th Annual Northwest Turfgrass Conference, Ocean Shores, Washington, Sept. 26-29, 1972.

[2]Research Plant Pathologist, Regional Cereal Disease Research Laboratory, Agricultural Research Service, U. S. Department of Agriculture, Pullman, Washington 99163

in the Siskiyou Mountains in Oregon.

Take-all came under very intensive study throughout the world between 1900 and 1940, as it grew in importance with expanded wheat production. Famous cereal pathologists such as Hurly Fellows, H. H. McKinney and Roderick Sprague in the U. S., A. W. Henry and R. C. Russell in Canada, S. D. Garrett in Australia and later England, Mary Glynne at Rothamsted in England, and A. W. Winter in Germany made great contributions through their research on this fungus. Garrett went on to write four books on the biology of root disease fungi, and laid much of the foundation for modern root disease studies. The result has been a compilation of more research papers on *Ophiobolus graminis* than probably any other soilborne fungus. As control measures were worked out for those times, research programs were gradually terminated. Ironically, *O. graminis* is again causing economic and aesthetic loss in many areas of the world, including the Pacific Northwest. As we examine the circumstances surrounding these new outbreaks, most are explicable in terms of the earlier scientific information. Nevertheless, this is of little comfort to managers and growers confronted with an epiphytotic of *Ophiobolus*. Moreover, some of the controls worked out initially are not entirely applicable today. The time has again come to take an in-depth look at *O. graminis*.

HOST RANGE AND PATHOGENIC SPECIALIZATION

Ophiobolus graminis is world-wide in distribution, as a parasite on most, if not all, species of grasses. In most cases, the fungi making up this taxonomic group cause little or no apparent damage to their host. However, at least three strains are highly pathogenic on important grasses, and thus are known for their economic importance. One variety, *avenae* (25) is highly pathogenic to oats and bentgrass as well as wheat, barley and many other grasses. It causes the *Ophiobolus*-patch disease of turf (12,23). Another strain, only recently named var. *tritici* (26), causes the severe take-all of wheat but apparently is not pathogenic to oats or bentgrass. The third and only other recognized strain is var. *graminis* which apparently is the cause of brown sheath rot of rice (26). This strain has been known as *O. oryzinus* and it rather than the wheat take-all fungus may have been the fungus originally described as O. graminis by Saccardo (26). The taxonomy and nomenclature within this species will undoubtedly be subject to careful scrutiny and change for years to come. Fortunately for control there is no evidence of strain specialization in terms of ecology and survival. The species seem to be a close-knit group ecologically, and thus information on management of one will generally apply to management of the other.

The name Gaeumannomyces graminis was erected in 1952 by Arx and Olivier to replace O. graminis (1). They correctly made this transfer on the basis that those types associated with cereals and grasses are significantly different from an Ophiobolus as represented by the type species, O. disseminans, described by Riess in 1852. A true Ophiobolus belongs in the Pleosporales because of bitunicate asci, whereas the cereal and grass parasites have unitunicate asci and belong in the Diaporthales. In general, however, pathologists continue to apply Ophiobolus because of its long standing usage. This paper will also use the more familiar name.

LIFE CYCLE

Survival and infection. -- Ophiobolus graminis persists from year to year in soil as vegetative mycelium in host debris (inoculum). Occupancy of the debris generally traces back to parasitic activities of the fungus while the tissues were still part of a living host. The fungus is a very weak competitive saprophyte and apparently does not invade organic matter buried in soil, nor does it ramify as mycelium through soil in search of a host. Instead, the fungus expends its energy during survival maintaining possession of the parasitically colonized tissues. New infections occur on roots or stolons, as, by random chance, they grow in contact with decaying infested tissues. The fungus grows into the tissues and the disease cycle begins.

The infection process starts with extensive superficial growth over a small area (infection court) on the host. The hyphae during this phase are large, dark brown, and often loosely intertwined into rope-like strands. Known as "runner hyphae" they can be seen with a 10x hand lense and are used in the field to confirm diagnosis. Colorless (hyaline) thin-walled microhyphae emerge from short branches off runner hyphae and penetrate deep into the host tissues.

The lesion grows both up and down the root stem, or stolon, following spread of the runner hyphae. The fungus spreads up the culm, generally beneath the leaf sheath, and death of the plant usually occurs shortly thereafter. A layer of mycelium develops over the stem base (base plate mycelium) and beneath the sheath making the stem appear black. The dead plant returned to the soil completes the disease cycle.

Spread within a field or lawn area is dependent on actual contact between plants. In this way, the fungus grows directly from one plant to another and avoids the competitive and other antagonistic effects of soil. This explains why the disease pattern is generally in patches; the fungus spreads radially outward in circular fashion, with plants at the extreme outer margin being the most recently infected.

Sexual reproduction and dissemination. -- Black, flask-shaped, beaked perithecia of this fungus form on the grass stems beneath the leaf sheaths under cool moist conditions. Their beaked feature allows the perithecium to protrude through the leaf sheaths, placing the opening (ostiole) into air slightly away from the plant surface. The ascospores are long and slender, and at maturity may be forceably ejected from within the perithecium into air currents above the plant, thereby constituting a form of airborne inoculum. Rains or heavy dew are generally required to soak the perithecium and trigger the ejection mechanism.

There has been considerable controversy over whether ascospores can serve as inoculum for this fungus in the field. Garrett (8) showed in Australia that they were infectious only in sterile soil and were easily inhibited by soil microorganisms. Brooks (2) showed that infection could take place only if the root or other infection court was above ground and relatively free of other organisms. In Polder soils (soils reclaimed from the sea by dikes) of Holland, Gerlagh (9) has clearly shown that ascospores produced on grasses along the dikes disseminate *O. graminis*. There is virtually no other suitable explanation for the appearance of scattered patches of disease in the new fields. The soil is probably low in microbial antagonism during the first crop or two, and thus would not prevent ascospore infection. A similar situation probably exists for *Ophiobolus* patch in turf; soil fumigation, although done for weed control, probably reduces the microbiotia below a level necessary to inhibit ascospore infection. The random scattering of patches is certainly indicative of airborne inoculum. Perhaps a mild fungicide applied during the first year or two following the establishment of turf on fumigated soil would provide protection against ascospores until an adequate microbiota could reestablish.

Possible asexual reproduction. -- Numerous workers have observed a possible conidial stage for *Ophiobolus graminis*, characterized by tiny, colorless, one-celled spores produced from phialades, and identical with or very similar to a corn root parasite, *Phialophora radicicola* (3, 15, 16, 21). The two fungi apparently are similar in cultural appearance on agar media. If *P. radicicola* and *O. graminis* prove to be separate stages of but one fungus, the asexual stage must be recognized as of possible significance in dissemination and infection. A *Phialophora* stage is suited to formation under moist conditions and the spores are disseminated by water. This would then provide not only a soil and air dispersal phase, but also a water splash phase.

MANAGEMENT BY ROTATION

In cereal grains, the alternation of wheat or barley crops with nonsusceptible crops has been a very effective control. This method was probably discovered first by farmers, but has been reinforced by research information. In essence, the inability of *O. graminis* to retain possession of the residue for long periods results in an ongoing and quite rapid attrition rate for this fungus in soil. Unless a new host is provided regularly and frequently, the population quickly drops to insignificant levels, although it is probably not eliminated. Unfortunately the method cannot be used by all wheat farmers, e.g. those who for economic or geographical reasons do not rotate. Moreover, this method is obviously of no value in turf management where rotation is impossible.

MANAGEMENT THROUGH FERTILIZATION PRACTICES

Applications of ammonium sulfate will greatly reduce damage from *O. graminis*, both in turf and in wheat. Smith (23) noted the benefit of this form of nitrogen fertilizer against *Ophiobolus* patch on turf and bowling greens in England in 1956, and it has also been noted by Gould et al.

(12) for turf in western Washington. The effect was first recognized with certainty in wheat in 1968 by Huber et al. (14), working in southern Idaho although hints of the suppressive nature of this and other ammonium forms of nitrogen can now be inferred from much earlier work (22). Of particular significance in the findings of Huber et al. (14) was that nitrate-N has an opposite effect, i.e., it increases take-all. Their observations provided the ground work for our studies (22) on the mechanism by which ammonium-N suppresses *O. graminis*.

Ammonium-N reduces soil pH in contrast to nitrate-N which raises it. *Ophiobolus* prefers an alkaline environment and grows slowly or not at all at pH values below 4.5-5.0. When lime was added to either Puyallup or Ritzville soil in pots, or in field plots at the respective locations, the suppressive effect of ammonium-N was negated. Thus, when the pH was prevented from dropping (as confirmed by pH test), disease was severe even though the ammonium-N by chemical analysis was the dominant form of N in the soil. In short, we believe the form of nitrogen effect is actually a highly significant pH effect.

The failure to recognize a pH effect in earlier root disease studies with nitrogen can probably be attributed to the methods of examination. Typically soil from the bulk mass has been used for the determination. In our studies, the significant pH changes occurred on or very near the root itself, where the runner hyphae were. Changes were not always detectable in bulk soil collected from the tillage layer at large. Up to two full units difference existed in pH of the root zone (pH_r) depending on whether ammonium or nitrate nitrogen was used, and the correlation between pH_r and take-all severity was highly significant (22).

The study further indicated that magnitude of pH change rather than actual pH may be the important factor. For example, the Ritzville soil is normally at pH 7.5, a pH_r drop to 5.5 virtually controlled take-all. The Puyallup soil is normally at pH 5.5 and as such is highly favorable to *O. graminis*. A pH_r drop of at least 1 unit, to 4.5, was necessary to suppress take-all in that soil. Goss and Gould (11) reported a weak correlation between severity of *Ophiobolus* patch and soil pH, but re-evaluation of their data (22) similarly indicates that their best correlation is between change in numbers of patches over a 4-year period vs. change in soil pH. Presumably, the greater the magnitude of pH shift the greater the impact of that shift on the established biological balance of which Ophiobolus is a part. Ammonium sulfate is thus useful in manipulating the microenvironment of an infection court, thereby suppressing O. graminis.

Phosphorus and potassium are also important in disease development, but not to the extent noted for nitrogen. Good well balanced nutrition is always important in maintaining maximal host resistance, and any deviation from good fertility expands the risk for increased disease.

MANAGEMENT THROUGH IRRIGATION PRACTICES

Ophiobolus graminis is characteristically most severe in wet seasons or with heavy irrigation. In the Pacific Northwest, for example, take-all east of the Cascade mountains is largely confined to the irrigation districts of the Columbia Basin and Southern Idaho (4). The fungus has a relatively high water requirement and virtually ceases growth if the water potential of its environment drops below -45 to -50 bars (about 97% RH) (6). We now know (5) that wheat tissues in our dryland areas may reach -30 to -40 bars water potential before maturity. This is undoubtedly suppressive to O. graminis. Turf with symptoms of moisture stress may similarly be too dry for mycelial spread of this pathogen, although actual measurements are yet to be made. Although stressing the grass for water is hardly a suitable control for Ophiobolus patch, nevertheless, a more conservative watering program at the proper time might be valuable in combination with other management practices to limit the disease.

BIOLOGICAL CONTROL

The naturally-occurring saprophytic organisms in soil are probably the least exploited but most promising tools available in our arsenal of weapons to suppress Ophiobolus graminis. For years, research workers have noted the extreme sensitivity of this fungus to other soil organisms. The failure of ascospores to infect in other than a near-sterile environment is but one of the many examples. The control with ammonium nitrogen works best in nonsterile soil, indicating that even here biological agents are involved (22). We have postulated that control below 4.5 to 5.0 is probably direct on the fungus, since it cannot grow below this pH range, but that control in the range 5.0 to 7.0 may be indirect, and operative through antagonistic microorganisms. Likewise with temperature, Henry (13) showed that take-all development in sterile soil was uniformly optimal over the range, 18-28°C, but that in nonsterile soil disease was progressively less at temperatures above 18°C. He postulated that amore active soil microflora limited _O. graminis_ at the higher temperatures. We also suspect that the restrictive effects of reduced water potential on growth of this fungus in nonsterile soil may likewise relate, in part, to action of soil microorganisms.

In each case of environmental influence, it would appear that a slightly unfavorable environment (i.e. pH, temperature or water potential) places _O. graminis_ at sufficient disadvantage in competition that the impact on disease is disproportionately large for the magnitude of change. Apparently, we need only to achieve partial suppression of _O. graminis_ with adverse environment, and if the proper flora are present, they will finish the task.

There is mounting evidence that a specific flora may develop in the presence of _O. graminis_, or the diseased tissues themselves that will eventually suppress the fungus and bring about nearly complete control. In wheat, the phenomenon is known as "take-all decline" (10) and results when the crop is grown continuously on the same land year after year. Usually four or more years are required. The fungus does not disappear, but rather, its ability to cause severe disease is reduced. The effect apparently occurs in _Ophiobolus_ patch of turf as well, as evidenced by the gradual disappearance of patches with time (23).

The question arises of whether the fairy-ring pattern of _Ophiobolus_ patch may reflect action of a specific antagonistic microflora. The greening up of the centers of _Ophiobolus_ patch due to establishment of _Poa annua_ and certain other grasses and dicots, may be due to their greater resistance to _O. graminis_ var _avenae_ as suggested (12,23), but may also be due to increased microbial antagonism there. In studies of _Phymatotrichum_ root rot of alfalfa, also characterized by fairy-ring-like patterns, King (15) spaded up the center of a patch and proved that alfalfa would again establish there, and remain healthy. Perhaps P. annua and the other grasses establish in preference to Agrostis species in the centers of patches by virtue of a more competitive nature with Ophiobolus having come under dominance of the antagonism.

With many of the Ophiobolus epiphytotics, the soil because of treatment or history, has a very minimal microbiotia. The cases of severe take-all in wheat in the Dutch Polders, and Ophiobolus patch of turf in fumigated soil are good examples. In some cases, turf is established on exposed subsoil created by recent construction activities, and which is also devoid of many organisms. With northwest irrigated wheat in addition to the ideal soil moisture situation, the land itself is recently reclaimed from the desert sagebrush vegetation and initially has a very low level of antagonism. Both the Dutch Polders soils (9) and the Northwest irrigated desert soils (20) eventually acquire a highly effective antagonism, where wheat is grown continuously, but sometimes not until severe economic loss has occurred. Studies are now underway at several locations around the world to isolate the antagonism and thereby put it to better use.

Our studies on the antagonism (20) have concentrated primarily on methods of detection and transmission. We now have a simple greenhouse technique to categorize soils as to antagonistic or non-antagonistic properties. It consists of amending a fumigated soil with 1 or 10% test soil, then introducing artificial inoculum of O. graminis and planting wheat. The wheat remains relatively healthy if the test soil is antagonistic, but shows progressively more black stem decay, stunting, and leaf chlorosis with progressively less-antagonistic soils. In a heat treatment study (20), and using the above method to test for antagonism, the factor(s) was eliminated at 140°F steam-air mixture, a fairly cool sterilization temperature. This suggests that the antagonistic factor may be fungal or certain non-spore forming bacteria known to be sensitive to 140°F. Studies in Holland indicate that certain saprophytic fungi may be involved. Considerably more work is needed to pinpoint the nature of the agent involved.

In the field, we have successfully reestablished antagonism to take-all at Lind and Puyallup, by rotovating small (0.5 to 1.0% by weight) amounts of antagonistic soil into fumigated plots (20). One soil from a field near Quincy, Washington and cropped 12 consecutive years to irrigated wheat has proven very antagonistic in our field and greenhouse tests. Some disease suppression (compared to virgin soil checks) was evident already in the first wheat crop sown after the amendment, but the real benefits of the amendment were not apparent until this year, in the second wheat crop. With no additional treatment and with a uniform level of natural inoculum, the second wheat crop was of normal height and was almost entirely disease free based on root inspections, to the edges of each of the four plots (four reps) where the Quincy wheat field soil had been placed 18 months earlier. This is encouraging because it suggests that use of the agent may be possible on a field or plot scale basis long before identity of the factor is known. This work is being continued in hopes that biological control of *Ophiobolus graminis* may someday be possible in both wheat and turf.

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The European Crane Fly-[1] *The Situation and potential in the Northwest*

G. R. Pesho[2]

The European crane fly, Tipula paludosa Meigen, is native to northwestern Europe where it is a pest of lawns, pastures, vegetable and grain crops. The first North American record of this insect was in 1955 on Cape Breton Island, Nova Scotia. In 1965 established larval infestations of lawns were found in the eastern outskirts of Vancouver, British Columbia, and this insect has continued to spread through the Fraser Valley (Wilkinson and MacCarthy 1967). Although adults were collected near the Washington-Canada border in 1966, the first larval infestation in the United States was confirmed in April, 1970, when larvae were found at and near Blaine in Whatcom County, Washington. At this time emergency plant quarantine regulations were imposed by U. S. Department of Agriculture, Washington and Canadian regulatory agencies.

The European crane fly is a member of the insect family Tipulidae which is a large family consisting of about 300 genera and more than 8500 species. Species of this family occur throughout the world but are most numerous in the temperate regions. The adults commonly are called crane flies and look like giant mosquitos. Because of their tough, leathery integument or skin, the larvae are called "leather-jackets." Larvae of various species of crane flies may be aquatic or terrestrial, and most of the terrestrial species are found in damp habitats. At least 13 species are known in western Washington, and the European crane fly is easily confused with 3 or 4 of the native species.

The biology of this insect has been studied extensively by European workers and more recently by Canadian workers.

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[1]Paper presented at the 26th Annual Northwest Turfgrass Conference, Ocean Shores, Washington, Sept. 26-29, 1972.

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In general, the habits and life cycle of the insect in Europe and North America are similar. In British Columbia and Washington one generation per year has been observed. In British Columbia the adults emerge from the pupal cases in the soil soon after sunset in mid July through September. However, in Washington, evidence has accumulated that adult emergence occurs during the early morning hours. They mate immediately after emergence, and most of the eggs are laid before daylight. The female lays 250-300 eggs in small batches of 5-6 eggs in the vicinity of the area from which she emerged. However, the female is capable of extended flight, and it is possible that a given female could lay her eggs several miles from the spot where she emerged. The slow spread of this insect to new areas indicates that it widens its geographic range steadily over short distances rather than in dramatic jumps of several miles. Egg laying is completed within 32 hours after adult emergence (Coulson 1962). The black, shiny eggs are laid at night on or very close to the soil surface. The eggs require high moisture, and it has been reported (Laughlin 1958) that the eggs will collapse within 2-4 minutes in less than 100% relative humidity.

Within two weeks the eggs hatch into grey, legless larvae or leatherjackets. Larval feeding is continuous through fall and warm winter periods. The larvae feed voraciously during the spring and grow to their full size of about 1-1/4 inches by April or mid May. Because of food demands associated with rapid larval growth, most damage occurs in March, April and May. The larvae do little or no feeding after reaching full size and enter a quiescent period following which they may pupate as early as July. However, climatic conditions may modify this timing considerably; for example, pupation this year occurred in August rather than July. Pupation occurs in the soil where the brown spiny pupae remain for about two weeks before wriggling to the soil surface where the adults emerge and leave the empty pupal cases protruding from the soil.

European workers have concluded this pest is favored by mild winters, cool summers and rainfall averaging at least 24 inches per year. Thus, the maritime climate of the wet, coastal belt of British Columbia, western Washington, western Oregon and northern California presents favorable conditions for the insect. The high moisture requirements of the eggs indicate that rainfall and relative humidity during the egg laying period are important factors limiting successful egg hatch. Canadian workers believe that establishment of the insect in areas outside the wet coastal belt would depend upon rainfall during the period from June through September. However, heavy irrigation schedules in otherwise dry areas could permit establishment. Because of rainfall patterns, they believe there should be a reduced probability of establishment in other parts of western Washington and in the Willamette Valley of Oregon. The effect of winter low temperatures in North America is uncertain because in some areas of Europe where high populations of the crane fly occur, it is not uncommon to have winter temperatures as low as -6 degrees Fahrenheit.

To date, no infestations of the European crane fly have been reported from Oregon and California. In Washington larval infestations have been confirmed as far as three miles east of Sumas in Whatcom County and as far south as Mount Vernon in Skagit County. Adults have been collected on Lummi and Orcas Islands. Compared with some introduced insect pests the crane fly has spread very slowly in the United States. About 20 males were collected in light traps in Mount Vernon, Washington, in the fall of 1969, but larval infestations at this location were not confirmed until 1972.

In British Columbia and Washington most damage from larval feeding has been to lawn and pasture grasses, but ornamentals and vegetable crops in home gardens also have been damaged. An associated problem is the nuisance resulting from concentrations of adults at lights in homes, motels and other public accomodations during the period of adult emergence.

At present, it is recommended that control practices be applied if the average number of larvae per square foot of lawn is 20 or more (Pennell 1971). Application of insecticides to control the leatherjackets is best done in the fall (October), after the eggs have been hatched, or in the spring. Fall applications of insecticides are not recommended unless leatherjacket damage occurred the previous spring or a large number of crane flies was observed in a particular area in August and September. The presence of leatherjackets in the soil can be detected by washing soil samples. Irritant chemicals which cause the leatherjackets to come to the soil surface have been used, but these are often of questionable accuracy.

Consistently successful biological control of the European crane fly in Europe has not been achieved. The most effective insect parasite reported from Europe is Siphona geniculata DeGeer, a small fly belonging to the family Tachinidae. The Canada Agriculture Department is attempting to establish this parasite in British Columbia. Although virus and fungal diseases and scavenger and parasitic nematodes infecting leatherjackets have been reported in Europe, none of these has given consistent control. Larval predation by European starlings, other birds, and moles in Europe also has been reported; although these agents intermittently have reduced leatherjacket populations, they are not reliable control agents. There are cultural practices which can reduce larval populations, but these practices, other than provisions for adequate land drainage, apply to agricultural crops and are not feasible for controlling the insect in permanent stands of lawn and turfgrasses.

The lack of reliable biological control agents which can provide effective long term control of the European crane fly presents the serious problem of avoiding environmental contamination if the insect becomes established in large population centers such as Seattle and environs. In an attempt to provide solutions to this problem, the Washington Agricultural Experiment Station and the U. S. Department of Agriculture are undertaking cooperative research efforts. These efforts involve cooperative work by agronomists, entomologists and other research scientists of both agencies. Our work is multi-faceted and involves searches for effective biological control agents, accumulation of detailed knowledge about the biology of the insect, and intensive studies of the relation of the insect to given host plants and habitats. For instance, experience has shown that well managed lawns seem to have excellent recovery abilities. As part of an effort to determine the relationship between the insect and various grass hosts, irrigated and non-irrigated research plots of pasture and turfgrasses have been planted on land made available to us by the U. S. Air Force at the Blaine Air Force Station near Blaine, Washington. Using these plots we intend to define more precisely the economic threshold of the insect in grasses and the effect of management practices on the stability and composition of stands of different varieties of turf and pasture grasses under repeated attack by the insect. If we find that the grass varieties commonly used in western Washington are susceptible to the crane fly, we will begin a search for resistant grass genotypes.

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Mowing Characteristics of Turfgrass

J. R. Watson [2]

To be suitable for the production of turf, a grass plant must be able to grow and persist under the environment to which it is subjected. For in the final analysis, good turfgrass is judged and accepted by standards of playability and usability as the case may be. And, unless a grass is able to survive under the type of maintenance demanded by players and users, it must be replaced or the maintenance practices to which it is subjected must be modified. Otherwise, use must be restricted. For those concerned with the production of turfgrass, restriction of use always should be considered a last resort. The primary objective of the supervisor is to produce high quality turfgrass suitable for the use or play at the time it is needed--irrespective of environmental adversity.

More often than not, practices which are desirable for good grass growth have to be modified extensively to meet turfgrass requirements for use or play. Such is the case with mowing practices. Height of cut on a putting green may serve to illustrate this point. The reduction in root growth that clipping to a height of 3/16 to 1/4 inch produces is well known -- but try and convince a golfer that the green should be cut at a height of 1/2 to 1 inch! To compensate for the reduction in root growth, all other maintenance practices - fertilizing, watering, cultivating and programs of disease, insect and weed control -- must be balanced one against the other and applied more intensively and with greater care.

Management practices, including mowing, must be keyed to the use for which the turfgrass area is being produced. Such severely limits the number of grasses that may be used to produce satisfactory turfgrass -- only a few (25-30) out of the more than 1,100 species known to grow in the

[1] Paper presented at the 26th Annual Northwest Turfgrass Conference, Ocean Shores, Washington, Sept. 26-29, 1972.

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United States. In view of the limitation that mowing places on selection of grass and intensity of management it may be well to ask, "Why mow"?

Why mow? Appearance and playability are the principle reasons for mowing turfgrass. And, with the advent of color telecasting, appearance and grooming have become very important considerations from the standpoint of spectator appeal. Unless it is mowed, a turfgrass area would soon become like an overgrown pasture -- an area covered with loose growing, spindly grasses and tall, rank weeds. These plants do not persist under normal mowing practices. The manner in which turfgrass is mowed will greatly influence its health, vigor, density, degree of weed invasion and longevity. In fact, good mowing practices are perhaps the most important factor contributing to a well groomed appearance and the longevity of any turfgrass area.

The development of good mowing practices from an agronomic standpoint must be based on an understanding of growth habits and characteristics of grasses. Also, an understanding of how these practices relate to the suitability of a particular species, or blend, for the level of maintenance prevailing on a given turf facility plays a key role in grooming of the site.

GROWTH HABITS AND CHARACTERISTICS

Growth Types - On the basis of growth type, grasses may be classified into three general groups:

1. Bunch type grasses, such as ryegrass and chewings fescue. These species produce new shoots and tillers which grow inside the sheaths of the previous stem growth.

2. Stoloniferous grasses, such as bentgrass. These spread by runners or stolons which develop from shoots that push through the sheath and run along the surface of the ground. They will root at the nodes (joints).

3. Rhizomatous types like Kentucky bluegrass spread and increase in density as a result of the shoots which develop from the nodes (joints) of these

underground stems.

Some grasses, like bermudagrass and Zoysia, spread by both rhizomes and stolons. This is one reason why bermudagrass is such a vigorous grower and why it is so difficult to control and keep out of flower beds, gravel walks and similar areas. It also accounts, in part, for the excellent wear resistance of bermudagrasses and Zoysia. There are also intermediate types of grass with decumbent stems which often root at the nodes. Examples are crabgrass and nimblewill.

Leaf Shape - The grass leaf is remarkably adapted for intercepting a maximum of sun rays which are essential for photosynthesis. The long flattened grass blades provide a maximum of exposure with a minimum amount of protoplasm, thus making efficient use of the living tissue. A reduction in the plant leaf area exposed to sunlight reduces the plant's capacity to carry on photosynthetic activity. This is a vital and basic consideration in determining the frequency and height of cut of turfgrasses.

Meristematic Area - The ability of grasses to withstand frequent and relatively close cutting is related to certain peculiarities unique to the grass family. Grasses exhibit basal growth, as opposed to terminal growth found in most other plants. Basal growth means simply that growth initiates in the crown and at the base rather than at the tip of the blade or stem. From a practical standpoint this means that normal and frequent mowing does not cut off or remove the growing areas of the grass leaf. Removal of too much leaf surface at any one cutting may, however destroy some of the growing points.

Height of Cut - The height at which a given perennial grass can be cut and still survive for extended periods is directly related to its ability to produce sufficient leaf surface for the photosynthetic activity required for its growth. Basically, this ability is related to the inherent type and habit of growth found in the particular species or cultivar of grass. The length of internodes, the number of stolons or rhizomes, and the number of basal buds all influence the amount of leaf mass produced by a given grass; hence, affect its ability to withstand low heights of cut.

In general, creeping type plants, such as bentgrass and bermudagrass, when properly fertilized and watered, are able to produce adequate leaf surface at very low heights of cut (3/16 inch). Buffalograss, although a creeper, cannot produce sufficient leaf mass when cut at low heights because too few basal buds exist and, therefore, it cannot withstand low clipping. For this same reason, Kentucky bluegrass and fescue must be cut relatively high (1 - 1 1/2 inches). If bunch type grasses are cut close continually, too much leaf surface will be removed and the plant can no longer carry on sufficient photosynthetic activity to sustain satisfactory growth.

As indicated, these characteristics apply in general to the species mentioned. There are, of course, differences within the species. And, it is worthwhile to note that a number of bluegrass and ryegrass cultivars respond in a different manner; i.e., the improved cultivars of bluegrass are tolerant of a lower height of cut and improved cultivars of ryegrass persist for longer periods of time. In addition, some of the "new" ryegrasses display "cutting" characteristics comparable to, for example, those of bluegrasses.

Frequency of Cut - Frequency of mowing is also an important consideration in the maintenance program. Infrequent clipping allows the grass to elongate to such a degree that any subsequent clipping removes an excessive amount of leaf surface. At no time should clipping amounts in excess of one-third of the total leaf surface be removed at a given mowing on lawns. Removal of large amounts of leaf surface will produce stubbly, unsightly turf, cause excessive graying or browning of the leaf tips, and curtail the photosynthetic production of food with a resultant depletion of root reserves.

It should be noted that Dr. John Madison has shown an increase in clipping yield up to a 15-day mowing interval on Highland and Seaside bents and on Alta fescue. Vigor was greater with the longer mowing interval; however, he points out that improved vigor resulting from longer mowing intervals is incompatible with requirements for most games.

In addition, the accumulation of excessive clippings may smother the grass and provide excellent environmental conditions for disease organisms and insects. The frequency of clippings for a given facility must be governed by the amount of growth. In turn, this is a response to weather conditions, season of the year, soil fertility, moisture conditions, and the natural growth rate of the grasses. And, most important, frequency of clipping is a direct function of the requirements for play or use of the given facility.

OTHER CONSIDERATIONS

In addition to the mowing practices related directly to habit of growth and use, there are other considerations that must be taken into account when developing a sound mowing program.

Fiber Content - The toughness and wear resistance as well as resistance to mowing is related, in part, to the fiber content of the grass leaf. Thus, tall fescue, red fescue, Zoysia, and some bermudas and ryegrasses are more "tough" and wear resistant than less fiberous grasses like bent or Kentucky bluegrass.

This toughness translates into a higher power requirement for mowing equipment. And, most importantly, necessitates keeping the cutting edges sharp and the mower in a good state of adjustment. Otherwise, the leaf tips become frayed, turn gray, then brown. Thus giving the turf facility a poorly groomed appearance. In addition to being unsightly, these frayed, mutilated tips provide a ready entrance for disease producing organisms.

Ryegrass, until recent years, was not a favored species, in part, because of this characteristic. However, most of the newer selections like Pennfine, Pelo, NK 100, Manhattan and others have been selected for, among other factors, their mowing characteristics. They cut more clean and do not fray as badly.

State of Growth - The stage of growth of turfgrass plays a major role in mowing practices. Young tender growth in the spring is generally soft and succulent. The moisture content of young immature turfgrass is much higher than that of mature grass. Likewise, the fiber content of young grass is much lower than that of mature grass. Such a condition influences mowing practices. Tender young grass must be cut with a sharp, well adjusted mower to avoid mechanical damage, and the early growth must be cut frequently to avoid the problems associated with high moisture.

Mowing practices during the early stages of growth exert a material influence on density of turfgrass. Cutting at heights somewhat lower than normal during early spring will encourage lateral growth which, in turn, promotes density and helps prevent weed invasions.

Washboard effect - Turfgrass areas regularly cut with power mowers or gang mowers sometimes develop a series of wave-like ridges running at right angles to the direction of mowing. (Similar to the washboarding or corrugating of a gravel road.) If such is not caused by too wide a frequency of clip, it may be prevented or partially remedied by regularly changing the direction of mowing (diagonal or right angles). If "clip" is responsible, the height of cut must be raised or the mower replaced with a unit having more blades or a faster reel speed.

A very similar washboard appearance is often observed on turf areas, but is no fault of the mowing equipment or the operator. Many times land is plowed or disked for seedbed preparation and not properly leveled or graded prior to seeding. Settling then takes place in the furrows and unevenness develops. Such a situation may be avoided by the use of specialized bed preparation and seeding equipment; or, reduced in severity over a period of years by heavy aeration followed by dragging. The dragging operation generally will remove most of the soil cores from the high areas and deposit them in the low areas.

Wet Conditions - Mowing wet grass should be avoided as much as possible, although available labor and time often make it impractical to do so. Dry grass cuts more easily than wet grass; and, it does not ball up and clog the mower as does wet grass. Most important, if grass is cut when dry, the lawn will appear to be better groomed. Also, timing tests show that mowing dry grass requires less time than mowing wet grass.

Uneven Terrain - Mowers are not built for grading purposes. Turf areas containing high areas which are continually scalped should be regraded in order that they may be cut properly and so that there will be a reduction in wear and an elimination of possible damage to mowing equipment.

Inadequate insect control may become a serious mowing problem. Areas heavily infested with earthworms or ants may have many soil mounds caused by their activity. Such may cause soil to build up on rollers, or in severe cases simply cause the cutting units to bounce. Both situations result in an uneven cut. Mounds of earth thrown up by gophers and other soil burrowing animals also will have the same results.

Improper operation - Irregular or uneven cutting often occurs due to bouncing of the mowing units when they are pulled at excessive speeds. On specialized area such as putting greens, bowling greens, lawn tennis, etc., improper handling of the mower on turns will result in turf damage through bruising and wearing of the grass.

Terraces and Banks.- Terraces and banks offer a difficult mowing problem. Scalping generally will occur if the bank or terrace is mowed across the slope. Up and down mowing generally is the most satisfactory method of cutting these areas.

SUMMARY

Mowing is not a simple operation to be regarded merely as a means of removing excess growth. Mowing practices are related to the species and the strain or cultivar of turfgrass being grown. They must be based upon the inherent physiological, anatomical and morphological characteristics of a given grass. These characteristics, in turn, will determine the height and frequency of mowing that will give the most satisfactory performance from a use standpoint. Mowing is one of the more time consuming of all management practices and has far reaching affects on the appearance and longevity of any turfgrass area. With the advent of color telecasting it has become a most important consideration and factor in regard to spectator appeal.

Turf Free of Poa Annua[1]

Dr. W. H. Daniel[2]

Progress with weed control has given weed-free turf in many instances. We expect the lawn to be free of broadleaves, clover and weedy grasses; thus to have monocultures of selected species available for specialty uses. The broadleaves keep germinating, but annual or less frequent treatments have relegated these to nuisance and maintenance values.

Currently the mixing of 2,4-D, MCPP and Dicamba gives selective kill of most broadleaf and viney weeds. Where possible, I prefer mid-fall applications of these so that the area starts the spring with no weeds present. The heavier the weed infestation the earlier the treatment should be so that grasses can recover and fill in during the favorable fall growth period.

Each weed has its time of germination - clover is in early spring, dandelion in mid-summer, which will reinfest if there is opportunity, such as wet weather, open space, or lack of competition. But, the program of control becomes one of maintenance procedures.

Grassy Weeds

The grassy weeds present a different picture. In much of the U. S. homeowners used to "cry" about crabgrass, and assume there was no hope; thus, appeals to use fertilizer, to put in irrigation systems, to buy new varieties secured limited interest.

With the advent of crabgrass killers during the 50's, then the supplanting of the crabgrass preventers during the early 60's, now many homeowners prevent crabgrass competition (as well as foxtail, barnyardgrass, etc); thus permitting

[1]Paper presented at the 26th Annual Northwest Turfgrass Conference, Ocean Shores, Washington, Sept. 26-29, 1972.

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the desired perennial grass to be free of the infestation and competition. When this occurred, all of a sudden home-owners were interested in new varieties, slow release fertilizers, automatic irrigation, vertical grooming and other good turf care techniques.

Poa annua

Among the professional turf managers the scourge of *Poa annua* continues to be No. 1 in concern. It is, of course, a weed in cool, humid areas of the world. It is believed to be a weedy grass in every county of every state in the U. S. at some time of year under some conditions. Fortunately or unfortunately, it has been both friend and foe. It can be the most perfect turf imaginable, or the most complete failure possible.

Some Want to Keep It

From this diversity some have localized conditions that permit and encourage good *Poa annua* performance, and normal *Poa annua* survival. These can well afford to keep their *Poa annua*, to maintain it in the vigorous, manicured, healthy state, useful and dependable in their conditions. For example, Oakland Hills at Detroit on their old eighteen have *Poa annua* and earthworms on a sandy soil, with much organic matter and good drainage, so *Poa annua* serves them very well. They have a few worms, excessive seedheads, but they also get their mechanical cultivation, topdressing and rejuvenation, and good quality turf predominating day after day, year after year.

In sharp contrast Indianapolis Country Club has slopes, clay soil, and for years had the problem of *Poa annua* infestation in the fall, survival in the winter (most years), then experienced thinning and often complete failure during the summer. So, they used arsenicals in the mid-50's, and stopped the *Poa annua* except on fairway 17. That fairway is often 80% *Poa annua*, even more, and the other fairways are clean bluegrass.

Poa annua is so bad in Europe that it is easy to look at an athletic field and see it is more than half *Poa annua*, so it is about three years old. And, throughout all Europe in 1969 there were no plots of *Poa annua* control. Hopefully, that is now being changed. In the U. S. we have been able to have chemicals available and develop control programs.

Arsenic Toxicity

Slow as it is, tedious as it is, there has been repeated success with arsenic toxicity in Poa annua and weedy grass control. The question is - do you wish to do without Poa annua, or are you willing to stay on a program for a period of time?

We have seen many courses - estimation of over 1,000 - that have cleaned up Poa annua, crabgrass and goosegrass. One of the earlier courses was Moraine Country Club, Dayton, Ohio. Since 1958 they have been Poa annua-free on the areas treated. The Miami Valley Country Club has been free of Poa annua for twelve years. In the fall of '72 Walnut Grove started treating their second nine based on the excellent control made on the first nine which were first treated in the fall of '71. We estimate there are another 1,000 golf courses that are using some Poa annua control, but have not cleaned up all fairways, so 2,000 are using arsenicals as an estimate. Sixteen of twenty-one country clubs around Indianapolis are using selective toxicity.

Poa annua removal is a difficult program -

1. Stop using phosphorus
2. Build up the arsenic toxicity
3. Repeatedly overseed the desired grasses - let them take over within two years.

It is a tedious job. Usually 4 lbs./1,000 of 48% calcium arsenate as Chip-cal Granular is repeatedly applied to achieve toxicity within one year. From 10 - 16#/1,000 is target rates. The Poa annua plant serves as bio-assay.

We have not favored the burning out of fairways with sodium arsenite, nor the attempts to burn up everything even though you kill existing Poa annua. These often permit a new crop of plants to germinate, and thus the problem continues. We have not favored the use of phosphorus fertilizers because they over-ride the arsenic. Excessive use of Milorganite, which carries both iron and phosphorus, can reduce effectiveness. Light applications seem to have less effect.

Alternate Programs

There are four alternative programs. One of these is to use Po-San, or growth restrictors, in a repeat application to stop the aggressiveness of the existing grass, and to open the door for the slower growing grasses, or the new seedlings. Po-San has proven to affect some of the seed survival in germination, and should reduce seed germination and survival. As a selective procedure and an interim step, Oak Park Country Club in Chicago, Highland in Indianapol and others have used the Po-San route.

An alternate is also available in the use of pre-emergent chemicals, which have reduced the infestation of new grasses. Dacthal, Balan, Betasan, and Bandane among others, can be used to stop the germination of *Poa annua* for a given time under given conditions. Generally these do not affect the mature *Poa annua* (unless used at, perhaps, excessive rates). These, therefore, depend on the existing perennial grasses to fill in, and present special problems when reseeding is desired.

In summary, the boards or policy making groups, must determine whether they have the desire to be free of *Poa annua*. When that becomes policy, the exact procedure, the schedule of budget for timing to accomplish that is a reality. As our turf demands increase, we do need to have the most dependable, wear-tolerant turf possible. Without *Poa annua* it is easier.

The Choice of Variety is Important to[1] Turfgrass Programs

D. K. Taylor[2]

Traditionally management has been the key factor in any successful turfgrass program. This is still so, for without good management the end result will be unsatisfactory to all concerned. Presumably the turfgrass manager knows what grasses or species will do best for him. When then does the choice of variety become of importance to the turfgrass manager? To those engaged in turfgrass varietal evaluation, differences among varieties are apparent and the better varieties are often superior in some of the following characteristics:

1. high density, good ground cover, competitive to weeds,
2. ability to recover from injury,
3. attractive color in all seasons,
4. tolerance to wear,
5. tolerance to low height of cut,
6. tolerance to chemicals,
7. tolerance to adverse temperatures,
8. resistant to diseases and pests,
9. tolerance to shade,
10. tolerance to neglect in low maintenance areas.

If a chosen variety has only a few of these desirable

[1]Paper presented at the 26th Annual Northwest Turfgrass conference, Ocean Shores, Washington, Sept. 26-29, 1972.

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attributes, management becomes that much easier and the over-all end result is much improved. Such improvements will be most obvious in a high maintenance situation. In fact, a successful high maintenance management program demands the very best in varieties.

Source of new varieties.

There is an increasing flow of new turfgrass varieties originating in North America and Europe. Governmental agencies and an increasing number of private companies are adding to the growing number of distinct varieties which are available. Advances in breeding techniques, particularly with Kentucky bluegrass, has increased the possibilities of combining many good characters in a single variety. Whereas most of our present Kentucky bluegrass varieties including Merion are the result of selection out of natural populations, more commonly future varieties will be the result of planned breeding programs to combine several to many good characteristics in one variety, or a series of varieties.

Choice of variety

In order for a new variety to become available to the turfgrass manager someone must have faith in the future of that variety and be willing to arrange for its increase in a suitable seed producing area. Publicity must be arranged in order for the merits of the new variety to become known. It is attractive for private companies to have exclusive rights to varieties in order that they will be compensated for their promotional costs. However, if each company promotes a different variety how can the user choose the right variety for his situation?

The turfgrass manager may depend entirely upon the reputation of the seed company for advice, or he may benefit from the experience of his neighbor. Regional turfgrass trials, especially from areas similar to his own may provide the information he is seeking. However, trial seedings of his own, in areas which are under play, may be most convincing of all and the most satisfactory basis for making major seeding decisions in the future.

Variety trial results

The Canada Department of Agriculture turfgrass program at Agassiz, B. C. is attempting to screen the many turfgrass varieties available. In two major seedings in 1969 and 1970 a total of 242 entries were planted in replicated plot trials. Briefly our management involves cutting heights of 3/4 and 1 1/2" for fescue and Kentucky bluegrass, 1/4" for bentgrass and 1 1/2" for perennial ryegrass. Plots are mown twice weekly and clippings removed. Ratings are made monthly for appearance plus observations when convenient on density, color, texture, and disease. Diseases often reach epidemic proportions when grasses are grown in pure stands and no fungicides are used except on the bentgrasses. However, it has been our observation that disease resistance is important to the success of species grown in mixtures. The non disease resistant varieties soon declined and made very minor contributions to the turfgrass mixture within a two year period.

Fine Fescue

The usefulness of the fescues for shaded conditions or ;oor soils is well known. Where moisture is plentiful and temperatures generally cool, fescues are attractive and can be maintained at lower cutting heights such as 3/4" without difficulty. Under similar conditions in Great Britain chewings fescues have been used in combination with colonial bentgrass for fine turf situations and even putting greens. At Agassiz, the chewings fescues as a group have been most promising for their density and resistance to red thread disease. Four varieties have been outstanding, Highlight, Jamestown, Koket and Wintergreen; while Rolax, Golfrood and Encota (Brabantia) gave above average performance. (See Table 1 for individual characteristics.)

Only two varieties were equal or superior to Pennlawn fescue among the creeping red varieties, Dawson and S59 both originating in Great Britain. (See Table 1). Both appear to have more resistance to Fusarium patch disease than Pennlawn. However, S59 is very light green over winter and Dawson became seriously discolored this past summer with an apparent attack of Colletot richum graminicola (Ces.) Wils. A numbered variety SAI 67 appears very promising in its first year of testing.

One hard fescue C26 (Eton) was outstanding for its dark green color, density and good resistance to red thread. Although a hard fescue botanically it gave no problem in mowing.

Table 1. A summary of some of the characteristics of promising varieties in the fescue trials at Agassiz, B.C., 1969-1971.

	Variety	Dark green color	Density	Resistance to Fusarium	Resistance to red thread
Chewings	Koket		G		F
	Highlight		G		F
	Wintergreen		G		
	Rolax	G	G	F	F
	Golfrood		G	G	
	Encota	G		F	F
	Jamestown	0			
Creeping red	Dawson	G	G	F	
	S59			G	
	Pennlawn				
Hard	C26 (Eton)	0	0		0

0 = OUTSTANDING, G = GOOD, F = FAIR.

Kentucky bluegrass

In the coastal area particularly, three main factors have limited the usefulness of Kentucky bluegrass as a turfgrass species. These are the predominately acid soils of the area, susceptibility to leaf spot - melting out disease and low tolerance to short clipping heights. The problem of acid soils can be corrected by proper management practices. Susceptibility to the leaf spot-melting out disease is being overcome by the release of more varieties with at lease moderate resistance. And now, low growing varieties are available which persist even at cutting heights of 1/2 - 3/4".

Test results with Kentucky bluegrasses from Agassiz indicate wide differences in appearance based mainly on resistance to leaf spot-melting out disease caused by Helminthosporium spp. Only those varieties which have at least moderate resistance to this disease can be recommended. (See Table 2.) Among the newer promising varieties which are becoming more available are Nugget, Fylking, Pennstar, Baron and Sydsport. Other varieties such as Birka, Golf, K412 and B101 are attractive but not available as yet.

The attractiveness of some of these newer varieties involves not only disease resistance, but increased density, tolerance of low cutting heights and fine texture. Increased density may resist weed encroachment and give a quick healing turf. Varieties which are tolerant of low cutting heights may be useful for planting tees. In addition fine textured bluegrasses give more attractive mixtures in combination with fescues.

Table 2. A summary of some of the characteristics of the more promising Kentucky bluegrass varieties tested in trials at Agassiz, B. C., 1969 - 1971.

Variety	Short plant Height	Texture	Dark green color	Density	Resistance to leaf spot
Baron	G	C	0		
Fylking		F		G	
Merion	G			G	G
Nugget	0	F	0*	0	G
Sydsport				0	
Birka		F			G
B101					
Golf		C	G		G
K412			G	G	G

0 = outstanding, G = good, F = fine, C = coarse.
*growing season appearance, becomes dormant in winter.

Bentgrass

When tested under a putting green type management, without wear, differences were apparent among the various Colonial bentgrasses tested. Four varieties from Europe, Brabantia, GS 2, Tracenta and Bardot have had superior appearance ratings. All appear reasonably disease resistant and Tracenta particularly has an attractive dark green color. Highland has rated low mainly because of its low summer ratings. Exeter which is light green in color has not shown to advantage as yet. (See table 3.)

Among the seeded creeping bentgrasses Penncross is attractive and has shown outstanding vigor. Consequently, thatch has a tendency to accumulate in this variety. Emerald approaches Penncross in performance. Seaside never looks quite as attractive as Penncross but at the same fertility level it has less tendency to accumulate thatch.

Jamestown is an attractive dark green variety of velvet bentgrass, superior to most of the other velvet bentgrasses under trial.

Table 3. Observations on Colonial bentgrass varieties tested at Agassiz, B. C. 1969-1971.

Brabantia GS 2 Tracenta Bardot	Attractive, promising, but seed not generally available.
Holfior NZ Browntop Eko Astoria	Very similar in performance, Holfior has darker green color
Exeter	Light green color, appearance ratings not superior yet.
Highland	Low appearance ratings in summer.

Perennial ryegrass

Perennial ryegrass appears to be a hard wearing grass suitable for sports turf seedings. Out of 12 varieties tested to date over a three-year period only Manhattan and Norlea have been outstanding. Both are fine textured and easy to cut but Manhattan is particularly attractive for its dark green color and superior density, While Norlea is the most winter hardy variety tested. All varieties have been susceptible to red thread when grown in pure stands. Possibly this disease would not be as severe when perennial ryegrass is grown in mixtures with Kentucky bluegrass. A new trial is underway to test additional varieties of perennial ryegrass, Kentucky bluegrass, dwarf timothy and other miscellaneous species both in pure stands and mixtures, using a wear treatment to simulate actual play. The results from this test should give more reliable results with direct application to sports turf seedings.

Top-Dressing[1]

Some New Thoughts On An Old Subject

William H. Bengeyfield[2]

In this age of blinding speed and unbelievable advances in science and technology, it is still difficult to improve on some things. The practice of top-dressing greens is one of them.

During the 1968 Northwest Turfgrass Conference, Mr. John Escritt, Director of the Sports Turf Research Institute, Yorkshire, England told this audience of his observations of Turf Management Practices in the United States:

"Americans," he mused, "seem to want to overdo everything. For example, I feel you are overdoing putting green fertilization. You apply far too much water. You are constantly spraying fungicides and insecticides. You seem forever to be verti-cutting and aerifying greens. But there is one important practice you should be doing and are not doing at all: Top-dressing greens!"

Many Agronomists in this country will heartily agree. His point is valid. Top-dressing is not easy. It may seem expensive, but properly done it is worth every effort and expenditure if your goal is championship putting turf. It is one management-tool your Golf course should use even though your neighbors have been overlooking it for the past three decades.

In the early days of greenskeeping, the ritual of top-dressing was carried out every few weeks. The old-timers may not have known all the reasons why, but they knew that it worked. World War II put an end to that. Shortages of

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[1]Paper presented at the 26th Annual Northwest Turfgrass Conference, Ocean Shores, Washington, Sept. 26-29, 1972.

[2]Western Director, U.S.G.A. Green Section, Garden Grove, California.

labor, equipment, and material practically eliminated the practice, and it has never regained popularity. The advent of the mechanical aerifier in the late 1940's further discouraged a return to top-dressing. The soil cores, it was believed, would do the job for us. Only in recent years have the better managed golf clubs returned to sound top-dressing practices.

Why is top-dressing important? How does it work? What are proper top-dressing procedures? Are there really major advantages for today's golfer and course superintendent in a top-dressing program? There is much to be said on the subject.

WHY TOP-DRESS AT ALL?

Golf has expanded so rapidly in the past 20 years that the technical advantages of top-dressing have perhaps been forgotten by the old and never fully appreciated by the new. Ask ten turf managers "why top-dress?" today and at least nine will reply, "to smooth the surface." But the story has far greater dimensions than this.

More than merely "to smooth the surface," the following amazing advantages also await the top-dressed green:

TIGHTER, FINER-TEXTURED TURF: By following proper top-dressing techniques, the fresh soil material encourages new growth of grass shoots and stems. A dense, fine-bladed turf results.

GRAIN IS CHECKED: Whether your greens are bentgrass, bermudagrass, or Poa annua, certain strains of any grass type are going to be more vigorous, more inclined to lay down than others. Top-dressing encourages upright growth and checks grain development in any type of turf.

THATCH CONTROL: With heavy fertilization, high or infrequent mowing, etc., aggressive grasses soon form a spongy layer known as thatch. Top-dressing checks dense thatch accumulation by intermixing soil materials with plant materials. It encourages new microbiological activity, which in turn breaks down thatch and converts it into valuable soil humus.

LESS DISEASE: Thatch is an ideal medium for disease organisms and insect activity. With thatch under control, this problem is reduced.

BETTER WATER AND FERTILIZER INFILTRATION: Because top-dressing checks heavy thatch accumulation by actually separating the plant residues, tight turf matting is prevented. The passages for air, water, fertilizers, etc., are preserved in the turf soil profile. Localized dry spot problems are reduced, and better over all irrigation infiltration is achieved.

ALLEVIATES COMPACTION: Top-dressing greens have better "holding qualities" for the golfer. The material physically supports the grass plant and thereby helps it absorb compacting forces. It develops resiliency. On heavily played greens, this point is of particular importance.

PROTECTS AGAINST WINTER KILL: Years of experience and research have shown that greens top-dressed just prior to the winter have fewer problems from desiccation and winter injury. The crown of the plant is protected from the winter's drying winds and wide temperature swings.

NEW DATA ON THATCH CONTROL

For the past three years, a USGA Green Section grant has supported the work of Dr. J. S. Koths, Connecticut Agricultural Research Station in attempting to control thatch through biological means. He tried six different biological approaches:

1. High temperatures - In greenhouse work, grass was subjected to favorable growth conditions except for very high temperatures (up to 140°F). No acceleration of thatch degradation was found.

2. Water Stress - Some scientists have suggested that water is the usual limiting factor in thatch degradation. Dr. Koths devised an experiment that assured an ample supply of water in the thatch area at all times. Although increased decay was observed on softer tissue, no decrease in thatch was found during the entire experiment on eight plots measured over a period of 13 months.

3. Fertilizer injection - Some have suggested that thatch accumulation results from excessive leaching of nutrients from the thatch layer. In other words, there are not enough nutrients for the microorganisms to do their work. A complete fertilizer was introduced in the thatch area along with the irrigation water.

The introduction of fertilizer elicited more luxuriant growth than that occuring under the accompanying nontreated areas. This growth might be expected to increase the thatch layer. This did not occur and it is postulated that degredation was increased in proportion to thatch formation, resulting in no net change.

4. Energy sources for microbes - Several different types of foods known to be used by microbes were introduced into the thatch area. Materials such as glucose, sucrose, humic acid and casein were used.

Although these materials did eliminate and cause the microbes to multiply initially, they then rapidly decreased to a less than normal population but returned to a balanced condition in about 3 weeks. None of these changes however, were associated with accelerated thatch breakdown.

5. Introduction of thatch-degrading microbes - Several different types of thatch degrading microbes were isolated, increased and successfully reintroduced to the thatch area. However, the increase in thatch degradation was not found to be significant.

6. Top-dressing and compost - The speed of biological disinteration of thatch is determined by the activity of the soil microflora and microfauna complex. Top-dressing was found to increase the activity of the microbes and was the most effective method in increasing the thatch decomposition rate.

Dr. Koths also noted that a composted top-dressing would be of greater value than merely top-dressing with a mineral soil. In other words, composting changes a 'soil mixture' into a 'top-dressing mixture' and the difference is important to the turf and therefore, important to the knowledgable turf manager. Composting was known to gardeners in the early 1700's and remains of extreme value today.

REDUCING COSTS THROUGH TOP-DRESSING

Putting greens seem to require unending attention. They must be aerified to check compaction; vertically mowed for grain and thatch control. Fertilization is essential. Disease, insect and weed control applications never end. Hand watering is needed for localized dry spots. The list goes on and on.

Because top-dressing is directly related to all of these practices, Dr. John Madison, University of California, Davis, has a new idea under investigation. Would it be practical, he wonders, to combine the above practices and top-dressing into one time and labor-saving technique for putting green management? He reasons that, if top-dressing is all we believe it to be, a program of light and frequent top-dressing (containing the needed chemicals for that particular application or time of year) may well do away with the costly individual applications (spraying, fertilizing, aeration, vertical mowing, etc.) now necessary! In other words, one properly prepared top-dressing every two or perhaps three weeks might produce even better greens with fewer man-hours required. The only other needed practices would be mowing and irrigation.

If this proves to be true, it would be relatively easy for the golf course superintendent to tailor a program for putting green management for his course. The development of larger, improved and efficient machines for top-dressing and matting would soon follow. Top-dressing, amended with the necessary chemicals and materials, would become the main technique in maintaining championship greens! Think about it. The idea has much to suggest.

IN SUMMARY

One might say many things for or against top-dressing. As we know it today, some may consider it expensive and labor consuming. It does require advance planning and organization. Although it does not produce immediate miracles, its long range benefits are undeniable. And the strange and unbeatable fact is that as of this moment, no substitute has yet been found for it in the production of high quality turf.

Turf Disease Problems and Current Research in the Central Prairie Region of Canada[1]

J. Drew Smith[2]

SNOW MOLD

Several, so-far unidentified organisms, consistently associated with snow mold patches on golf, bowling and lawn turfs were isolated after the winters of 1970/71 and 1971/72 in transects from Dawson Creek in British Columbia to Yorkton in south-east Saskatchewan (3). Their taxonomy and pathogenicity is being investigated. The best known is a basidiomycete which forms microsclerotia (not to be confused with the unidentified low temperature basidiomycete). It was first reported from a bowling green turf in Saskatoon in 1965. Effective control of the snow mold where this fungus was implicated was achieved by single fall applications of quintozene, chloroneb, carboxin and phenyl mercuric acetate at the recommended dosage, but not with thiram in the 1970/71 tests (3).

In the 1971/72 tests with artificially inoculated turf, effective control of Fusarium nivale snow mold on Merion Kentucky bluegrass turf was obtained with one fall application of quintozene, chloroneb, mercuric/mercurous chloride, phenyl mercuric acetate and carboxin fungicides but not with those containing benlate, topsin and three other experimental materials at manufacturer's suggested dosages. Likewise, on Kentucky bluegrass/creeping red fescue turf inoculated with Sclerotinia borealis, quintozene, topsin, phenyl mercuric acetate, mercuric/mercurous chloride mixture, benlate, BAS 3201/F, were effective fungicides but CA 70203, BAS 3050 and thiram were ineffective. In the case of Kentucky bluegrass/creeping red fescue turf inoculated with the unidentified low temperature basidiomycete,

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[1]Paper presented at the 26th Annual Northwest Turfgrass Conference, Ocean Shores, Washington, Sept. 26-29, 1972.

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chloroneb, carboxin, phenyl mercuric acetate, quintozene and mercurous/mercuric chloride mixture at recommended dosages for snow mold were effective but thiram, salicylanilide, cadmium chloride,/urea and topsin were ineffective fungicides. At low dosage (30 g a.i./1000 ft^2) benlate appeared to encourage the disease.

On golf green turf of Penncross bent at Swift Current in southern Saskatchewan, naturally infected with *S. borealis*, quintozene at 45, 90, 180, and 360g a.i./1000 ft^2, chloroneb at 160 g, and benlate at 30g effectively controlled this disease. Mercuric/mercurous chloride and phenyl mercuric acetate fungicides were ineffective. Surveys in 1971 and in 1972 showed that *S. borealis* was a common pathogen on fine turf grasses of golf and bowling greens of *Agrostis* spp., *Festuca rubra* and *Poa annua* and on coarser lawn and roadside turf from Dawson Creek in B. C. to south-east Saskatchewan.

FAIRY RINGS

A survey in August 1972 of 684 domestic lawns in Saskatoon showed the following distribution of fairy rings in lawns of different age classes:

Age class/yr	0-5	5-10	10-15	15-20	over 20
% of lawns without rings	53	18	19	92	98
Number of lawns in age classes	133	138	133	139	141

Rings were smaller and more abundant on lawns of the 0-5 year class than in older classes. The survey results suggest that perhaps the most reliable way of eliminating fairy rings is to allow them to grow out. They also illustrate how common the fairy ring problem is and indicate that further research effort is justified on this subject.

BREEDING FOR DISEASE RESISTANCE IN POA PRATENSIS AND OTHER TURFGRASSES

Few grasses have been developed for turf purposes in the Central Prairies and some of those adapted to conditions elsewhere e.g. Merion Kentucky bluegrass, have proved very susceptible to our particular spectrum of snow molds and other pathogens. It seems as if it will be necessary to test grasses for several years before clearing them for general use since inoculum build up to levels which will permit epidemics may take several years. In turf, rust and powdery mildew and *Helminthosporium vagans* leaf spot and stem rot are not major diseases of bluegrasses with us, although the first two can cuase considerable problems in seed rows. Desiccation resistance and snow mold resistance in combination with good general agronomic characters are what we are looking for in bluegrass. A start was made in 1967 by making local selections of *Poa* spp. surviving or recovering from attacks of snow mold. Material introduced from world sources has also been screened in nurseries and selections of these are now in replicated turf plots. A microplot technique is also being used with introduced material. About 20 lines of *Poa pratensis* are being multiplied for cooperative turf tests. Similar work is in progress with *Festuca* spp., *Agrostis* spp. and some native grasses.

COLLETOTRICHUM GRAMINIS ON FESCUES

Bleached patches on turf of several fescue cultivars on Dr. D. K. Taylor's turf plots at Agassiz Research Station, B. C., showed the acervuli and spores of *Colletotrichum graminis*. This fungus is very common on culms and leaves of *Festuca rubra* in Western Canada and is a pathogen on oats and *Poa annua*. It may also be the fungus responsible for the disease on the turf plots at Agassiz. Dr. Taylor is keeping this disease under close observation.

PUBLICATIONS

The results of tests and surveys summarized here will be reported in detail in the Canadian Plant Disease Survey.

1. Smith, J. Drew 1969. Snow mold on lawns in Saskatoon.

Can. Plant Dis. Surv. 49:141.

2. ---------------1971. Powdery mildew on bluegrass cultivars and selections. Research Report (Mimeo.) 24 Dec. 4 p.

3. ---------------1972. Snow mold of turf in Saskatchewan in 1971. Can. Plant Dis. Surv. 52:25-29.

Agronomic Research Report[1]

Roy L. Goss[2]

SULFUR STUDIES - Studies on the effect of wettable sulfur on turfgrass response were continued in 1972. Sulfur rates of 50 and 150 lbs. per acre were continued in all combinations with putting green fertilizers as discussed.

Sulfur applied at 150 lbs. per acre produced turf with highest quality from the standpoint of color and density. Fifty lbs. of sulfur per acre produced good quality turf at the highest nitrogen treatment but was not readily observable at the low nitrogen treatments. Essentially the same results were observed at the intermediate nitrogen range (12 lbs. N/1000 sq. ft/season) as was observed at the 20 lb. nitrogen rate.

Although sulfur does not produce striking color responses on the low nitrogen plots under the conditions of this test, there are other quality factors to be considered.

All plots that received phosphorus, regardless of the nitrogen level, showed increased *Poa annua*. In general, the highest nitrogen plots (20 lbs/1000 sq ft/season) had higher percentages of *P. annua*. True to form, the intermediate ranges of nitrogen had the second highest level and the lowest nitrogen treatments contained the fewest *P. annua* plants.

Low nitrogen (6 lb N/1000 sq ft/season) with 150 lb of sulfur/acre produced turf that was essentially *Poa* free. These low nitrogen plots have good color and excellent density as well. All quality characters of low nitrogen plots with the high sulfur application are better than adjacent plots that do not receive sulfur with other nutritional treatments being equal.

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[1] Paper presented at the 26th Annual Northwest Turfgrass Conference, Ocean Shores, Washington, Sept. 26-29, 1972.

[2] Agronomist, Western Washington Research and Extension Center, Washington State University, Puyallup.

No conclusions have been reached as to the cause of this, but it may be speculated that sulfur has decreased the pH in the surface to a point where phosphorus availability is lower, hence, *P. annua* finds it a little more difficult to become established and prosper. At the end of 4 years of sulfur treatments, there is no evidence of sulfur toxicity on any of the randomized sulfur plots.

Studies are continuing to determine the level of sulfur containing amino acids, total amino acids, and protein content of turf with various levels of sulfur and nitrogen. This work is being done in cooperation with Dr. S. E. Brauen, Agronomist at Puyallup, also.

POA ANNUA PRE-EMERGENCE STUDIES - This experiment has been conducted for 2-1/2 years at this time, hence, the data are becoming more meaningful since the treatments have had a longer period of time to show results for toxicity. Treatments were initiated in April 1970 and *P. annua* plants were counted and marked at the outset of the experiment. *P. annua* plants have been counted and recorded in 1971 and 1972.

The following table indicates the treatment, the percent *P. annua* in the plots, the color and density. These figures are averages of four replications.

Table 1. The effect of Pre-emergence herbicides and fungicides on Poa annua in bentgrass turf.

	% Poa annua	Color	Density
1. Betasan alone (once annually) 15#/A	26	8.5	9.0
2. Betasan alone annually 15#/A + Fore/PMAS[1]	23	9.0	9.5
3. Betasan alone annually (15#/A) + Benlate[2]	17	9.0	10.0
4. Betasan repeat + Fore/PMAS	1.5	8.5	9.5
5. Chip-Cal tricalcium arsenate (18#/1000 sq. ft in one year) +Fore/PMAS	1.0	8.5	7.5
6. Chip-Cal (18#/1000) alone	1.0	9.0	7.0
7. Chip-Cal (18#/1000) + Benlate	1.0	8.0	6.0
8. Fore/PMAS alone	26	9.0	10.0
9. Benlate alone	35	9.0	9.5
10. Check	40	8.0	8.0

[1]8 ox Fore alternating each 2 weeks with 3/4 liquid oz of 10% PMA/1000 sq ft.

[2]2 oz every 3 weeks per 1000 sq ft.

It is obvious at this point, that only two treatments have shown efficacy in the control of P. annua and the reduction of mature plants over the past 2.5 years. Bensulide (Betasan) applied alone once annually at 15 lb per acre has caused only a slight reduction in P. annua. Combinations of Bensulide with fungicides has further reduced P. annua but only to a minor extent. Bensulide with the fungicide Benlate produced the best results of those treatments applied once annually.

Bensulide applied at the rate of 12 lb active ingredient/ acre and then repeated with 3 lb active ingredient/acre every 3 months has significantly reduced P. annua in all replications. As shown in the table, there is only a trace of P. annua to be found in any of the "Bensulide repeat" plots. Although the color rating is slightly depressed in the Bensulide repeat plots, it was not significant and this does not represent any serious degree of phytotoxicity. Turf density in the Bensulide repeat plots received the highest rating, indicating no thinning action from repeat applications. There were no repeated Betasan treatments without fungicides so it is not known to what degree the fungicides may have improved plot quality. Root measurements will be taken in the fall of 1972 to determine any root reduction, if any.

Chip-Cal tricalcium arsenate was applied in three different treatments in combination with fungicides. The Chip-Cal was applied in the following manner: 4 lb of product/1000 sq ft in one application foll
1000 sq. ft two weeks later. Two months after the second application, 4 lb additional material was applied. In February 1971, 4 additional lbs of product were applied bringing the total to 16 lb/1000 sq ft. In May of 1971, two additional lbs were applied to bring the total level to 18 lbs/1000 sq. ft. This is the maximum level intended on putting green turf with sandy loam soil conditions and hereafter only maintenance rates of 2 lbs product in the fall and spring are applied to maintain arsenic toxicity.

The Chip-Cal material produced Poa free turf in all treatments at the time of the August evaluation of 1972, the color of the plots was very acceptable and in some cases superior to other treatments. Color improved tremendously over that rated in June, 1972 when color ratings were down considerably.

Chip-Cal produced turf with lowest density ratings. These plots have recovered considerably as compared to June observations, when density ratings were very low. Earlier ratings showed considerable thinning, off color and adverse effects. These effects may possibly be related to extreme soil wetness which was caused by record breaking rainfall in the spring of 1972. These plots will be observed for another year or two to determine if the grass will improve or become worse.

The fungicides Fore and PMAS applied alone, produced plots with an average of 26% P. annua and Benlate applied alone produced plots with 35% P. annua, however, these ratings are in relative proportion with the original levels of P. annua in these plots. The check plot showed a 40% P. annua invasion. It is determined that all plots would have had as much as 40% P. annua with none of the treatments which were applied above since P. annua was nearly uniformly established in all plots at the beginning.

POA ANNUA POST EMERGENT TRIALS - Post emergent materials were applied to Merion bluegrass turf on August 9, 1972. A uniform invasion of P. annua was in the Merion bluegrass. Plots were treated with one of the following materials:

1. Endothal in 3 different formulations including one with ammonium sulfate..

2. MAD (an organic arsenical)

3. Ansar 529 at 2 rates (organic arsenical)

4. Ronstar at 2 rates (pre-embergent herbicide with some post-emergent toxicity)

5. Sinbar at 2 rates. This material previously exhibited phtotoxicity on certain grasses.

6. MH30 (growth retardant)

7. Mon 2139 at 2 rates (Monsanto experimental)

8. Kerb

9. Balan at 3 rates

10. Dacthal at 2 rates.

Since these are merely screening trials, the rates applied per acre are not listed due to the preliminary nature of this testing. This report is to keep you informed that post-emergent work is being carried out and at this early date we can make some of the following observations. Little results have been shown from Endothal treatment, however, some mature *P. annua* showed signs of injury. All organic arsenicals have severely weakened and killed some of the *P. annua* plants. This may be due to the fact that the materials were applied when weather conditions were between 80-85°F. The 2 rates of Ronstar proved to be extremely phytotoxic to bluegrass. The lowest rate effectively removed all *P. annua* with only a slight bit of toxicity to the bluegrass. Since this material is a pre-emergence herbicide, there was no evidence of any new *P. annua* seedlings germinating or developing in the plots. The same observation was true of Balan and Dacthal in regard to *P. annua* and seedling germination. The lowest rate of the Monsanto experimental material did not kill the bluegrass, however, the highest rate killed all vegetation in the plot. *P. annua* seedlings were observed in all plots where materials did not have pre-emergence qualities.

Kerb applied at a very low rate was showing some selectivity, but at the time of the preparation of this report, the bluegrass was not completely killed.

From these initial screening studies, certain of these materials will be repeated again in another set of plots with a wider range of treatment rates which will also include Po-San. By the time of the 1972 Turf Conference, additional information may be available from these plots and will be orally reported at the Conference.

New Fungicides and A New Method for[1] Controlling Fusarium Patch

Charles J. Gould and Roy L. Goss[2]

We now have two more fungicides available for use against Fusarium Patch. They are: Cleary's BROMOSAN and Mallinckrodt's MF-509 (to be named "FUNGO"). The active ingredients are ethyl and methyl thiophanates, which were developed in Japan. They are related to benomyl (BENLATE or TERSAN 1991) but, according to reports, are supposed to last longer. Data from these and other treatments in the 1971-72 tests are shown in the accompanying table. Note that there were two severe outbreaks of Fusarium - one in October and another in February, the latter following repeated snowstorms.

Benomyl (as TERSAN 1991 and PROTURF + DSB) again gave good control when used regularly. The poor results with FORE during the severe epidemic in October once again indicate that a three-week spraying interval with this material is too long. During severe 'Fusarium' weather, FORE (or TERSAN LSR) should be applied every 10-14 days. We use a three-week interval for experiments because it usually gives a better separation of the compounds and also indicates whether the fungicides have residual qualities.

Neither DACONIL nor DYRENE gave satisfactory control. Chemagro's BAY DAM 18654, another benzimidazole, was found to be safe on bentgrasses but was entered in the tests too late to obtain data on control of Fusarium. EL-273 injured bent at the high rate and was relatively ineffective at the low rate. Applications were discontinued on January 3 at request of the company. The rate for MERTECT FLOWABLE was dropped from 2 to 1 1/2 oz. because of phytotoxicity.

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[1]Paper presented at the 26th Annual Northwest Turfgrass Conference, Ocean Shores, Washington, Sept. 26-29, 1972.

[2]Plant Pathologist and Agronomist, Western Washington Research and Extension Center, Washington State University, Puyallup 98371

Although benomyl effectively controls Fusarium, for some reason its repeated use does not always produce as good grass as do some other treatments. Although FORE does not have much residual action against Fusarium, it supplies sulfur,and controls algae and perhaps other pathogenic fungi. Because of these desirable features and because we wanted to reduce the risk of the development of benomyl-resistant strains, we tried alternating the two compounds. The results were excellent. Tests by some superintendents have verified our results. We plan, therefore, to recommend, on a trial basis, alternating FORE (or TERSAN LSR) with whatever benzimidazole compound (TERSAN 1991, BROMOSAN, FUNGO, or PROTURF) is used, unless such compound is already composed of a mixture of similar products.

We found, in several previous tests, that benomyl apparently had residual action. In one test in 1971, for example, benomyl was applied five times in the spring at a 2 oz rate. During a severe outbreak in October, 135 days after the last application, there were only 12% as many spots in the treated plots as in the untreated ones. In this same test, FORE-treated plots has 63% as many spots. Results from the 1971-72 tests confirmed the prolonged activity of benomyl. Single applications were made on September 23 of Benomyl and certain other materials. The most persistent benefits came from the benzimidazoles (TERSAN 1991 and MF-509) with very satisfactory control still present 141 days later during an outbreak of Fusarium Patch following repeated snowstorms. Best results were achieved with TERSAN 1991 at 8 and 16 oz rates. The quality of benomyl-treated turf at the end of the test, however, was not as good as that produced by some of the other treatments. Therefore, it appears desirable to incorporate FORE into the schedule. One of the treatments we will try in the 1972-73 tests is an application of TERSAN 1991 at 6-8 oz every 3 months and FORE at 8-12 oz once a month between TERSAN 1991 applications. Such a program would cut the number of applications in half, resulting in a considerable saving of labor.

We are grateful to all the companies for their donation of materials and to the following companies for their financial support: Merck Chemical Division, W. A. Cleary Corp., Chemagro Corp., Mallinckrodt Chemical Works, Eli Lilly and Company, Diamond Shamrock Corp., and Jim Chapman

(O. M. Scott & Sons).

Reference to commercial products or trade names is made with the understanding that no discrimination is intended and no endorsement is implied.

THE SEARCH FOR FUSARIUM-RESISTANT BENTGRASSES

Charles J. Gould and Roy L. Goss

An expanded search for Fusarium-resistant bentgrasses is underway, thanks to assistance of the U.S.G.A., Green Section - Research and Education Fund.

One hundred and two selections from eight countries have been planted as of August 1, 1972. Both seeded and stolon types are included. Most are commercially available varieties but several new selections are also being tested. We will rate them for their resistance to Fusarium and other pathogens, as well as for their cultural characteristics. In about two years, the most promising types will be planted in larger plots for management studies and continued evaluation of disease resistance. The ones now under test are listed in Table 1. We invite you to examine and help us rate the varieties any time you are in the vicinity.

We are very grateful to the U.S. G. A. for their assistance; to Carl Kuhn who kindly designed the automatic irrigation system; and to the companies who supplied seeds and/or stolons of the bentgrass varieties.

Results of Tests on Control of Fusarium Patch on Highland Bentgrass, 1971/72

Tr. No.	Compound[a]	Application dates and rates in oz 1971: Sept. 23	Oct. 14	Nov. 3	Nov. 23	Dec. 14	1972: Jan. 3	Feb. 10	March 16	March 27	April 17	May 8	May 30	Total Number Spots of Fusarium[d] per 125 ft^2 - CJG: 10/6/71	10/11/71	10/15/71	11/19/71	2/11/72	Color[d] (50=darkest) CJG: 12/17/71	RLG: 4/3/72	RLG: 6/21/72	Overall Quality[d] (50=perfect) CJG: 11/5/71	CJG: 6/6/72	RLG: 6/21/72
1	None	-	-	-	-	-	-	-	-	-	-	-	-	380	340	508	465	254	34	41	37	39	23	35
2	Tersan 1991	2	2	2	2	2	2	2	2	2	2	2	2	110	17	0	24	14	42	42	40	43	31	37
3	Tersan 1991 alt. with Fore[b]	2	8	2	8	2	8	2	8	2	8	2	8	85	20	3	7	0	46	49	41	49	32	38
4	Bromosan (New)	4	4	8	8	8	8	8	8	8	8	8	8	14	20	0	25	0	48	49	39	46	35	36
5	Daconil	4	4	8	8	8	8	8	8	8	8	8	8	130	195	270	254	0	30	34	30	37	22	27
6	Daconil	6	6	6	6	6	6	6	6	6	6	6	6	79	430	585	303	2	28	34	33	35	23	31
7	Dyrene. Later (//) BAY DAM 18654	4	4	4	4	4	4//	2	2	2	2	2	2	164	358	437	325	26	32	44	36	40	28	37
8	Dyrene. " " "	8	8	8	8	8	8//	4	4	4	4	4	4	360	500	675	350	0	32	42	36	38	29	36
9	EL-273	4	4	4	4	4	-	-	-	-	-	-	-	205	215	395	263	0	25	40	41	33	25	33
10	EL-273	8	8	8	-	-	-	-	-	-	-	-	-	85	27	I[e]	I[e]	4	25	38	43	35	27	34
11	Fore	8	8	8	8	8	8	8	8	8	8	8	8	65	292	485	21	0	46	47	42	44	33	38
12	Mertect Flowable	2	2	1½	1½	1½	1½	1½	1½	1½	1½	1½	1½	220	41	8	107	6	36	43	38	37	26	33
13	MF-509	2	2	2	2	2	2	2	2	2	2	2	2	51	17	30	21	16	43	48	45	45	38	39
14	MF-542	6	6	6	6	6	6	6	6	6	6	6	6	58	98	130	69	0	35	40	42	40	27	41
15	Proturf + DSB. Setting #[c]	4½	4½	4½	4½	4½	4½	-	4½	-	4½	4½	4½	35	10	0	47	5	41	45	45	43	36	39
16	Tersan 1991	2	-	-	-	-	-	-	-	-	-	-	-	85	8	0	42	145	38	43	36	43	27	32
17	"	4	-	-	-	-	-	-	-	-	-	-	-	73	25	4	107	50	38	41	32	43	29	31
18	"	8	-	-	-	-	-	-	-	-	-	-	-	55	2	0	39	38	39	42	35	45	26	33
19	"	16	-	-	-	-	-	-	-	-	-	-	-	60	16	0	55	10	41	40	35	44	24	32
20	Mertect Flowable	8	-	-	-	-	-	-	-	-	-	-	-	I[e]	I[e]	I[e]	I[e]	10	32	41	36	33	26	34
21	Fore	16	-	-	-	-	-	-	-	-	-	-	-	8	16	24	475	261	31	41	37	44	28	37
22	"	32	-	-	-	-	-	-	-	-	-	-	-	17	15	63	550	167	27	43	40	45	30	38
23	Daconil	12	-	-	-	-	-	-	-	-	-	-	-	30	93	124	490	334	25	33	37	37	25	33
24	Dyrene	16	-	-	-	-	-	-	-	-	-	-	-	145	247	337	795	226	21	43	37	37	23	33
25	MF-509 (Fungo 50 W.P.)	6	-		-	-	-	-	-	-	-	-	-	120	15	0	100	99	38	41	34	42	21	32

a Materials applied in 10 gallons water (except #15) per 1000 sq ft. Five reps. of 25 sq ft each.

b Alternating applications of two oz of Tersan 1991 and 8 oz Fore.

c Dry applications with Scott's spreader.

d Counts (of spots) or ratings made by Gould (CJG) or Goss (RLG). Ratings from 1 to 10 with 10 being best. Totals for 5 reps.

e Counts impossible because of severe injury.

Bentgrass Varieties Being Tested for Resistance to Fusarium nivale

C. J. Gould and R. L. Goss
(Western Washington Research & Extension Center, Puyallup, Washington 98371)

Name	(Our #)	Spec.*	Source	Name	(our #)	Spec.	Source
A74	(44)	pal.	Scott's	Mamelou	(48)	ten.	Kweekbedrijf
A75	(45)	"	"	Mikro Daehnfeldt	(29)	stol.	Daehnfeldt
ACA 61	(41)		Saatzucht	N3-44	(20)	ten.	Northrup King
Agrettina	(30)	can.	Deutsch Saat.	N.Z. Cert. Browntop	(18)	ten	NZ Dept. Sci.
A. palustris	(54)	pal.	USDA-Turkey	Nimisila	(62)	pal.	Warren's
"	(56)	"	" Afghanistan	Northland	(63)	"	Canada - Lebeau
"	(59)	"	" Switzerland	Novobent	(19)	can.	Mommersteeg
A. sclera	(58)	scl.	" Canada	OE-0332	(49)	ten.	Ohlsens
A. stolonifera	(57)	stol.	" Iran	Orbico	(21)	ten.	Cebeco
A. tenuis	(53)	ten.	" Turkey	Old Orchard	(37)	pal.	Cal-Turf
"	(55)	"	" "	Penncross	(22)	"	Great Western
"	(60)	"	" Italy	Pennpar	(38)	"	Warren's
"	(61)	"	" Rumania	PennState #3	(82)	"	Turf-Seed
Arlington	(33)	pal.	Godwin	PennState #4	(83)	"	"
Astoria	(1)	ten.	Puget Sound	PennState #5	(84)	"	"
Astra	(2)	can.	Van Engelen	Pipo	(50)	ten.	Kweekbedrijf
AT1	(42)		Mommersteeg	Prominent	(23)	stol.	Zwaan & Dewiljes
AT4	(43)		"	Rusta	(24)	can.	Cebeco
Avanta	(3)	can.	Van Engelen	S-4979	(27)	stol.	Canada - Knowles
Barbella	(4)	can.	Barenbrug	Saboval	(32)		Nat'l Seed-Eng.
Barbinet	(5)	ten.	"	Seaside	(25)	pal.	Puget Sound
Bardot	(7)	"	"	Smaragd (Emerald)	(26)	stol.	Weibull
Barida	(6)	can.	"	Smith's S-704	(86)	pal.	Canada - Smith
Boral (Bore)	(8)	ten.	Oseco	" S-705	(87)	"	"
Cohannsey	(34)	pal.	Cal-Turf	" S-706	(88)	"	"
Congressional	(35)	"	Godwin	" S-707	(89)	"	"
Contrast	(9)	ten.	Zwaan & Dewil.	" S-708	(90)	"	"
EGS-1	(10)	"	Van Engelen	" S-709	(91)	"	"
EKO	(11)	"	Maple Leaf	" S-720	(92)	"	
EKS-3	(12)	can.	Van Engelen	" S-721	(93)	"	"
Enate (Brabantia)	(13)	ten.	"	" S-730	(94)	"	
Evansville	(36)	pal.	Warren's	" S-731	(95)	"	"
Exeter	(14)	ten.	Puget Sound	" S-732	(96)	"	"
Highland	(15)	"	Oregon	" S-733	(97)	"	"
Holfior	(16)	"	Van der Have	" S-734	(98)	"	"
Huffine MCC-3	(76)	pal.	Huffine-Okla.	" S-735	(99)	"	"
" HCC-7	(77)	"	"	" S-736	(100)	"	"
Hummel	(46)	ten.	Kweekbedrijf	" S-737	(101)	"	"
Igeka	(47)	"	Rolimpex	" S-738	(102)		"
Keen's #19	(66)	pal.	Keen - Kansas	" S-739	(103)	"	"
" #22	(67)	"	"	Strandhem	(51)	stol.	Ohlsens
" #27	(68)	"	"	Tendenz	(52)		Saatzucht.
" #28	(69)	"	"	Toronto	(39)	pal.	Godwin
" #36	(70)	"	"	Tracenta	(28)	ten.	Mommersteeg
" #41	(71)	"	"	TurfSeed TS-666	(85)	pal.	Turf-Seed
" #42	(72)	"	"	Washington	(40)	"	Warren's
" #43	(73)	"	"	Waukanda	(64)	"	Canada - Lebeau
" #52	(74)	"	"	Yale's Selection	(65)	"	Goss
" #53	(75)	"	"	Youngner UCR-53	(79)	"	Youngner
Kingston	(17)	can.	Puget Sound	" UCR-30	(80)	"	"
Ligrette	(31)	ten.	Deutsche Saat.	" UCR-13	(81)	"	"
Madison UCD-1	(78)	pal.	Youngner				

*can. = canina; pal.=palustris; ten.=tenuis; stol.=stolonifera.

Addresses of Sources

Barenbrug's - Barenbrug's Zaadhandel N.V. Arnhem, Postbox 4, Arnhem, Holland
Cal-Turf - Cal-Turf, 5417 Santa Clara Ave., Camarillo, CA 93010 (USA)
Canada - Dr. R. P. Knowles, Canada Dept. of Agriculture, Research Station, University Campus, Saskatoon, Sask., Canada
Dr. J. B. Lebeau, Canada Dept. of Agriculture, Research Station, Lethbridge, Alb., Canada
Dr. J. Drew Smith, Canada Dept. of Agriculture, University Campus, Saskatoon, Sask., Canada
Cebeco - Cebeco, P. O. Box 182, 31 Blaak, Rotterdam-1, Holland
Daehnfeldt - L. Daehnfeldt Ltd., Field Seed Dept., P. O. Box 185, 5100 Odense, Denmark
Deutsche Saatveredelung - Deutsche Saatberedelung Lippstadt-Bremen, 4780 Lippstadt, Postfach 105, West Germany
Godwin - Hiram F. Godwin & Son, 55150 West Ten Mile Road, South Lyon, MI 48178 (USA)
Goss - Dr. R. L. Goss, Agronomist, Western Washington Research & Extension Center, Washington State University, Puyallup, WA 98371
Great Western - Great Western Seed Co., Ninth & Jackson Sts., P. O. Box 387, Albany, OR (USA)
Huffine-Okla. - Dr. Wayne W. Huffine, Dept. of Agronomy, Okla. State Univ., Stillwater, OK 74074 (USA)
Keen-Kansas - Dr. Ray A Keen, Dept. of Horticulture & Forestry, Kansas State Univ., Manhattan, KS 66502 (USA)
Kweekbedrijf - N.V. Kweekbedrijf C.I.V., Landgoed Zelder, Ottersum (L.), Holland
Maple Leaf - Maple Leaf Mills Limited, P. O. Box 370, Station "A", Toronto 116, Ontario Canada
Mommersteeg's - N.V. H. Mommersteeg's, Zaadteelt en Zaadhandel, Vlijmen, Holland
N.Z. Dept. Sci. - Mr. J. B. Fergusson, Dept. of Scientific & Industrial Research, Grasslands Division, Private Bag, Palmerston North, New Zealand
Northrup, King - Northrup, King & Co., 1500 Jackson St. N.E., Minneapolis, MN 55413 (USA)
Ohlsens - J. E. Ohlsens Enke, DK-2630 Copenhagen-Taastrup, Denmark
Oregon - Oregon Highland Bentgrass Commission, 2111 Front St., N.E., Suite One, Salem, OR (USA)
Oseco - Oseco Limited, P. O. Box 219, Brampton, Ontario, Canada
Puget Sound - Puget Sound Seed Co., 1050 W. Nickerson, Seattle, WA (USA)
Rolimpex - Centrala Handly Zagranicznego, "Rolimpex", 1 AL. Jerozolimskie 44, P. O. Box 364, Warszawa, Poland
Saatzucht - Saatzucht Steinach, 8441 Steinach uber Straubing, Germany
Scott - O. M. Scott & Sons, Research Division, Marysville, OH 43040 (USA)
Turf-Seed - Turf-Seed, Inc., 77 West G Street, Hubbard OR 97032
U.S.D.A. - Dr. W. H. Skrdla, Regional Plant Introduction Station, U.S.D.A., Iowa State Univ., Ames, IA 50010 (USA)
Van der Have - D. J. Van der Have, Plant Breeding Dept., Kapelle-Biezelinge, Holland
Van Engelen - Gebr. Van Engelen, Zaadteelt en Zaadhandel N.V., Postbus 35, Vlijmen, Holland
Warren's - Warren's Turf Nursery, Palos Park, IL 60464 (USA)
Weibullsholm - Weibullsholm Plant Breeding Institute, Turf Grass Div., Landskrona, Sweden
Youngner - Dr. V. H. Youngner, Agronomist, Dept. of Plant Sciences, Univ. of California, Riverside, CA 92502 (USA)
Zwaan & De Wiljes - Zwaan & De Wiljes Limited, P. O. Box 2, Scheemda, Holland

Fugicides Past, Present, Future[1]

William A. Small[2]

In the last several decades there have been some outstanding accomplishments in all phases of agriculture. Total production has been dramatically increased to meet the needs of an expanding, affluent population. The efficiency of production is dramatically represented in these graphs from a recent article in Horticulture.

The accomplishments in recreational turf production are no less significant. The number of rounds of golf played on any particular course have increased and new course construction has difficulty meeting the increasing demand. The yield in turf production cannot be precisely defined in terms of bushels or tons. But the results are visible and those of you whose memory goes back to conditions a few decades will agree that turf quality is better now in spite of the increasing demand and stress placed upon it. Or, to put it another way, our present pressure of play could not have been supported with the technology of 30 years ago.

There are many facets in management and I want to talk particularly about fungicides in the technology of pesticides.

The first important breakthrough in the control of turf diseases on golf course greens came with the introduction of the inorganic mercurial fungicides. Their broad spectrum activity on the enzyme systems of many fungus species has not been matched.

The organic mercurials were then introduced to turf. The high activity of these compounds against some of the most troublesome fungi on turf made possible some of the least costly disease control programs ever utilized on turf.

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[1]Paper presented at the 26th annual Northwest Turfgrass Conference, Ocean Shores, Washington, Sept. 26-29, 1972.

[2]Mallinckrodt Chemical Works, Second & Mallinckrodt Streets, St. Louis, Missouri 63160

Phenylmercuric acetate brought the cost of fungicidal treatment on fairways within the economic range of many golf courses for the first time. It also made possible the control of crabgrass on greens before effective selective herbicides were developed. It is a very active agent which alters the physiology of plants so that the stomata of the leaves are closed, which may help to prevent wilt of plants. Unfortunately, these compounds may also have ecological impli-ations and the baby may be thrown out with the wash water in today's ecology binge.

The dithiocarbamate fungicides of which Thiram, Zineb, Maneb, are a few examples, really became important during the war years of the early 40's. They were cheap chemicals because they, or intermediate compounds to their synthesis, were already in high volume use in the rubber industry. It will indeed be a serious blow to agriculture if some of the environmental questions which have been raised for these compounds are not satisfactorily disposed of.

The cadmium compounds were introduced in the 50's and were among some of the most effective chemicals against the spot diseases of dollar spot, copper spot, Typhula snow mold and red thread. Their combination with several other active ingredients led to the introduction of the first commercial broad spectrum fungicide for turf as Kromad.

The development of antibiotics for animals also led to the development of cycloheximide as an antifungal agent. It has been combined with other active ingredients to broaden its spectrum of activity. It is among the most toxic of chemicals in the fungicide arsenal; but good formulation and adequate instructions have apparently avoided serious problems. Actidione is one of the more economical products for use.

Research with triazine compounds led to the development of Dyrene which has found use in turf.

A newer compound of recent years from the research with chlorinated phthalic acid compounds led to the development of Daconil which is an effective foliar fungicide.

Until recent years the Pythium fungi which cause damping off, grease spot or cottony blight of turf was a scourge of cool season grasses when favorable disease conditions occurred. The introduction of Koban or Tersan SP now provide reasonable solutions to that problem. Ryegrass seed treatment with Koban by Northrup,King is a new innovation this year which is expected to save the superintendent time and assure uniform germination of overseedings. Seed treatment of other grass seeds may become a reality in the near future.

Systemic fungicides have been the dream of plant pathologists. Some of their aspirations have been realized by the research with benzamidazole and thiophanate compounds. Benlate, Mertect, Tobaz, Fungo and Topsin are illustrative of products in this class. They are effective against some of the common turf disease but a broader spectrum of activity is needed. In general they only move upward in the plant and are not translocated downward toward the roots. Mowing, therefore, does remove the plant parts which are richest in fungicide content. However, because they are systemic, they do appear to afford disease control for longer periods of time than protective fungicides, if sufficient quantities are available in the soil for root absorption. Intimate and complete coverage of the plant is apparently not so important for preventive disease control once the minimum critical concentration is attained within the plant. Coverage is an important factor in the curative disease situation.

In recent years advances have been made in the uniformity of application of all pesticides including fungicides. Boom type sprayers are being utilized and the old squirt gun approach is being abandoned. The reasons are obvious because often the judgement as to when retreatment is needed is based upon the first indications of failure in effectiveness. These indications often come at the points where non uniform treatment has been minimal.

There is another aspect concerning all pesticides which is receiving increased enphasis and that is their possible impact on the environment.

Because there appears to be considerable misunderstanding about mercurial fungicides, I'd like to explain what has happened and what Mallinckrodt has done to help clarify any questions that have arisen about the use of inorganic mercurials on the golf course.

Misunderstanding the significance of the EPA's revocation of mercurial fungicide registrations earlier this year, many turf managers have labored under the illusion that this move automatically removed all such materials from interstate commerce.

These notices were actually the mechanism through which EPA and industry, via requests for Advisory Committee review or hearings, can fully review the scientific evidence upon which to base an eventual decision about the mercurials in turf use.

Upon receipt of the revocation notice covering the mercurial fungicides, several firms immediately requested Advisory Committee reviews of these products. The requests have been acknowledged by the EPA, and during the period preceding final resolution of the questions by the Advisory Committee and EPA, these mercurial fungicides may be sold and used in turf management normally, as before, in all except the few states where all mercurials have been specifically banned.

Mallinckrodt has submitted two reports to the EPA. The first included the results of a preliminary survey of golf superintendents and other experts as to their views regarding the need for the mercurials in golf course maintenance. Preliminary analytical data also indicated that golf course greens still held substantially all the mercury that had been applied in their upper soil horizons. These studies were elaborated upon and a second report of those results submitted. The following slides will illustrate the study plan and the results obtained.

In summary, expanded studies to sample in additional geographic areas and more comprehensively sample all the selected sites confirmed the highly fixed nature which the inorganic mercurials form in the turf, thatch and soil.

Examination of golf course greens in several climatic and soil conditions, and with decades of mercurial use history, show no evidence that biomethylation of mercury occurs in the turf of golf course greens.

Examination of nearby streams and fish in them show no abnormal levels of mercury which can be attributed to inorganic mercurials in this use pattern even after several decades of use. The sum of all possible routes for movement of inorganic mercurial residues from golf course greens have not added a significant amount to existing levels of this naturally occurring element in the aquatic environment.

What of the future then? Certainly a greater awareness of the environment is with us. Manufacturers will have to spend more and more on product development to get answers to environmental implications to fish and wildlife as well as humans. It is hoped that rational decisions can be reached based upon facts rather than political expediency or popular fancy.

The consumer will have to use greater care to see that label instructions are followed. Disposal of spray tank residues, etc., will have to be done in ways which do not contaminate streams and ponds, etc.

Operators will almost surely have to become registered; and they should welcome the opportunity to set themselves apart as professionals from the fly-by-night persons.

Future advances in application may come by injection of pesticides and fertilizer into the irrigation water as more automation and better designed systems are installed. In another way the systemic fungicides apparently offer an approach to treatment in larger dosages that can be drenched into the soil less frequently as a reservoir for root absorption and translocation. Encapsulation for controlled release is another possibility which might develop.

Greater use of biological control may become a reality. There are saprophytic organisms which do tend to keep the parasites in check. So you might end up spraying your crop with fungi which do good rather than harm. I'm not certain just how we will accomplish this -- but you can always tell the good guys from the bad guys because the good guys wear white hats.

In any event, new pesticides will be costly because of all the developmental work which must go into proving the value and safety of a new product. The odds for financial success are less favorable than heretofore and many companies have abandoned research on pesticide products. New products will have to demonstrate that their higher cost enables the grower to get more yield in terms of food, fiber, or recreational turf than he has ever been able to get before with the same expenditure of time or money. Progress is being made, but the rate will probably be slower.

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1. Annual dues, \$30.00, payable on or before May 15th each year. Dues are based on annual due date non-prorated.

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 \$30.00 registration fee. For further information on dues, contact Dick Haskell, Treasurer, Northwest Turfgrass Association.