NORTHWEST TURFGRASS ASSOCIATION

Proceedings Of The 30th Northwest Turfgrass Conference

Sept. 29, 30 & Oct. 1, 1976
Spokane Sheraton Hotel
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PRESIDENT'S MESSAGE

John Monson

It was a pleasure to serve as President of the Northwest Turfgrass Association through 1975-76. I wish to express my sincere appreciation to the officers and directors and committee chairmen who worked hard to help run the affairs of the Association and to make the recent Turfgrass Conference a big success.

I believe we accomplished a considerable amount in 1976 through the continuation of the Association's support to the Washington State University research program. I compliment Al Blair for his continuing leadership role in the Finance Committee for the Special Research Fund which has now been going for two years and it appears that there will be adequate funds to continue for the third year.

The annual conference is the ultimate gathering place each year for all Association members, so take it upon yourselves to let everyone know about the conference, when it will be and where, and encourage them to attend. It is no more difficult to prepare for a conference for 300 or more than it is for a conference of 150.

I extend my best wishes to Joe Lymp and his officers and directors for the forthcoming year.

NORTHWEST TURFGRASS ASSOCIATION

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ADAPTING TURFGRASSES TO SHADE[1]

John Thorne[2]

It has been estimated that over 20% of all turfs are maintained in some degree of shade. I'm sure you can all think of those problem areas where little or no grass will grow. They are normally associated with trees but can also occur on the north side of buildings. Shade is a common component of golf course design, in that the trees surrounding tees and lining the fairway contribute to both aesthetics and course difficulty. Greens are usually spared this problem, unless they are flanked by dense shrub or tree plantings as part of their landscaping. Under these circumstances, shade-associated problems -- such as decreased air circulation, elevated relative humidity, and increased disease -- are present.

While shade itself produces a microclimatic change, its effects can be modified by local weather conditions. For example, a 1966 Pennsylvania survey of 326 golf course superintendents indicated shade as their number one maintenance problem. But a similar Washington survey conducted by Goss, Wilcox and Law in 1967 ranked shade tenth behind weeds (1st), wear (2nd) and diseases (8th). The differences between the two surveys undoubtedly involved the vastly different state climatic conditions. A decade after that survey was published the maintenance of good turf under shaded conditions continues to be a major challenge to professionals and

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1/ To be presented to the 30th Annual Northwest Turfgrass Association Conference, Spokane, WA, September 29, 30, and October 1, 1976.

2/ Agronomist, Jacklin Seed Company, Spokane, WA.

homeowners alike. This is in spite of varietal development research and considerable sophistication in our understanding of the natural microclimate encountered in the shade. Because of the aesthetic value of ornamental plantings, the superintendent usually can only minimize the problems and make the best of the situation. He should know that he cannot expect to maintain as high a quality of turf in the shade as full sun. However, he can often provide acceptable turf. To do this, he needs to develop a basic understanding of the shade environment and its effects on the growth and development of turfgrasses.

THE SHADE ENVIRONMENT

The most obvious effect of shade is the reduction in solar radiation. As sunlight filters through a dense tree canopy, deciduous tree leaves can often almost totally exclude light. Trees such as maples, oaks, and linden will provide the greatest light reduction. Others such as birch, locust, or poplar allow considerable light in the form of sunflecks to reach the turf.

Thus shade can be extremely variable, from relatively bright open shade where peripheral trees block only direct sun, to a complete overhead canopy of leaves which filters and restricts all incoming radiation. Unless the canopy is dense, shade can also be extremely dynamic. Solar altitude changes during the daily cycle cause bright sunflecks and deep shade to continuously move to new positions. More rapid fluctuations result from wind-driven leaf movements.

The effect of reduced light intensity on turf is initially a reduction in photosynthesis, the fixation of atmospheric carbon dioxide (CO_2) into sugars. For most turf species, photosynthesis in an unshaded condition will exceed respiration, a process by which sugars are utilized as an energy source in plant growth. Adequate carbohydrate reserves are critical for the seasonal development of roots and shoots. When the photosynthetic rate is reduced below the level of carbohydrate accumulation, continued respiration can exhaust supplies and lead to the deterioration of turfgrass quality.

Not only intensity of solar radiation is affected by tree leaves, but altered light quality is also a major problem encountered beneath deciduous trees. Their leaves will absorb most of the red and blue wavelengths of visible light, but show less interest in the green or infrared wavelengths.

While this causes the leaves to appear green, it also means that the turf below receives transmitted light that is greatly enriched in green and infrared wavelengths. Many growth processes relative to shaded conditions (eg. inhibition of seed germination, elongated stem, leaf, and internode growth, and depressed reproductive growth) are caused by this wavelength imbalance.

No great change in light quality occurs in the shade of evergreen trees such as fir (in western Washington) and pine (in eastern Washington). These needles (leaves) merely act as a neutral filter, reducing the intensity with little spectral change. Perhaps part of the difference between the Pennsylvania and Washington surveys was due to the deciduous vs. evergreen tree shade encountered.

Other factors affecting turfgrass growth are associated with the peculiar microenvironment of shade. Air movement restricted by vegetative growth is a particularly covert problem. Due to inadequate mixing of the atmosphere, transpiration by the turf and trees causes increased relative humidity. Dews and rainfall are also very slow to evaporate, creating ideal conditions for disease development.

The moderation of both air and soil temperature by the tree canopy significantly alters the shade environment. Day temperatures will be lower without direct sunlight and night temperatures higher because radiation cooling is prevented by the tree canopy.

Tree-root competition for water and nutrients provides eastern Washington superintendents a major challenge. Shallow feeder roots can seriously deplete the soil of these important products, especially when the infrequent rainfall is also intercepted by the tree canopy. Deep fertilization and infrequent, heavy soaking will help discourage shallow tree roots.

TURF GROWTH IN SHADE

Plants that are shade-adapted actually thrive under the environmental conditions that I have just described. Their dark green leaves develop into broad, thin antenna for gathering the dim light. Their greater photosynthetic efficiency allows them to "turn-on" at much lower light intensities than sun plants brought into the shade.

Because of this, they can accumulate carbohydrates and grow at light intensities prohibitive to sun plants. If moved into bright sun, their sensitive photosynthetic mechanism would actually be damaged.

The respiration of shade-adapted plants is almost unaffected by temperature, a protective mechanism which also dictates slow growth rates. The respiration rate of most sun plants is strongly affected by temperature - usually doubling for every 10 degree rise in temperature. This can burn up an extraordinary amount of carbohydrates.

True shade plants are also not overly responsive to the enhanced infrared light found under deciduous canopies. Thus they maintain conservative growth patterns and are not forced to produce undesirable plant characteristics as are sun plants brought into the shade. For example, a truly shade adapted grass would retain a horizontal growth pattern. Most sun-adapted grasses develop long, thin leaves and take on an upright growth pattern. At low light levels, a reduced shoot density occurs in sun grasses as root, tiller, and rhizome production drops off.

Another protective mechanism of true shade plants is an ability to store water without becoming overly succulent. Turfgrasses, on the other hand, respond to reduced light intensity by developing increased succulence due to underdeveloped vascular and support tissue, and thinner cell walls. Shade grown turf is thus particularly sensitive to disease attack. This succulence also leads to decreased tolerance to wear, heat, cold and drought stress.

Since most, if not all, cool season turfgrasses are sun species and not truly shade plants, their existence in dense shade will be threatened as follows: (1) seriously reduced photosynthesis due to reduced solar radiation, resulting in a depletion of carbohydrate reserves, and producing undesirable plant characteristics, such as thinner leaves, reduced shoot density, reduced shoot and root growth, reduced tillering, and reduced sod strength; (2) more succulent leaf tissue, predisposing turf to injury from wear, disease, or climatic stress; and (3) increased disease development caused by decreased air turbulence, increased relative humidity, prolonged dews, and a more delicate, succulent leaf structure.

TURF SPECIES WITH MODERATE SHADE TOLERANCE

A number of turfgrass species can be maintained as a suitable turf under moderate shade, despite the lack of true shade adaptation. The key is a proper management program coupled with selection of species with acceptable levels of shade tolerance. The following table lists the relative shade adaptation of cool season turfgrasses in Washington.

In western Washington, shaded areas are usually dominated by bentgrass, *Poa annua*, and *Poa trivalis*, especially on wet, poorly drained sites. In fact, the heavy precipitation, low levels of daily solar radiation, and acid soils encourage the dominance of these species almost everywhere there. Although these grasses will, for the most part, perform quite adequately, their limitations in terms of wear, heat, cold, drought, or disease tolerance must be recognized.

TABLE 1. Relative shade adaptation of cool season turfgrasses (upper level may vary within groups)

DENSE SHADE	MODERATE SHADE	OPEN SHADE	MINIMUM SHADE
Ground covers only	Fescue species*	Colonial bentgrass	Most Kentucky bluegrass
		Creeping bentgrass	
	*Poa trivialis***	Tall fescue	
	*Poa annua***	Perennial ryegrass	
	Glade Kentucky bluegrass		
	A-34 Kentucky bluegrass		
	Nugget Kentucky bluegrass		

* DRY SHADE - Grouping includes Creeping Red, Chewings, Sheeps, and Dwarf Hard Fescue

** WET SHADE

Eastern Washington shaded areas are usually dominated by one or more species of fescue. Over the years, a reputation has been established for an ability to persist in dry, shaded conditions. For this reason, grass seed mixtures formulated for shade have traditionally included large percentages of fine fescues. There are several species to choose from and often many varieties within a specie. Table 2 describes the major fescue characteristics.

The performance of tall fescue, perennial ryegrass, and bluegrass in the shade has been variable, but generally they have proven medium to poor. Recently, however, three improved varieties of Kentucky bluegrass have demonstrated moderate shade tolerance, often outperforming red fescues, especially on wet sites. Glade, Nugget, and A-34 are now finding their way into more and more shade blends, especially when the site is to be sodded. Their resistance to powdery mildew is unusual for Kentucky bluegrasses. Glade's improved resistance to the diseases encountered in the sun as well has sparked a reputation as a "dual-purpose" turfgrass.

SHADE ADAPTIVE MECHANISMS

What factors, morphological or physiological, confer a degree of shade tolerance to one variety or specie when others cannot persist? Surely resistance to shade-encountered diseases, especially powdery mildew and leafspot, contributes. But other adaptive mechanisms are functioning as well. Red fescues, for example, retain their horizontal leaf angle at low light intensities and modified spectral quality. Bluegrasses demonstrate an upright growth pattern and are possibly less efficient at intercepting available light than fescues. Certainly a low growth profile allows less photosynthetic tissue to be mowed away.

As mentioned previously, there are a number of additional mechanisms of shade adaption evident in true shade plants (non-turfgrass species). These include anatomical and physiological characteristics which allow them to thrive in deep shade (but usually not in full sun). These adaptive mechanisms are fairly well understood. Shade adaptive mechanisms of turfgrasses must be inves-

THE FINE FESCUES (all are tolerant of dry, moderate shade)				
FESCUE TYPE	GROWTH HABIT	SPREADING ABILITY	TYPICAL VARIETIES	COLOR**
Hard Fescue	Narrow leaves, low growing, attractive turf, weak seedling vigor. Drought tolerant.	bunch type, very little spread (by tillering only)	Biljart Scaldis Durar (not a turf type)	Dk green Dk green Dk green
Sheeps Fescue	Very low growing narrow, tough, wirey blades. Very drought tolerant. Tufted densely.	bunch type, very little spread (by tillering only)	Barok Covar	Blue-Grey
Creeping Fescue	Medium texture, drought tolerance, and growth Poor heat tolerance.	little spread	Dawson Golfrood Oasis	Dk green Lt green Md green
Spreading Fescue	Broader leaves (more like Kty. bluegrass). Moderately tall growing (should be cut at 2-2½")	Fairly good spreading, slowly fills in damaged areas.	Boreal Ensylva Fortress Novorubra Olds Pennlawn Ruby	Md green Md green Dk green Dk green Md green Md dark Dk green
Chewings Fescue	Narrow leaves, low growing, densely tufted. Poor heat tolerance. Many varieties are suscept ble to powdery mildew.	bunch type, very little spread (by tillering only)	Atlanta Banner Barfalla Cascade Halifax Highlight Jade Jamestown Koket Minuet Scarlett Waldorf Wintergreen	Md dark Md dark Md dark Md dark Md green Lt green Md dark Md dark Md dark Md dark Md dark Md dark Md dark

* Ranked according to decreasing shade tolerance by Dr. Robert Duell, Rutgers University. Order may change considerably with local environment and management.

**Color will vary with fertility and maintenance.

tigated more thoroughly so that plant breeders can develop truly shade tolerant turfgrass species and varieties.

WHAT CAN YOU DO?

1. Increase light intensity at ground level by selectively pruning limbs of a dense canopy, allowing sunflecks to move across the shaded turf. Prune lower limbs to a height of seven feet or more to allow penetration of early morning and late afternoon sunlight.

2. Enhance light interception by mowing one-half inch above normal in the shade. This also helps conceal the thin turf.

3. Improve air drainage by thinning or removing dense underbrush or shrubs in the path of the prevailing wind. This will lower the relative humidity and enhance drying of the turf, helping reduce disease.

4. Provide fungicides where necessary. Benomyl or cycloheximide will both do an excellent job on powdery mildew.

5. Prune shallow feeder roots with a rototiller when establishing turf in shaded areas. Deep fertilization and irrigation will discourage their return.

6. Establish turf in the fall under deciduous trees to take full advantage of the increased light intensity.

7. Minimize succulence by irrigating only when needed and then deeply.

8. Avoid excessive fertilization, helping to be conservative in its growth and development. This is very important for good root development. Increased tissue succulence is also avoided -- helping the plant better withstand environmental stresses and disease attacks.

9. Minimize wear by routing carts away from trees.

Presently no turfgrass specie will survive as a turf in dense shade. Research in this area is ongoing, but if you are unable to grow acceptable turf despite all attempts, you may need to use a truly shade tolerant ground cover. In non-use areas, English Ivy, Myrtle, or Pachysandra may be necessary.

WATER AND SALT PROBLEMS[1] IN TURFGRASS PRODUCTION

Jackie D. Butler[2]

In the more arid regions of the U. S. there are several indigenous, and often serious, turfgrass problems. A general shortage of water for irrigation, and soil and water salt problems are frequently of concern to the turfgrass professional in drier areas of the west.

WATER

In the past, grasses used for turf have not varied much, if any, between areas that receive adequate or near adequate precipitation for quality turf, and those areas where serious moisture deficits exist. Today, with a rapid increase in population in the drier regions of the U. S., and a general concern for food production, the use of so much water for turf irrigation is being seriously questioned. And, in Colorado when priorities for water use have been established, water for turf irrigation has normally been given a very low priority.

The need for careful planning of water use throughout the U. S. is evident if one considers that the dependable supply of water, as well as man's ability to store and transport this exhaustible resource is limited. The largest dependable fresh water supply for the U. S. is anticipated to be about 650 billion gallons per day (Lunin).

1/ To be presented to the 30th Annual Northwest Turfgrass Association Conference, Spokane, WA, September 29, 30, and October 1, 1976.

2/ Extension Associate Professor, Dept. of Horticulture, Colorado State University, Fort Collins, CO.

Presently in the U. S., about 400 billion gallons of water are used daily. By 2000 A.D. the projected daily water needs will be in excess of 100 billion gallons. Therefore, by 1980 it is likely that water will need to be used at least twice before release to the environment.

WATER CONSERVATION

In the more arid regions of the U. S., there is a definite need for careful planning in developing additional turf sites. In the future the water requirements and allocations for golf courses, parks, home lawns, etc. will have to be justified, and in much of western U. S. regulations will determine just how much water of a given quality can be used for a given purpose.

An important aspect of water economy for any turfsman is the consideration of conditions on site. Too often slopes and flat, low areas are given the same treatment. When this happens, drainage, as well as drought, often becomes a problem. The removal of topsoil can reduce the rate of infiltration, and the ability of the soil to store and supply water to plants. Areas that are protected from the wind and sun require less water than more exposed sites. Thus, it is evident that a site review could point to ways of saving significant amounts of water without detracting from turf quality.

Tremendous improvements have occurred in turfgrass irrigation equipment during the last decade. Most irrigation systems can be used, or altered, for efficient water use. Night watering, cyclic watering on slopes (to allow for better infiltration with minimum runoff), etc. will allow better utilization of water. Because of poor planning (for example, the same valve operates heads on turf grown on very heavy and very light soils), and the ease of pushing a button, it has become easy to over water and to waste water. Improper irrigation has caused frequent disease and weed, notably *Poa annua*, problems.

On site inspection to determine turfgrass water needs seems to be done less and less. And, when it is done, the presence of one small dry spot often calls for the activation of the whole system. Many irrigation systems give very poor distribution, even if there is no wind, and it seems that virtually no turfsman will work on improving distribution if simply more water will solve the problem.

A good wear tolerant turf depends upon the relationship of soil, air and water. A turf grown under wet soil conditions will usually lack a suitable root system to withstand stress; whereas, inadequate water may produce a sparse stand, and a turf that can be easily damaged by traffic.

Turfgrass watering programs remain more of an art than a science. Factors such as footprinting and loss of leaf lustre are useful indicators of drought stress, and the need for water. Indicated water need may or may not call for immediate irrigation. An immediate or delayed need for water will depend on environmental conditions. If available water for the plant is limited and evapotranspiration losses are high, it is not unusual to see turf go out in a short time. Tensiometers, soil moisture blocks and other sophisticated equipment may be used as a basis for irrigating. Observations indicate that, through conditioning, it may be possible to "harden" turfgrass to where it will provide an acceptable turf through 2-3 weeks or more of dry weather without watering.

In the drier areas of the West, it has not been unusual for golf courses to plant high water requiring turfgrasses from fence to fence, and to face annual water bills of $40-50,000 or more. Other segments of the turf industry have tended to overuse high water requiring turfgrass and other plant material. True, the irrigated greenery is an oasis in the desert; however, with water in short supply, many governmental agencies and landscape planners are seriously looking for ways to conserve water. Today, primary thoughts are toward the use of more "native" or low water requiring plants, with high quality turf and landscape material being located where they will be more fully utilized and enjoyed.

TURFGRASSES FOR DRY AREAS

In the northern cool regions of the U. S. there are several "turfgrasses" that occur naturally. Some of these grasses are now used extensively for turf, and others have turf potential. A brief review of some of the grasses and their possibility for turf use in dry areas is now in order.

Buffalograss is a short prairie grass which has good drought tolerance. Irrigation can be beneficial in establishing stands of buffalograss, but watering, unless very carefully done, will cause it to be replaced by cool season grasses. The lack of competitiveness of buffalo is partially due to its low growth habit. Buffalograss is very "shade intolerant". Buffalograss is a warm-season grass that is not competitive under conditions of poor light and spring moisture. Such conditions may be adequate for cool season grasses, such as Kentucky bluegrass, quackgrass, and tall fescue.

Buffalograss, in pure stands, under certain climatic and soil conditions, may not require mowing; however, it will withstand frequent and close mowing. Mowing is a useful tool for keeping competition for light from taller growing grasses and forbs in check. It needs little, if any, supplemental fertilizer for satisfactory growth.

Pure stands of buffalograss are quite variable and patchy with individual plants ranging from yellow-green to blue-green.

Buffalograss is an important grass for unirrigated home lawns, fairways, roadsides, etc. in the high plains. This grass does not seem to do well at altitudes above 6,000 feet. Buffalograss will stand traffic well.

Blue grama is often associated with buffalograss in semi-arid regions, and it is known to survive extreme drought. It is a warm season grass and produces short rhizomes that may result in a relatively dense turf. Blue grama requires little, if any, supplemental fertilization under arid conditions. It can be maintained at a height of 2 to 3 inches. Its population under arid conditions tends to increase when taller growing grasses and weeds are mowed low or heavily grazed. Because of its open and somewhat bunchy growth, it does not have enough density to form a really smooth turf. Blue grama can be readily propagated from seed, but requires special machinery and treatment to assure a reasonable stand when planted under arid conditions.

Saltgrass - Desert saltgrass grows well on dry sites and stays green during long dry periods. Without mowing, its height usually does not exceed 4 to 6 inches. Saltgrass turf is often relatively low and open, but some plants may produce a dense turf. It has excellent wear resistance, and it can be found on walkways and playgrounds where other grasses do not exist. Some drawbacks of this grass result from the fact that it is a warm season grass and may not compete well with cool season grasses that receive good maintenance. Although especially sought after by park superintendents in Colorado, there is no commercial source of saltgrass seed. It can be established vegetatively from sod pieces. The rhizomes may be 6 to 8 inches deep in native soil. Nurseries established from rhizomes produce stolons on the soil surface the second year.

This grass will grow through asphalt causing it to break and deteriorate, and it can become a serious weed in landscape plantings.

Bermudagrass - Although "common" bermudagrass is found widely in northern Colorado, the hardiness of the elite turf types in cooler areas is questionable. Bermudagrass found in cool, dry areas is normally coarse and stemmy and produces an open, low-density turf. This warm season grass may exhibit exceptionally good drought tolerance, and it may deserve testing for use on certain adverse growing sites.

The wheatgrasses, in general, have exceptionally good drought tolerance, and are found growing under adverse conditions throughout cool dry areas. The wheatgrasses show little promise of providing fine, high-density turf. Their accepted place is normally as range grasses and for roadside erosion control. The wheatgrasses are frequent components of native grass mixtures for droughty areas.

Tall wheatgrass - This coarse bunch grass often grows 3 to 4 feet high. It is not of value for a high density turf, but has ornamental value for certain sites. This grass will remain fairly green through extended drought periods.

Western wheatgrass - This strong, drought resistant rhizomatous grass is found growing widely in the West. It is found growing at high altitudes and under very droughty conditions. Western wheat will remain bluish-green during extended dry periods. However, under extremely dry conditions it may produce only very sparse stands. Western wheatgrass does not produce a dense turf with low cutting (2 inches) and frequent irrigations. At 4 to 5 inches mowing height, and infrequent watering, this grass can develop into a tough, drought resistant turf of fair density.

Quackgrass - This rhizomatous grass can develop a strong sod that will remain green through extended drought periods. It may retain good density when subjected to either high or low levels of maintenance. Quackgrass is a restricted noxious weed in many states. Although long considered a serious weed of cultivated fields, it seems to have a promising place in turfgrass culture. Under conditions apart from cultivated crop areas it seems to be worth further consideration for revegetation projects. As laws and attitudes change, this grass may become important for turf.

Crested wheatgrass - Crested wheatgrass has very good drought tolerance. It has the disadvantage of turning straw colored in the heat of summer, but it is green in spring and fall. The major disadvantage as a "turfgrass" of this relatively fine-textured grass is its bunchy growth habit. The slowly spreading bunches can be a nuisance on golf course roughs when the raised clumps cause undue playing hazards. Crested wheatgrass originated in Russia, but has achieved it major success in the U.S. Fairway crested wheatgrass is sometimes used for lawns, particularly in the northern plains states. It needs only infrequent watering to remain green.

Other wheatgrasses - Two other coarse stemmed wheatgrasses adapted to droughty and semi-droughty conditions that may have use on specialized sites are intermediate wheatgrass and thickspike wheatgrass.

Smooth brome - This coarse-textured, strongly rhizomatous grass was introduced from Europe, and it is now quite common throughout the northern U. S. This brome can be found growing under very dry conditions and at high altitudes. Smooth bromegrass plants often appear with distinct differences in density, texture, etc. Smooth brome will remain green through extended periods of drought. Smooth bromegrass plants may be used for pure seedings, and it is a frequent component of mixtures for revegetating areas. It seems to offer promise as an economically important turf of the region. About 20 named varieties of smooth brome are available. Some 1,500 individual plants of smooth brome are being screened at Colorado State University for "better" turf types; of these, 15 that seem the most promising are being increased. Perhaps in the not-too-distant future specially adapted smooth bromes will become available, especially for use on playgrounds, golf course roughs, roadsides, roadside parks, etc.

Tall fescue - In the Transition zone, between the cool-and-warm-season areas of the U. S., this grass is considered to have good drought tolerance. The deep root system of tall fescue would be expected to contribute to good drought tolerance. However, under natural arid conditions there may be little moisture that reaches the "root area" of tall fescue. With heavy, but infrequent irrigation, tall fescue often remains green and does well through much of the growing season. This coarse grass certainly seems to have more of a niche in dry areas as a turfgrass than it now enjoys.

Kentucky bluegrass - This grass is generally considered to be very intolerant of drought, but it is found persisting in certain areas with about 12 inches yearly precipitation. Often Kentucky bluegrass will go dormant during prolonged dry periods, but there are individual plants that remain green well into extended dry periods. In 1974 some 200 Kentucky bluegrass selections were made from semi-arid regions of Colorado, and these have been increased for further evaluation, both for drought tolerance and turf quality.

In 1975, Dernoeden at Colorado State University, in a project supported in part by G.C.S.A.A., did extensive research on the drought tolerance of many varieties of Kentucky bluegrass. In general "common" type Kentucky bluegrasses exhibited the best tolerance to drought. Unfortunately, these common types do not possess turf characteristics which are normally desirable such as good color, density and disease resistance. For quality turf, savings on water from the use of common types could be offset by increased costs for pest control.

SALTS

Because of the shortages of water in the western U. S., turfgrass irrigation is often dependent upon low quality water. In the West sewage effluent is frequently used to irrigate turf, and the availability of effluent water is considered a valuable asset that can dictate the location of turf installations.

For irrigation, the contamination of water with nitrates, phosphates and sediment may not be of great concern; in fact, certain contaminants may be beneficial for plant production. A major concern in plant production is the presence of significant amounts of soluble salts, especially sodium in the irrigation water.

In order to determine the suitability of water for irrigation, a water test will provide general information on whether or not the water is suitable for irrigating plants. It is also necessary that one know the crop to be grown, soil and climatic conditions, etc. before a sound judgement on the suitability of water for irrigation can be made. The table below presents basic guidelines for water use relative to salt content.

TABLE 1: Salinity hazard of irrigation water.

Hazard	Dissolved Salt Content ppm	EC - micromhos/cm
1. Waters for which no detrimental effects will usually be noticed	500	750
2. Waters which may have detrimental effects on sensitive plants	500-1000	750-1500
3. Waters that may have adverse effects on many plants and require careful management practices	1000-2000	1500-3000
4. Waters that can be used for salt tolerant plants on highly permeable soils with careful management practices and only occasionaly for more sensitive plants	2000-5000	3000-7500

C.S.U. S/A .506

Salt Affected Soils

Saline soils contain large amounts of water soluble salts which limit germination and plant growth. Sodium soils are high in exchangeable sodium. If more than 15% of the ions retained by the clay in the soil is sodium, then the soil is considered to be a sodium soil. Saline sodium soils contain large amounts of salts as well as more than 15% exchangeable sodium.

Saline soils are not reclaimable by chemical means. However, leaching can remove salts from the root zone. The soil must have adequate internal drainage to allow the water to pass through and remove the salts. The quantity of water required for leaching is related to the amount of salt in the soil, the final salt level desired, and the quality of the irrigation water.

The amount of good quality irrigation water passing through a foot of soil will decrease the salt concentration by the approximate precentage listed below:

Acre-feet of water/acre	% salt reduction
½	50
1	80
2	90

C.S.U. S/A .503

Since sodium soils are high in exchangeable sodium, such soils may be treated by replacing absorbed sodium with a soluble source of calcium. Calcium in the irrigation water, native gypsum or chemical amendments such as gypsum can supply calcium to reduce the sodium. Water is necessary to dissolve applied or native gypsum. One acre-foot of irrigation water will dissolve about one ton per acre of gypsum.

Soil test results in the West often provide information on soluble salt levels. When the pH is above 8.5 or when salt levels are high, a sodium absorption ratio (SAR) test should be considered necessary. The SAR test is reported as a special ratio of sodium to calcium plus magnesium. A gypsum test in conjunction with the SAR test provides information on native gypsum in the soil. If sufficient gypsum is present in the soils, additions of this material may not be necessary and reclamation can proceed provided water can move adequately through the soil.

SALT TOLERANT TURFGRASSES

In many instances, because of impervious soils, the use of water high in salts, etc., leaching to lessen soil salt problems does not provide for satisfactory soil improvement. As with other crops, more salt tolerant turfgrasses are sometimes sought and used to provide a solution, although perhaps temporary, for salt problems.

Kentucky bluegrass has a low salt tolerance. As soluble salt readings approach 4.0 mmhos/cm, problems in establishment and maintenance of Kentucky bluegrass turf can be anticipated. Typically, Kentucky bluegrass, especially during hot summer weather, will thin and brown out as salt levels exceed 4.0 mmhos/cm. Grasses such as perennial ryegrass, creeping bentgrass, quackgrass and alkaligrass will thrive as the Kentucky bluegrass goes out. The noticeable presence of such grasses is often indicative of salt problems in Kentucky bluegrass turf. Although there are probably significant differences in Kentucky bluegrass cultivar tolerance to soluble salts, such information is presently quite sketchy.

Red fescue is sometimes grouped with Kentucky bluegrass for salt tolerance. However, field observations would indicate that this grass is superior to Kentucky bluegrass in salt tolerance. Golfrood, an earlier cultivar of fine fescue, was said to be salt tolerant (tolerated more salts than certain other cultivars).

The colonial bentgrasses are normally considered to have salt tolerance below 4 mmhos/cm. Whereas, creeping bentgrass cultivars appear to exhibit relative salt tolerances of 8-12 mmhos/cm. In the west, Seaside creeping bentgrass, which has medium salt tolerance, is sometimes used where salts have proven to be a limiting factor in turfgrass production.

Field observations indicate that <u>perennial ryegrasses</u> grown for turfgrass will tolerate salt levels of 8-10 mmhos/cm or more. With the development of elite perennial ryegrasses, more dependence has been placed on them for turfing areas relatively high in salts. And in regions where salt problems are common, there often seems to be merit in the use of Kentucky bluegrass - perennial ryegrass mixtures. More information on the salt tolerance of specific perennial ryegrass cultivars is needed. Perhaps, in the not too distant future there will be perennial ryegrass cultivars marketed specifically for use on sites with salt problems.

<u>Tall fescue</u> is tolerant to salt levels of 8-10 mmhos/cm. Currently most of the turf developmental work with tal l fescue is being carried out in the East, where salt problems receive little, if any, consideration. As more refined cultivars of tall fescue become available they will likely, because of drought and salt tolerance, become more widely used in the West.

<u>Bermudagrass</u> will tolerate salt levels of 16-18 or more mmhos/cm. Even with substantial improvements, bermudagrass semms to offer only little promise to provide high quality turfgrass for northern areas of the West.

Three <u>alkaligrasses</u> - weeping alkaligrass (*puccinellia distans*), lemmon alkaligrass (*P. lemmoni*), and Nuttall alkaligrass (*P. airoides*) - are found growing rather widely in the West. The alkaligrasses seem to have relative salt level tolerances of 30-40 (or even more) mmhos/cm. In the West on salty sites, alkaligrass is often an alternative to mud. Lemmon and weeping alkaligrass are fine textured, low growing, cool season bunch grasses. These grasses appear to be quite similar to Kentucky bluegrass except that they are not rhizomatous. These grasses have a rapid rate of tiller production, and they develop extensive root systems. The alkaligrasses are not found growing where drought stress is severe. The U.S.G.A. Green Section has supported management studies on alkaligrass at Colorado State University. Although "Fults" weeping alkaligrass will tolerate a short (golf green) mowing height, it did not, during the first year, produce density comparable to creeping bentgrass. At higher cuts it has been possible to produce an attractive turf of weeping alkaligrass.

Desert saltgrass is a strongly rhizomatous, warm-season perennial highly tolerant to salt. This grass is found throughout the West, eastward to Iowa and Missouri. Its presence is especially noticeable on heavy use playgrounds in cities of the West, and on salt flats where it may be found as a companion of alkaligrass. This dioecious grass is a poor seed producer, and propagation, as noted earlier, presents problems.

Unfortunately, it is not possible within the scope of this presentation to discuss other grasses that would further point out variability in salt tolerance, and their possible use for vegetating salty sites.

PRE AND POST EMERGENCE[1]
POA ANNUA CONTROL PROGRAM

Thomas W. Cook[2]

Work on the *Poa annua* control program has progressed rapidly in 1976. Considerable refinement of rates and procedures has been accomplished on both bluegrass lawn turf and bentgrass putting turf. At this time there appear to be several factors that are very important in determining whether or not control is successful.

Foremost is the need for timely pre-emergence herbicide application to prevent *Poa annua* recovery from germination. All tests conducted so far show that when no pre-emergence control is used, *Poa annua* recovers rapidly from germinating seed. In many cases germinating seedlings have been ovserved as soon as three weeks after apparently successful post-emergent applications of endothall. Repeated applications of endothall without pre-emergence herbicides have reduced *Poa annua* populations, but not to the extent that pre-post emergent combinations have.

Next is the importance of growth rate of the turf as affected by season and nitrogen fertility. For example, in western Washington best control of *Poa annua* in Kentucky bluegrass is achieved between June and mid-September. This coincides with the peak growth period for Kentucky bluegrass in this area. Early spring applications of endothall are often ineffective and may injure

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1/ To be presented to the 30th Annual Northwest Turfgrass Association Conference, Spokane, WA, September 29, 30, and October 1, 1976.

2/ Turfgrass Research Associate, Western Washington Research and Extension Center (WSU), Puyallup, WA.

the slow growing Kentucky bluegrass. Late fall applications often give good *Poa annua* kill, but do not allow time for the Kentucky bluegrass to fill in the gaps left by dead *Poa*. Best *Poa annua* control in bentgrass putting turf comes between late April and mid June and again during the first three weeks in September. This also coincides with peak growth periods for bentgrass putting turf in western Washington. Mid-summer applications of endothall often cause unacceptable discoloration of the bentgrass turf. Nitrogen fertility seems to influence the tolerance and rate of fill in by both bentgrass and bluegrass turf. With both grasses, turf growing slowly due to lack of nitrogen will show more discoloration and be slower to fill in areas where the *Poa annua* is killed. For this reason, optimum fertility aimed at juvenile vigorous turf facilitates best control of *Poa annua* and minimum injury to desirable turfgrasses.

Weather conditions during the treatment period are very important. During peak control periods endothall gives best control when applications are followed by at least one day without rain or irrigation. Significant rainfall during or shortly after application reduces the effectiveness of endothall. On the other hand, it does not appear critical that the sun be shining though activity may be slower under cloudy conditions. Temperatures above 85^{o}F may contribute to a loss of selectivity. Finally, endothall applied to turf under drought stress may cause general injury and a loss of selectivity. Fortunately, with our mild climate these last two factors are not major considerations.

One other factor about which there is some confusion concerns spray volume. My general impression based on work done so far is that spray volumes in excess of 100 gal/acre maximize *Poa annua* kill by enhancing physical coverage of the plants in the field. However, generally acceptable control has been achieved with volumes as low as 50 gal/acre. It is possible that lower volumes may give good results on short cut turf, but not on taller turf. More recently it appears that addition of a spreader may enhance control at lower volumes. We hope to get more information on this next season.

Successful Experimental Programs

Kentucky Bluegrass Lawn Turf - 3/4" to 1-1/2"

1. Encourage growth with adequate fertilizer during late spring.

2. Apply pre-emergence herbicide near the end of May or in early June and thoroughly water in. Ex) bensulide 10-12 lb ai/acre.

3. One to two weeks later apply endothall at 6 to 8 qts/acre (equals about 2-3 lb acid equiv.). At lower rates add spreader at rate of 1 pt/100 gal spray solution.

4. One week to 10 days later apply nitrogen fertilizer to stimulate recovery and filling of bare areas.

5. Repeat endothall application 6 to 8 weeks after first application if necessary. Follow all repeat applications with adequate nitrogen fertilizer.

Bentgrass Putting Turf - 3/16" to 1/4"

1. Encourage growth with adequate fertilizer during spring.

2. Around mid-April apply pre-emergence herbicide. Ex) bensulide 10 lb ai/acre.

3. One to two weeks later apply endothall at 2 - 2½ qts/acre (equals about 3/4 to 1 lb acid equiv.)

4. One week to 10 days later apply nitrogen fertilizer to stimulate recovery and fill in.

In general, the program for *Poa annua* control in Kentucky bluegrass has worked better and more consistently than the program for putting turf. The major difference seems to be that at the lower rates used on putting turf numerous *Poa annua* variants show resistance.

As a result, treatment of putting turf reduces the *Poa annua* population, but does not eliminate it. At the higher rates used on Kentucky bluegrass, resistant types have not proven to be a problem yet. Recent tests indicate hope for solving the current resistance problems on putting turf.

These experimental programs unfortunately are not in accordance with label recommendations which make it impossible to recommend endothall based on our research. However, as our program continues we will be in close contact with the manufacturer in an effort to gain enough information to warrant any necessary label changes. UNTIL THAT TIME WE CANNOT MAKE ANY OFFICIAL RECOMMENDATIONS concerning the use of endothall turf herbicide for *Poa annua* control.

Continued Research

At the present time it appears we will be able to fund this project for one more season. Because of the short time period left our work will concentrate on the following areas:

1. Continued refinement of current procedures. This includes additives and combinations to increase efficacy. All work so far has been done with the 19.2% di-sodium salt solution. In 1977 testing of the di-potassium salt and granular form will be initiated.

2. Accumulation of repetitive data to generate support for possible label changes.

3. Expanded work with bentgrass lawn turf and perennial ryegrass turf.

4. Attempt to gain additional information for basic programs in eastern Washington.

ACKNOWLEDGEMENT

The existence of this program is due largely to the members of the Northwest Turfgrass Association who realize the need for continuing research on the many problems in turf management. Believe me when I say, we appreciate your contributions very much.

BLUEGRASS, FESCUE AND RYEGRASS VARIETAL[1] EVALUATIONS AFTER THREE YEARS TESTING

Stanton E. Brauen[2]

In western Washington in recent years there has been considerable interest in seeding turf areas to grass types other than bentgrass or fescue. Bluegrasses in particular and ryegrasses in some instances, are being seeded where once mostly bentgrass was seeded. For example, bluegrasses dominate the sod industry. Bluegrass and ryegrass mixtures are recommended for sports turf. A great part of the increased interest in the use of these grasses has been due to the improved availability of improved grass varieties and increased national advertising of these varieties.

However, turf managers know that bluegrass varieties of the past have not been well adapted to persistent use in western Washington. More agressive *Agrostis* and *Poa* species invade the bluegrass plantings and often times result in less than desirable turf conditions.

These trends in turfgrass use plus the recent increase in availability of improved turfgrass varieties from both foreign and domestic sources led to the initiation of extensive turfgrass variety screening studies at Puyallup. Collection of turfgrass materials was intiated four years ago from turfgrass breeders, seed companies and seed suppliers from throughout the world.

1/ To be presented to the 30th Annual Northwest Turfgrass Association Conference, Spokane, WA, September 29, 30, and October 1, 1976.

2/ Associate Agronomist/Extension Agronomist, Western Washington Research and Extension Center (WSU), Puyallup, WA.

Varieties and selections of approximately 120 bluegrasses, 90 fescues and 60 ryegrasses were seeded three years ago in July, 1973. Regular evaluations have been conducted since that time for turf quality, general appearance, density, texture, color, and acceptability plus turf reaction to specific diseases that have been identifiable over this period of time.

I am sure you are all aware that true variety adaptability to an area cannot be determined in the course of a three-year evaluation. Persistent, competitive varieties that have good turf quality characteristics that are nearly resistant to the major disease organisms in the region can only be identified through long-term variety management evaluations in conjunction with demonstrated and intended use under turf conditions. These variety evaluations as they are reported here encompass the weaknesses of any short-term variety evaluations. These shortcomings are reflected in the fact that they represent only one soil-plant microclimate being managed under one set of cultural conditions and are evaluated by two or three, perhaps not unbiased, human individuals. Nevertheless, these trials do identify the varieties or selections that may be adapted to western Washington conditions and will identify those varieties which are least desirable for use in the area.

The list of potentially adapted varieties will likely be narrowed by further experience and management research, while the list of least acceptable types will expand. The line of acceptability versus non-acceptability will be drawn by others for my ideals of acceptability may be somewhat different than yours. Your standards for turf quality, density, texture, disease reaction, compatability with other varieties or grass types and general turf desirability or mowing characteristics may not be recognized in research evaluations. Thus, the results presented to you today should not be construed as absolute but should be used as indicators of progress in variety evaluation and variety usage development.

For presentation today only 50 varieties have been chosen out of 200 varieties being evaluated. These 50 varieties were selected either because of their superior performance among the varieties being tested or because they are named varieties currently available or potentially available and familiar to you. Many other experimental types have been omitted because the developers are no longer interested in their performance, their release is not anticipated or their performance to this point has been below average or absolutely unacceptable.

BLUEGRASS

The bluegrasses as a genus are susceptable to several disease organisms. Probably most important of these diseases for the area west of the Cascades are several rusts, several *Helminthosporium* species and perhaps blister smut. Table 1 lists the ratings on several bluegrass varieties for blister smut, *Helminthosporium* leaf spot and a winter crown disease (probably caused by *Helminthosporium* sp). Although nearly all the varieties listed in Table 1, with the exception of Pennstar, Newport and Park, show considerable resistance to the winter crown disease. Nearly all varieties show considerable susceptability to *Helminthosporium* leaf spot. Pennstar, Newport, Park, P-59, Galaxy, Victa, Bonnieblue, Baron, Rugby, Fylking, Geronimo and Parade all showed high susceptability to blister smut which was observed for the first time at Puyallup in the winter of 1976. Touchdown, Brunswick, Merion, Glade, Cheri, Kimono, Monopoly, Entensa, A-34, Adelphi, Birka, Sydsport and Nugget showed near resistance to the smut condition. The combination of blister smut and winter crown disease drastically effects the appearance, turf quality and resulting acceptability of affected bluegrasses during the winter months. Blister smut may be a disease which will not develop each year. This past winter the duration of disease was quite short-lived lasting only for a period of 6-8 weeks. Accordingly, blister smut may be a disease which could be tolerated at least where varieties are blended with the resistant types.

Varieties that are susceptible to the winter crown disease should be avoided entirely. A tentative classification of the susceptibility of bluegrass varieties to winter crown disease and blister smut is listed in Tables 2 and 3. Blends and/or mixtures should use two or more combinations of bluegrass varieties that most nearly reduce the total susceptibility to these diseases yet are compatable in other agronomic characteristics. Little is know at present about the compatability of these bluegrass varieties in blends.

It is good to know the reaction of individual varieties to specific diseases. But general turf quality at different times of the year and in the end acceptability will add meaningful information to variety users. Table 4 lists the ratings of some bluegrasses for these characteristics. Generally, those varieties that combine good to moderate resistance to winter diseases plus have good winter density and color rate highest in acceptability.

Table 5 provides a listing of adjusted acceptability of bluegrass varieties. This classification of varieties is an attempt to group the varieties when their total year-round performance is considered. During the first three years of these evaluations, numerous varieties have changed in reaction to the environment from year to year. Some that performed well the first years have declined in performance this past year. Others that were moderate in performance the first year have maintained that level or improved. Undoubtedly, continued testing will separate the varietal performance more dramatically and make varietal preferences more distinct in the future.

TABLE 1. Reaction of Kentucky bluegrass varieties to Blister Smut, *Helminthosporium* and Winter Crown Disease at Puyallup, WA.

Variety	Leaf Spots[1/]		Winter[2/]
	Blister Smut	Helminthosporium	Crown Disease
P-59	9.0	6.6	17.1
Adelphi	2.0	8.5	17.9
Bonnieblue	8.0	8.8	17.9
Rugby	9.8	7.9	17.9
A-34	1.8	9.0	18.8
Birka	1.3	8.0	18.8
Parade	9.0	8.5	18.8
Majestic	2.0	8.6	19.2
Merion	1.0	6.5	19.6
Geronimo	7.8	8.4	20.0
Galaxy	9.3	6.5	22.5
Touchdown	2.0	5.0	22.5
Kimono	2.3	6.8	22.5
Entensa	1.0	5.4	24.6
Baron	6.8	7.3	25.0
Monopoly	1.0	5.8	26.3
Cheri	1.0	7.9	27.1
Victa	8.0	8.3	27.9
Glade	1.3	8.0	29.6
Sydsport	1.0	8.9	29.6
Brunswick	1.5	8.3	31.9
Newport	7.8	7.2	33.8
Pennstar	7.5	8.3	34.2
Fylking	6.0	7.8	34.6
Nugget	1.5	7.9	37.9
Park	8.5	7.9	55.8

1/ Rated 1 to 10. 1 = resistant, 10 = very susceptable

2/ Percent of turf area affected

TABLE 2. Classification of susceptibility of bluegrass varieties to winter crown disease in western Washington.

Winter Crown Disease	Variety
Good Resistance	Adelphi, A-34, Parade, Merion, Bonnieblue, Rugby, P-59, Majestic, Geronimo, Nugget
Moderate Resistance	Touchdown, Galaxy, Victa, Baron, Glade, Cheri, Kimono, Monopoly, Entensa, Sydsport, Brunswick
Moderate Susceptible	Fylking, Pennstar, Newport, Vantage
Very Susceptible	Park, Cougar, Delft, Prato, Kenblue, Palouse, Arboretum

TABLE 3. Classification of the susceptibility of bluegrass varieties to blister smut (*Entoloma irregulare*) in western Washington.

Blister Smut	Variety
Resistant	Monopoly, Entensa, Glade, A-34, Adelphi, Cheri, Birka, Sydsport, Kimono, Nugget, Merion, Majestic, Touchdown, Brunswick
Susceptible	Geronimo, Parade, Victa, Bonnieblue, Baron, Rugby, Fylking, Pennstar, Newport, Park, P-59, Galaxy

TABLE 4. Winter turf quality plus winter and summer acceptability ratings of Kentucky bluegrass varieties at Puyallup, WA.

Variety	Winter 1/ Turf Quality	Acceptability 2/ Winter	Acceptability 2/ Summer
A-34	6.6	4.5	4.5
Monopoly	7.2	3.8	4.3
Nugget	6.0	4.8	4.3
Sydsport	6.0	4.8	4.3
P-59	6.5	4.0	4.0
Bonnieblue	5.8	4.3	4.0
Parade	6.3	4.0	3.8
Birka	6.0	4.0	4.0
Baron	5.6	4.0	4.3
Merion	5.9	4.0	3.8
Rugby	5.5	4.0	4.0
Victa	5.9	3.8	3.8
Majestic	5.6	3.8	3.8
Touchdown	6.1	3.5	3.5
Adelphi	6.0	3.5	3.8
Glade	5.3	4.3	3.3
Kimono	4.4	4.5	4.0
Galaxy	5.5	3.5	3.5
Cheri	5.6	2.8	4.0
Brunswick	4.4	4.0	3.5
Fylking	3.6	4.0	3.3
Newport	4.6	2.8	3.0
Pennstar	3.5	3.5	2.5
Park	2.8	1.5	1.3

1/ Rated 1 to 10. 1 = poor quality, 10 = excellent quality

2/ Rated 1 to 5. 1 = very unacceptable, 2 = unacceptable, 3 = questionable, 4 = acceptable, 5 = veryacceptable

FESCUE

The majority of fine leaved fescues being evaluated are better adapted to our climatic conditions than the bluegrasses. Due to the lack of time, little rating information will be presented. Acceptability and thatch accumulation data is listed for only the better performing and named varieties (Table 6). Many very acceptable and acceptable varieties of chewings and spreading fescues exist. These are listed in Table 7. As with bluegrasses, many of the common named and available fescues were questionable or unacceptable as turf varieties in these tests. Several of the fescue varieties listed in Table 7 are currently under production and should be used in place of common types for good turf performance.

PERENNIAL RYEGRASS

Only a few high quality turftype ryegrasses exist for western Washington use. Table 8 shows the average performance of many known varieties. Clearly, Manhattan and Pennfine are far superior to older varieties such as Norlea, Game and Linn. Newer varieties such as Citation, Derby, Yorktown and Ensporta sometimes perform better than Manhattan although Citation, Derby and Yorktown have been observed for only two years.

Much attention will be needed to more clearly define variety performance. Particularly, compatability between blends within species (bluegrass variety blends) and mixtures among species (chewings fescues-bluegrass; spreading fescue-bluegrass, etc.) will need extensive study. Of course these can only be done successfully under different management schemes involving nutrition, cutting practices, turf use and shade.

This work has been done in cooperation with Dr. Roy L. Goss and Dr. Charles J. Gould. The variety testing was supported in part by the Northwest Turfgrass Association.

TABLE 5. Adjusted acceptability rating of Kentucky bluegrass varieties at Puyallup, Washington.

Adjusted Acceptability	Variety
Very Acceptable	A-34, Sydsport, Nugget*, Birka
Acceptable	Bonnieblue, Baron, Rugby, Adelphi, P-59, Monopoly, Touchdown, Glade, Parade, Merion, Victa, Kimono, Majestic
Questionable	Galaxy, Cheri, Brunswick, Fylking
Unacceptable	Pennstar, Park, Newport, Prato, Belturf, Cougar, Vantage, Delft

* Winter dormant type

TABLE 6. Winter and summer acceptability ratings and thatch development of fine-leaved fescue varieties at Puyallup, WA

Variety	Acceptability1/ Summer	Winter	Thatch2/ (mm)
Frida	5.0	4.8	28.8
Dawson	5.0	4.8	22.5
Halifax	5.0	4.8	21.5
Waldorf	5.0	4.5	26.5
Sonate	5.0	4.5	21.3
Polar	5.0	4.3	21.5
Wilton	5.0	4.3	15.8
Jade	4.8	4.5	24.3
Biljart	4.8	4.5	23.0
351 Daehnfeldt	5.0	4.0	22.5
Menuet	5.0	4.0	27.5
Checker	4.5	4.5	23.0
Koket	4.5	4.3	23.0
Highlight	4.3	4.5	22.3
Earfalla	4.8	4.0	27.5
Banner	4.8	4.0	24.3
Atlanta	5.0	3.5	24.3
Famosa	4.0	4.5	23.5
Encota	4.0	4.5	24.8
SVR-007	4.8	3.8	19.8
Lifalla	4.0	4.5	21.0
Wintergreen	4.3	4.3	22.0
Paj 72-1-93	4.0	4.3	23.8
HF-11	4.8	3.5	24.3
S-59	4.3	4.0	19.8
Rolax	4.3	4.0	21.5
Mariet	4.0	4.0	24.0
Oasis	4.0	4.0	18.3
Jamestown	4.3	3.8	25.6

1/ Rated 1 to 5. 1 = very unacceptable, 2 = unacceptable, 3 = questionable, 4 = acceptable, 5 = very acceptable
2/ Millimeters of accumulated thatch compressed by 32 g/cm^2.

TABLE 7. Turf acceptability classification of chewings, spreading, creeping and hard fescue varieties at Puyallup, WA

Chewings	Spreading	Creeping	Hard
	Very Acceptable		
Frida	Polar	Dawson	Biljart
Halifax	Wilton	Sonate	
Waldorf	351 Daehnfeldt		
Jade			
Menuet			
Checker			
	Acceptable		
Koket	Highlight	Oasis	Scaldis
Barfalla	SVR-007	HF-11	
Atlanta	Lifalla		
Famosa	Wintergreen		
Encota	S-59		
Mariet	Jamestown		
Banner			
	Questionable or Unacceptable		
Cascade	Durlawn		Durar
	Duraturf		
	Illahee		
	Olds		

TABLE 8. Density, texture, leaf shredding, turf quality and acceptability ratings of perennial ryegrass at Puyallup, WA

Variety	Density1/	Texture1/	Leaf Shredding1/	Turf Quality1/	Acceptability2/
Citation	8.8	6.8	6.8	7.5	3.5
Derby	9.0	7.0	7.4	8.0	4.0
Yorktown	7.7	6.7	7.1	8.0	3.5
Manhattan	9.3	7.2	7.8	7.3	4.0
Pennfine	7.8	7.3	6.6	6.5	4.0
Ensporta	7.1	8.2	7.0	7.2	4.0
Birdie	7.5	6.7	6.8	5.7	3.0
Norlea	5.1	5.0	3.6	6.3	2.0
Game	6.0	5.8	5.6	4.8	3.0
Pelo	6.6	7.0	6.4	6.5	3.0
Linn	4.1	3.7	3.9	2.3	1.5

1/ Rating 1 to 10. 1 = low density, broad leaf texture, high leaf shredding, and poor quality turf.

2/ Rated 1 to 5. 1 = very unacceptable, 2 = unacceptable, 3 = questionable, 4 = acceptable, 5 = very acceptable.

PREPARING A SOUND BUDGET[1] —ITEMS TO INCLUDE

William H. Bengeyfield[2]

I Description of Facilities and Extent of Services

II Organizational Chart

III Labor Costs

A. Salaries and Wages

1. Salaried personnel
2. Hourly personnel
3. Holiday, sick and vacation pay
4. Overtime pay

B. Related Salary Expenses

1. F.I.C.A.
2. F.U.I.
3. S.U.I.
4. Health and Welfare
5. Workman's Compensation
6. Medical group insurance
7. Retirement
8. Life group insurance
9. Meals
10. Laundry

1/ To be presented to the 30th Annual Northwest Turfgrass Conference, Spokane, WA, September 29, 30 and October 1, 1976.

2/ Western Director, USGA Green Section, Tustin, CA.

IV Materials and Supplies

A. Fertilizers
B. Irrigation parts & repairs
C. Pesticides & other chemicals
D. Equipment parts
E. Sand, topdressing, etc.
F. Plant material & care of trees
G. Seed
H. Cart path repair & maintenance
I. Expendable supplies
J. Tools, new & replacement
K. Miscellaneous

V Utilities

A. Water & pumping costs
B. Trash service
C. Power, light
D. Sewer
E. Heating fuel
F. Telephone

VI Gas, oil, grease, etc.

VII Equipment Rent and Lease

VIII Professional fees and other outside service including Superintendent and Committee expenses

IX Property - State and Federal Taxes

X Depreciation

XI Capital Equipment Purchases

XII Capital Improvement Expenses, Building Repairs, Fence Repairs, etc.

CURRENT STATUS OF PESTICIDES USED[1] IN TURF GRASS MANAGEMENT

Dick Maxwell[2]

In February of this year I discussed this same subject at a turfgrass management workshop in Pullman. Many of the items I covered then are still pertinent today, so I will simply modify my previous talk to bring it up to date.

Currently, the turfgrass industry faces the same problems as all other users of pesticides--namely, the real and potential loss of many chemicals that have been extremely useful for many years, some for longer than 25 years. Perhaps the greatest threat at the moment is in the reregistration process scheduled for completion by October 1977. (It is doubtful this deadline can be achieved.) All currently registered products must be reviewed during this period to see if they meet the new registration requirements, which are considerably more stringent than they were in the past. Very few products will satisfy these requirements, so additional data will be required in most instances. At this point much depends upon the attitude of the manufacturers. If the additional data requirements are very extensive and the market potential of the product is low, they may simply decide to abandon their products. It is too early to know what their decisions will be.

1/ To be presented to the 30th Annual Northwest Turfgrass Association Conference, Spokane, WA, September 29, 30, and October 1, 1976.

2/ Agricultural Chemicals Specialist, Washington State University, Pullman, WA.

EPA has classified pesticides into one of five categories, depending on the data required for re-registration. Category I is for those products which have satisfied the data requirements. It includes most of the copper fungicides.

Category II pesticides require toxicological studies which may require several years to complete. Chemicals in this category include Baylan, Betasan, Lorsban, Demosan, Tersan SP, Bravo, and many others used on turf. If anyone is interested, I can supply him with a complete list. Although the time required to complete these studies may exceed the 1977 deadline for registration, EPA has indicated it will allow these uses to continue beyond the deadline if the manufacturer can show the necessary studies are underway.

Category III pesticides require short term studies which can be completed by October 1977. These studies may involve toxicity tests on mammals, birds, fish, etc. There are only 17 pesticides in this category. Those which might be of interest to the turfgrass industry include Bandane and Vorlex.

Category IV pesticides are those which are considered too toxic or too environmentally hazardous for reregistration. Manufacturers will be given the opportunity to present arguments and/or data to persuade EPA these pesticides can be used safely. More will be said about this category later.

Category V pesticides are those which have not been reviewed and are waiting for assignment to one of the other categories.

Pesticides in categories II and IV are, of course, of the most immediate concern -- category II because of extensive data requirements and possible abandonment by the manufacturer, and category IV because the odds against registration of these products is very great.

To date we know of four pesticides placed in category IV. None are important to the turfgrass industry. They are Kepone, chlorobenzilate, chloroform, and endrin. However, EPA has provided a list of about 40 more which are definitely being considered for this category and unofficially we have been told the list may be expanded to 180. Of the list of 40, products of particular interest to the turfgrass industry include cadmium fungicides, PCNB, paraquat, benomyl, silvex, and a group called ethylene bis dithiocarbamates. This group includes nabam, maneb and zineb with trade names such as Dithane M-45 and Tersan LSR.

Pesticides which have been lost to the turfgrass industry or which have been restricted include the following:

1. Chlordane and heptachlor. Production of these chemicals has been suspended for all turf uses. Existing stocks can still be used in accordance with label directions.

2. Mercury fungicides are being phased out for some uses, but other uses will be permitted. This is the end (for now at least) of a long, drawn-out battle between EPA and five companies producing mercury fungicides. Last February EPA banned nearly all uses of mercury fungicides leaving only treatments for mold on sawn timber, Dutch elm disease, and treatments for outdoor covers such as tarps, boat covers, etc. The manufacturers appealed to the courts and legal proceedings have continued ever since. However, an agreement has been reached which apparently satisfies all concerned. It consists of a decision to discontinue use of mercury for seed treatments and summer turf diseases after two years' production is reached. Existing stocks will then be allowed to be used. Thus, seed treatments and summer turf disease uses can be continued for the next two years or more.

   The use of mercury for winter turf diseases will be continued indefinitely, subject to certain restrictions. They cannot be used within 25 feet of any water where fish are taken for human consumption, and they can be applied only by or under the direct supervision of golf course superintendents. The products will be classified as restricted use pesticides, requiring that golf course superintendents be certified by the states to apply restricted use pesticides.

At the moment this is as much as I know about the status of turfgrass pesticides. We will try to keep abreast of what is happening and do what we can to retain the pesticides we have, or to test and help in the clearance of new ones.

THE NEED FOR TECHNICALLY TRAINED[1] TURFGRASS SUPERINTENDENTS FOR PARKS

Joe Lymp[2]

Good morning ladies and gentlemen. My name is Joe Lymp, and I am the superintendent of the Golf Course and Grounds for Sunriver Properties, Inc. I have been the Golf Course Superintendent at Sunriver since 1969 and have had the combined Golf Course and Grounds responsibility since 1975. As many of you remember, Sunriver hosted the Northwest Turfgrass Conference in 1974.

In the turfgrass business many of us tend to have a limited scope of vision. By this I mean we tend to think of our particular facit of the turfgrass industry as being the most important. We forget about the other areas and their problems.

This opportunity to speak to you members of the NTA allows me to cover areas that pertain not only to golf courses, but also to parks and school districts. Sometimes I feel as though the NTA is primarily golf course oriented. However, it strives to serve all segments of the turfgrass society.

Most of my turfgrass experience has dealt with golf courses, but the past year has had its share of park-related challenges. Because of this recent experience I hope to present informative material to all areas of turfgrass management.

1/ To be presented at the 30th Annual Northwest Turfgrass Association Conference, Spokane, WA, September 29, 30, and October 1, 1976.

2/ Superintendent, Sunriver Golf Course, Sunriver, OR.

There is a definite need for technically oriented turfgrass superintendents for parks.

Measures must be taken to prevent damage to turf areas from the constant wear caused by the ever-increasing public use of parks, sport fields, and golf courses. Proper cultural practices, wear-tolerant grass varieties and traffic control where possible will help to keep the turf resilient. The proper management of turf is the same in parks, sport fields and golf courses. The differences lie in the turfgrass varieties and the uses made of the turf areas.

I recently talked with a park director and a park superintendent who told me "Maintenance isn't much of a problem - but we do need to know more about propagation, ------ what makes the grass tick." One of the best ways for the park people or other turfgrass managers to become more knowledgeable is to attend all local conferences and turf "Short Courses".

If a problem arises and we are not sure of the solution, perhaps we should talk with someone who has had a similar situation. They may have tried an unsuccessful method and discovered an alternative solution. This could mean we might be able to use their method or a modification of their method to achieve success on our first try.

Today's parks must be designed to fit many varied needs and desires. These multi-use facilities, by their nature offer the park superintendent a real challenge. If it is a true multi-use park, it will appeal to everyone and will see much traffic. Soon the park superintendent will be asking himself, "When will I be able to perform the maintenance that I need to do?"

About three years ago Sunriver started to build a multi-use park. Our first step was to put together a complete design of the park area. We call it Fort Rock Park. We began with two plexipaved tennis courts and a 5+ acre multi-purpose turf field. This turf field has a combination of two baseball diamonds and a soccer field. The next year we added six more plexipaved tennis courts. This year we added restrooms, a sand volley ball court and horseshoe pits. Next year we plan to add a playground, three more acres of irrigation and hard surfacing of the parking lots. Along with the major improvements already mentioned, we will also add more picnic tables, benches and assorted play equipment. We didn't have the money to build the entire park in one year, so we will build it over a 5 to 7 year period.

Joggers can be a problem on some turf areas and as their numbers grow they will continue to cause problems for turf managers. One solution is to have jogging trails to concentrate the wear on paths instead of on the turf. The least expensive year around trails would be constructed with gravel or cinders. This type of path requires continual maintenance. We tried to hand rake these paths and it was an impossible task and very expensive. So several winters ago we decided to build a path leveler to be pulled by a tractor. We saw a picture of a 3 point hitch mounted path leveler in an advertisement in Grounds Maintenance. With the help of this picture my mechanic was able to build a most fantastic path leveler. This tool is a real labor saver. With it we are able to grade our five plus miles of cinder path in two directions in about four hours. It does a much better job of path leveling than hand raking. It cuts down the high spots and fills in the low spots.

We also have over 17 miles of paved bicycle paths. We have learned quite a lot about building bicycle paths since we started. Our bicycle paths are now built flush with the ground instead of 6 to 8 inches above ground level. We now use one way bicycle tunnel underpasses instead of two way. The asphalt paths need to have weeds killed that grow up under the paths and cause the asphalt to crack. We spray the edges and any cracks with a non-selective herbicide annually. Occasionally we have to patch a hole where a ground squirrel has under-mined the bike path with his tunnel. We find both the cinder and asphalt paths are popular with the jogging community. The asphalt paths require less maintenance than the cinder ones.

We are currently building a Jog Par Course. The original idea was developed by a Life Insurance Company in France. The original courses were called Vita Par Courses. Our course is a one mile loop with sixteen stations. The start and finish of our first course is at the swimming pool. Approximately every 100 yards there is a routed wooden sign to mark the exercise station. Half are calisthenic stations where the jogger does something like Jumping Jackson, toe touch and the other half are more elaborate exercise stations. These exercise stations include balance beam, log vault, chin-up bar, horizontal ladder, leg raise, leg stretch, etc.

As turfgrass managers, I am sure that everyone in this room is involved with budgeting to one degree or another. A very important aspect of managing any turf installation is the efficiency of operation or the cost of maintenance. The cost of mowing is one of the biggest expenses accrued in maintaining large turf areas. Labor runs as high as 50 to 70 percent of our total budget. If we attempt to hold the costs of budgets down, we must analyze our mowing practices. We should select the largest mower that can easily do the job. One of the past issues of Grounds Maintenance had an interesting feature article on selecting the most efficient mower for your particular needs. For instance, a 21" rotary mower is rated at <u>4 acres per day</u> and a 72" rotary mower is rated at <u>20 acres per day</u>.

<u>Example</u>

Problem:

We have a twenty acre turf area to be mowed twice a week. We have a 12 month growing season and the grass grows at the same rate year around. Should we mow this 20 acres with 5 four-acre-per-day machines or with 1 twenty acre per day machine. We pay $2.00 per hour.

5 Mowers Cost $1375	1 Mower Cost $5000
5 - 4 A/P	1 - 20 A/P
10 x 8 = $80/day	2 x 8 = $16/day
80 x 2 = $160/week	16 x 2 = $32/week
160 x 4 = $640/month	32 x 4 = $128/month
640 x 12 = $7680/yr labor cost	128 x 12 = $1536/yr labor

Cost of 5 - 21" mowers	$1,375
+ 1 yr labor	7,680
Cost at end of 1 yr	9,055
2nd yr labor	7,680
Total	$16,735

Cost of 1 - 72" mower	$5,000
+ 1 yr labor	1,536
Cost at end of 1 yr	6,536
2nd yr labor	1,536
Total	$8,072

This illustration does not take all the facts into consideration, but it does show the importance of matching the proper mower to the job. Some of the turf areas we take care of are probably not as efficient to maintain as we could have them. By removing a rock or a tree, so a larger mower could do the job, we are going to save valuable dollars. If care is taken during this process, the aesthetic value will not be damaged.

Another important area to save money is by eliminating as much hand trimming as possible. By using a non-selective herbicide around trees, buildings and other hand trim areas, many labor man hours can be eliminated. If you spray these areas twice a year as opposed to hand trimming every two weeks, the savings becomes readily apparent. When these sprayed areas first die, they look bad. The brown dead grass is very striking next to the green grass. By the second year when it has turned into a ring of bare dirt next to the tree, it adds to overall manicured appearance.

The question may arise whether the chemical trimming is harder on the trees than the mechanical trimming. I have found that the mechanical method of using a small rotary mower in conjunction with a weedeater can leave scars on the tree trunk. Extra care should be taken around deciduous plants when using herbicides. I haven't found any adverse effects from chemical trimming of evergreens. Both methods depend on the person doing the work as to their degree of success. I always warn a person going out to spray a non-selective herbicide that they are just like an artist with a paint brush. Where they apply the spray material on purpose or by accident they leave their signature.

Pay attention to the main focal areas in your landscaping. It is important to keep these areas especially well groomed. A wise man once told me, "What people see first is going to form their lasting impression. . ." Watering and fertilizing are probably the most important aspects, followed closely by weed control. One of the easiest components to overlook, because you see it every day and its change is gradual - is the mulching material, ie., barkrock, river rock, etc. It has two main functions. First is moisture control - protection from winter and summer desiccation. Its second function is appearance. After several years a fresh layer of this material should be put down to cover the old material and accumulated debris. It's like icing on a cake. I would like to leave you with a challenge to get better acquainted with all of the people in your area that work in turfgrass related jobs. Get together with these people several times during the next year to exchange ideas and get to know one another better. If you do this, I am sure you will realize the benefits of exchanging ideas.

THE PAST, PRESENT AND FUTURE OF TURFGRASS[1] DISEASE RESEARCH IN THE NORTHWEST

Charles J. Gould[2]

Most people are known by the company they keep; but golf course superintendents are recognized by the turf they keep. Anything that affects their turf adversely, reflects on their reputations. Among these adverse factors are disease.

Diseases undoubtedly exist on native grasses even before man attempted to grow them for turf, but they appear to be increasing both in number and in severity. Part of this apparent increase is the result of better diagnosis. The improved handling of turf (correcting nutritional deficiencies, preventing thatch, etc.) has made it easier to recognize diseases as a major problem. The increase in diseases may also be due in part to the planting of a single grass variety, more liberal summer irrigation, heavier fertilization, and perhaps, an increased spread of pathogens resulting from a combination of such factors as more area planted, more movement of propagative material (seeds, stolons, sod, etc.) and more movement of people - whose shoes may be second only to mowers in their efficiency as vectors of parasitic turf fungi.

Although Sprague listed 384 fungi (not including rusts and smuts) on various wild and cultivated grasses,

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1/ To be presented to the 30th Annual Northwest Turfgrass Association Conference, Spokane, WA, September 29, 30, and October 1, 1976.

2/ Plant Pathologist, Western Washington Research and Extension Center (WSU), Puyallup, WA.

only a relatively few of these organisms seriously affect turfgrasses. The disease situation, however, is still poorly understood and has proven to be very complex. In fact, the more turf is studied, the more diseases are found and the more complex the picture becomes. Consequently, we are often amazed that any grass can survive at all.

In the "good old days", golf was played under rather adverse conditions so a few blemishes did not create much excitement. Gradually, golfers began to expect perfection (I'm told that they still do) and then they decided to do something about diseases. The first serious attempt to control fungi started about sixty years ago in the eastern United States, primarily under the auspices of the U. S. Golf Association. Until recently, however, turfgrass was neglected by most pathologists as indicated by the dearth of publications in this field - only two books and a few comprehensive bulletins. The agronomists have us far outnumbered in both numbers of workers and in publications, but we are trying to catch up.

The ever increasing value of the crop certainly justifies more research in all fields. Dr. Felix Juska estimated that there were about 14,000,000 acres of established turf in the United States in 1957 with an annual maintenance cost of 2-3 billion dollars. We should be safe in assuming that because of inflation and an increase in acreage planted, the current maintenance cost is near 5 billion dollars with a replacement value of at least $15 billion. In fact, Dr. Goss estimates the present annual maintenance cost of over $100,000,000 for turf in Washington State and a replacement value of one half to one billion dollars. The costs of all the turf research to date represent only a small fraction of this.

Although research on the control of turf diseases was underway sixty years ago in the East, it did not get started seriously in Washington State until 1949. However, prior to that time, various scientists, particularly Drs. Roderick Sprague and George Fischer had been identifying fungi on all types of grasses, including turf types. Dr. Sprague also was a great help to us when we were getting started.

RESEARCH IN EASTERN WASHINGTON

Apparently, the first research on the cause and control of turfgrass diseases in eastern Washington was started in 1951 by Dr. Jack Meiners (WSU) who worked on snowmold (*Fusarium nivale* and *Typhula incarnata*) at Pullman and Spokane. He found that phenyl mercury acetate was the most effective fungicide available. In the late 1950's, Prof. Al Law and Ted Filer ran some tests and found that the time of application was a critical factor. Ted also did some research at WSU on the Fairy Ring problem for his PhD thesis. During 1972/73 and 1973/74, Gould, Goss, Ensign and Law compared the effectiveness of several new and old fungicides as well as different rates and times of application for snowmold control in five locations in Washington and Idaho. We found that an application of a *Fusarium*-fungicide in early fall, followed by a combination against both *Fusarium* and *Typhula* before snowfall gave excellent control. A new material, chloroneb, proved to be very effective against the *Typhula*. In 1974 we established plots at the Hangman Valley course with the help of Bud Ashworth to test the resistance of 138 varieties of bentgrasses to snowmold. Another study was started at Spokane Golf and Country Club with the help of Norris Beardsley to study the effect of different types of nutrition on snowmold invasion.

RESEARCH IN WESTERN WASHINGTON

The first research on turfgrass disease in western Washington was on Fairy Ring disease in lawns. At that time, Fairy Ring was the cause of more inquiries from homeowners than all other ornamental diseases combined. Vern Miller and I began working on this problem in 1949 and continued for several years. In 1955, the Northwest Turfgrass Association asked us to take a look at some of their problems on golf courses, including "Dollar Spot", which they were having trouble controlling. It soon appeared that the suspected Dollar Spot was actually *Fusarium* patch for which different control measures were required. At that time we also discovered that Corticium Red Thread was a serious problem. An experimental green was established in 1955 at the Experiment Station in cooperation with Dr. Herman Austenson to use for fungicidal testing.

In 1956 we also started a cooperative experiment on a green at Overlake Golf and Country Club in cooperation with Milt Bauman and a newcomer by the name of Roy Goss. The testing area was expanded in 1957 to the Tacoma Golf and Country Club with the help of Henry Land Sr. and to Broadmoor Golf Club in cooperation with John Jaslowski, and later to many other courses. In 1958 Roy Goss came to the Station as a full time research and extension turf agronomist. We have cooperated ever since on most of the disease research and also with Dr. S. E. Brauen for variety testing and Professor Al Law on research in eastern Washington.

Our first goal was to determine what types of diseases were present and which ones were most important. After we found that *Fusarium* patch and red thread were major threats (*Ophiobolus* patch was found later), Roy and I decided to attack them by three methods: fungicidal, nutrition, and disease resistance.

Fungicidal Research

It was obvious that fungicides would give us the quickest response so we rapidly enlarged our experimental program, working on our own turf as well as, whenever possible, setting up plots on nearby golf courses (such as Allenmore, Broadmoor, Earlington, Enumclaw, Fircrest, Inglewood, Overlake, Rainier, Seattle, and Tacoma). In recent years, because we were constantly testing new materials which might damage turf, and because funds were tight, we have had to confine the experiments to our own area at Puyallup. This research has paid off and we now have several effective fungicides available for use against both *Fusarium* patch and *Corticium* red thread.

Our present situation is much different from that encountered by superintendents sixty years ago. The only common fungicides they had available against *Rhizoctonia* brown patch were sulfur, which was ineffective, and

Bordeaux mixture. The latter mixture was the first fungicide generally used to control turfgrass diseases on golf courses in the United States. It was first tested in 1917 and was in general use by 1919 according to Monteith and Dahl of the USGA. However, repeated applications of Bordeaux resulted in toxic accumulations of copper. Bordeaux was then replaced by mercuric chloride and Semesan in the early 1920's. The next major advance was the recommendation in 1927 by the USGA Green Section for use of a mixture of mercuric and mercurous chloride. This mixture is effective and is still frequently used against many turfgrass pathogens.

Thiram, developed in the early 1930's, came into widespread use during the second world war when mercury supplies were short. Thiram was followed by many other related (dithiocarbamate) fungicides including one which we still depend upon - Fore (mancozeb). Next came a multitude of new materials, including Dyrene, Daconil, Terraclor, Actidione, Cadmiums and others, plus newer types of mercury of which PMA (phenyl mercuric acetate) was one of the best. Finally, in the late sixties, came the breakthrough for which we had long been dreaming - systemic fungicides (benzimidazoles). The first was Mertect (TBZ) which, unfortunately, proved to be slightly toxic to most grasses. It was soon followed by Benlate (Tersan 1991 or benomyl) which became very popular for the control of many fungus diseases. Unfortunately, several of these fungi, including *F. nivale*, have developed resistance to the benzimidazoles. Fortunately, another new fungicide appears to be ready to take its place. It is a hydantoin (Rhodia 26019), which is very safe and very effective against most major diseases of turfgrasses including *Fusarium* patch and red thread. We have been told that it should be registered by next summer. The question is: how long will it last? We cannot predict, but we do know that the pathogens are constantly mutating so I would expect it to fail, sooner or later. To delay this development, Roy and I suggest using a procedure which we have been recommending for several years and that is to alternate the 26019 with another fungicide, such as Tersan 1991 (Benlate) or Fore. Another method of reducing the opportunity for development of resistance by the pathogens is to apply mixtures of different fungicides. Such mixtures are commercially available and often produce excellent results but, in general, I believe that alternating the fungicide may be more effective as well as a less expensive procedure.

Nutrition

We realized, at the start, that the study of nutritional effects on diseases would take longer than that of fungicides. But, it didn't take long to observe that high nitrogen helped control red thread while low nitrogen was best against *Fusarium* patch. Potash gave some reduction in *Fusarium*, but phosphorus was relatively ineffective. Later, we found that a balanced (3-1-2) ratio of N-P-K was best for keeping *Ophiobolus* at a minimum, although the effect was somewhat influenced by the age of the turf. In general, to control most diseases most of the time, a balanced fertilizer is usually superior.

Certain fungicides rather consistently made the grass a darker green and often reduced disease incidence. Finally, Dr. Goss and I realized that their molecules contained large amounts of sulfur. This led to the discovery by Roy that (1) we were in a sulfur deficient area insofar as turf was concerned, and (2) sulfur alone could often reduce the incidence of *Fusarium* patch to a certain extent. Sulfur also proved to be our best weapon against *Ophiobolus* patch and is still more effective than any fungicide we have tested. The addition of chlordane also aids in control, but how it works and how sulfur works is unknown at present. Do they act directly as fungicides; or indirectly by changing pH; or by inducing resistance in the plants; or by increasing the numbers of beneficial and antagonistic microflora of other microorganisms which may either kill the pathogen or compete with it for food supplies in the soil? I think the indirect activity may be important with *Ophiobolus* but to prove it may require a great deal of research. We suspect the microorganism possibility because *Ophiobolus* is most severe in three locations where microbial activity is low: (1) in recently fumigated soils; (2) in recently cleared forested areas planted to grass; and,

(3) in sand and organic matter mixes. *Ophiobolus* is usually much less severe in old established turf where microbial activity is much greater.

Although nitrogen is the single most important nutrient affecting diseases, we have found that certain forms of nitrogen react differently. Thus ammonium sulfate is much more effective in reducing both *Fusarium* and *Ophiobolus* than other inorganic types of nitrogen. In recent experiments Milorganite also reduced *Fusarium*, but it stimulated *Poa annua* (annual bluegrass) so Dr. Goss is now trying to overcome that problem by adding sulfur at various rates to the Milorganite.

In addition to nutrition, there are other cultural/ management factors such as temperature, relative humidity, soil and air drainage, pH, soil type, and others which need investigation in relation to disease development.

Disease Resistance

The third major goal in our fight against diseases was the search for bentgrass varieties which had good cultural characteristics, but were more resistant to *Fusarium* than were Highland, Astoria, and other types in common use. Dr. Austenson and I had tested a few varieties at the Tacoma Golf and Country Club as early as 1957. Penncross was the best of these for two years but then it went to pieces - not only in our plots but also on a couple of golf courses. After that the resistance study was dormant until 1971 when we began collecting varieties and selections from all over the world. There are now 160 different bentgrasses in the experiment. Many of these are very susceptible to *Fusarium* patch. Some others have poor texture, produce too much thatch, or go dormant during the winter. However, several have good resistance, good color and good texture. Among these are: Boral, Congressional, Dudeck's ARC-1, Emerald, Huffine's MCC-3, Kingstown, Kozelnicky's TG040, Nimisila, Penncross, Rusta and Szego's Z-2000. Dr. Goss has planted these and 18 other promising types in larger plots for studies involving low and high levels of nitrogen and the application of fungicides. Several varieties continue to give outstanding results.

A similar study was started in 1973 in cooperation with Roy Goss, Al Law, and Bud Ashworth at Hangman Valley Golf Club to test resistance to 138 bentgrass varieties to Snowmold (*T. incarnata* + *F. nivale*). In general, the stolonized types seem to be more susceptible to *Typhula* than do the seeded types, but none are highly resistant. The most resistant appear to be: Bardot, Boral, Congressional, Contrast, Kingstown, Metropolitan, Mommersteeg's AT4, Saatzucht's ACA-61, Skogley's (AC-5, AP-1, APD1-1 and Hyannasport Velvet), Svertge's N-010, Tendenz, Toronto, Yale Selection, and Vaartnou's (HV-T-2, HV-T-3, and HV-TC-4). Several of these resistant varieties also have good cultural characteristics.

Dr. Goss and I have also been cooperating with Dr. S. E. Brauen in the evaluation of a number of bluegrasses (117), fescues (94), and ryegrasses (56) planted by him in 1973. Several of these appear very promising but no one variety is resistant to all pathogens so a blend of at least three of the better varieties will probably be desirable. The main disease on both fescues and ryegrasses has been red thread, while bluegrasses have been regularly attacked by leaf spot *Helminthosporium vagans*) in cool weather and by various rusts (*Puccinia* spp.) in warmer months. In addition, some bluegrass varieties are susceptible to red thread and a few varieties have been severely attacked by *Septoria tritici* which causes a leaf blight. Also, during the winter of 1975/76, most bluegrasses were infected with a blister smut (*Entyloma irregulare*). The only other severe attack by this smut occurred at Pullman in 1951, so we are hoping that this disease will not become a chronic problem.

THE FUTURE

We now have the knowledge and materials to produce reasonably disease-free turf in the Pacific Northwest by growing disease-resistant varieties under proper management, supplemented with fungicides whenever necessary. Of these three factors, I consider management as being the most critical in most situations.

Although we are in reasonably good shape now for giving recommendations, we cannot stop at this point.

The disease picture is constantly changing with changes in climate, in fertilizer practices and in other conditions. For example, the possible increased use of bluegrasses in western Washington may result in disease problems that we don't even know about today. Therefore, we cannot stand still. Among the factors needing additional investigation are:

1) DISEASE SURVEY. An expanded survey is desirable in order to determine more accurately the distribution of some of our 'new' and still minor pathogens such as *Septoria* and *Entyloma* since these could develop into major problems. We also need to find out if pathogenic organisms are responsible for certain unresolved problems, such as 'dry' spots on greens, dying out of bluegrass in the Columbia Basin and Yakima areas, etc. Also, in order to obtain better control of Snowmold, a pathologist should 'live with' this disease for a few weeks in the fall and again after snowmelt in the spring.

For both disease survey and evaluation of test plots, we need better methods of diagnosing different diseases more rapidly. As one means to this end, I have been experimenting with the use of welder goggles fitted with different colored filters. This approach appears promising. For example, a filter containing pink will accentuate red thread, yellow helps with rusts and a deep amber seems best for *Fusarium* patch. However, we have only had time to 'play' with this technique so additional research is needed to determine whether it is consistent under all conditions and also if it can be used with other diseases such as *Typhula* snowmold, and *Helminthosporium* blights.

2) CULTURE. Good culture represents more than half the battle against diseases. We know that nitrogen is very important, but research on the effect of different sources of nitrogen needs to be expanded. The experiments with combinations of sulfur and sewage sludge for *Fusarium* control are exciting. If they work, then we need to determine the reasons, so we can adopt them for use against other diseases.

And how does sulfur affect diseases - by its effect on the pathogens, on the hosts, on beneficial microorganisms, or in all three ways?

Turf under stress usually becomes more susceptible to many pathogens. Therefore, we need detailed studies on disease development as affected by compaction, thatch, and the deficiency or excess of water, major and micro nutrients, and other factors.

We all know that, in general, cool moist weather favors development of *Fusarium* patch, but how cool and how moist? Also needed are detailed studies of the micro-climate around each infected leaf, crown or root to help explain disease outbreaks and to help plan both preventative strategies and counter attacks accordingly.

3) FUNGICIDES. We now have a good arsenal of fungicides effective against *Fusarium* patch, red thread and *Typhula* snowmold but periodic screening of new materials should be continued in case the pathogens develop resistance to the old fungicides, or EPA cancels their registration (as it may do with Fore), or sales decline and companies withdraw them from the market. There is also the hope that new materials may be more effective (as with Rhodia's 26019) or cheaper than the old ones.

We need to study the long range effect of fungicide accumulation and their possible interaction with herbicides, insecticides, surfactants, and fertilizers.

Turf and the soil combine to form a living system containing many organisms. A single spoonful of soil usually holds millions of bacteria, spores, and fragments of fungi. Fortunately, probably 99 percent or more of these are beneficial. They retard growth of the parasitic types by secreting substances antagonistic to pathogens or simply by competing for the available food. Some also serve as mycorrhiza in a symbiotic relationship. If it were not for these benficial microorganisms, there wouldn't be any grass.

By using unnecessary fungicides we may be unfavorably affecting many of these beneficial organisms. This could result eventually in increased pathological problems, perhaps of a different type than those for which treatment was originally made. Most of us have witnessed dramatic losses when damping-off organisms reinvaded fumigated soils. We have also seen *Ophiobolus* become very destructive to turf grown on methyl bromide-treated soil, while adjacent unfumigated areas remained relatively disease-free. Therefore, the effect of fungicides should be considered not only on pathogens but also, insofar as practicable, on the beneficial organisms. As mentioned previously, we suspect that the beneficial effects of sulfur and chlordane against *Ophiobolus* may be an indirect one through their favorable influence on beneficial organisms. The selection of materials favoring development of beneficial organisms might even provide a new approach to the control of turfgrass diseases.

Finally, we must accept the probability that in the future there will be fewer fungicides available and they will take longer to come on the market. This will result from a combination of stiffer EPA requirements, increased costs of research from inflation, registration of labels, etc. The costs have risen so much that there is also a growing reluctance on the part of many companies to register their products for a crop unless sales will be fairly high. Therefore, most major turf fungicides in the future will probably be 'spin-offs' after their use has been established on such major crops as potatoes, apples, corn, etc.

4) <u>DISEASE RESISTANCE</u>. This seems to me to be the best long range solution to most of our turfgrass disease problems, particularly for lawn, park, cemetery and similar type turf. On the basis of our research to date, it appears that good strong resistance, rather than immunity from disease is the most we can hope for.

We have discovered several good cultural varieties which were developed elsewhere, that are resistant to our major pathogens. Now we need a breeding program to incorporate the best features of these varieties into turfgrasses especially adapted to the Pacific Northwest.

5) INFORMATION EXCHANGE AND RETRIEVAL. We still need more effective methods of transmitting information rapidly, both among turfgrass pathologists as well as between pathologists, agronomists, and horticulturists. In the West, the formation of WRCC-11 (Western Regional Project on Turfgrasses) has helped in this regard.

As one means of promoting such an exchange of information, Dr. John Haridson of Oregon and I organized in 1962 an informal conference of turfgrass pathologists for an exchange of ideas at the annual meeting of the American Phytopathological Society. These annual informal conferences continued through July of this year when we met in Kansas City for the last time. A formal Turf and Ornamental Committee has now been appointed and will arrange future meetings.

Under the auspices of WRCC-11, I also started a Turfgrass Pathologist's Newsletter in 1975 as a means of expediting the exchange of information nationwide. Presumably this newsletter will also be carried on by the new committee of APS. These measures have helped somewhat in speeding up the exchange of new information but they have been only partially successful.

We also need a good system of retrieving information. There is a tremendous amount of useful data which is buried in annual reports, miscellaneous proceedings, or obscure publications. Literature on disease resistance is a good example of this burial. In almost every Proceedings that I have seen, someone touches upon disease resistance, usually in the middle of a paragraph. How much time we could have saved if, for example, we could only have had all this fragmentary information available before we started checking bluegrass varieties for their resistance to *Helminthosporium*!!

6) REGIONAL RESEARCH. In general, climatic conditions and the complex of turfgrass diseases are relatively similar in Washington, Oregon and Idaho. They vary mostly according to whether the area is east or west of the Cascades. In view of this similarity, and in view of the generous support in the past by grants and other support from Superintendents and Associations in this region, I

recommend investigating the possibility of obtaining a Regional Turfgrass Pathologist to be stationed at WWREC. He could cooperate with local specialists in each of the areas in Washington, Oregon and Idaho. At first he would have to travel much more than we have in the past in order to become familiar with local conditions and to resolve the disease complex. Eventually, however, the travel load should lighten, particularly if fungicidal research and similar applied research could be handled on a cooperative basis with local specialists.

I believe that with our previous research, much of which has been of an applied and practical nature, we have established a solid basis on which to build an excellent future program. Future pathological research should increasingly emphasize basic or fundamental aspects. Such studies could be handled more effectively by one pathologist working full time in cooperation with a full time agronomist and/or plant breeder, than by three pathologists working parttime at three locations.

I understand that the precedent of Northwest regional appointments has been established in certain fields. There are certain drawbacks to such a project, but with funds becoming increasingly tight, I feel strongly that a regional turfgrass pathologist would be most effective for all three states.

Finally, I want to express my deep appreciation to all who have helped in so many ways to expedite the disease research program. Many of you here today have cooperated with us at one time or another in running experiments which have been described in the proceedings of previous conferences. We also are indebted to many sources for grants including the Northwest Turfgrass Association, USGA Green Section, Golf Course Superintendent Associations in western Washington, Inland Empire, Oregon and British Columbia, many chemical and seed companies, Worth Vassey and Evelyn Morris, and particularly my colleagues: Dr. Roy Goss, Dr. Stanton Brauen and Mr. Vernon Miller at Puyallup; Prof. Alvin Law at Pullman; Dr. Ron Ensign at Moscow; and Dr. Douglas Taylor and his associates in Canada. It has been a real pleasure working with you. Good luck to you in the future.

ADDENDUM

Principles of Turfgrass Disease Control

The following comments and suggestions for turfgrass disease control are based upon the observations and results of the experiments carried out with my associates during the past twenty years.

REMEMBER: GOOD CULTURE IS THE BEST PREVENTION FOR DISEASES

Location. Be certain that both soil and air drainage are good. Most diseases thrive best in moist, shaded areas with poor air movement. Eliminate excess trees, thin hedges, etc. Water-logged soils favor many fungi and are bad for turf.

Planting. Start with 'clean' soil. Old plantings that are badly diseased or infested with weeds should be fumigated. Recently cleared forested areas or sand plus organic mixtures are probably OK as is. However, with these, it is necessary to guard against invasion by *Ophiobolus* (see next section).

Nutrition. Use a balanced (3-1-2) fertilizer unless recommended otherwise. Where *Ophiobolus* and/or *Fusarium* may be a problem, use ammonium sulfate as the source of nitrogen or add sulfur at a rate of 100 lbs ±/acre. Since a suitable microbial balance appears to be necessary for the suppression of *Ophiobolus*, perhaps the addition of some organic matter such as sewage sludge would be worth testing.

Varieties. Use suitable resistant types. Only a single bentgrass variety is usually recommended for use on greens because of appearance, but similar types may be blended. Blends of 3 or more bluegrasses and fescues should be used on fairways, lawns, and similar turf in order to obtain suitable resistance to all the major pathogens. With this method of planting, if one variety succumbs to a certain disease, the other varieties will still provide good green turf.

Mowing. Don't mow any shorter or longer than is desigable. Too short mowing puts the grass under stress, rendering it more susceptible to many pathogens while too high mowing provides a beautiful 'moist chamber' for fungus development in western Washington and Oregon.

Compaction. This increases stress because of poor root growth and insufficient oxygen and therefore increases the possibilities for disease. Periodic aerification and use of sand for topdressing are highly desirable.

Thatch. The thicker the thatch the more chance there is for disease attack. The grass is under some stress and also thatch provides a suitable haven and food for many fungi.

Disease Watch. Examine your turf often so you will discover disease outbreaks before they become serious.

Fungicide Usage.

a. Be certain that you are using the correct fungicide for the particular disease problem affecting your turf. Although we recommend specific diseases on golf greens, we suggest mixtures for home lawns for two reasons: 1) the homeowner usually can't diagnose his ailment accurately, and 2) he's apt to have more than one problem.

b. Do not use the same fungicide repeatedly against the same pathogen. Alternate fungicides, preferably every other application, with an entirely different recommended type. This not only will help prevent the development of strains of pathogens resistant to fungicides, but it will retard the accumulation of possible toxic levels of fungicides.

c. Adopt a year-round preventative treatment program. Treat golf greens regularly during spring and fall and at least once a month during winter and summer to retard buildup of *Fusarium* patch in western Washington. In eastern Washington, treat greens at least once during September for *Fusarium* control. Then, before snowfall, apply a mixture of two fungicides, one effective against

Fusarium, and the other effective against *Typhula*. If the early treatment for *Fusarium* is omitted, the grass is weakened and thereby made more susceptible to subsequent attacks under snow by both *Fusarium* and *Typhula*.

Homeowners seldom apply fungicides more than once or twice a year. For lawns, we recommend one application in the spring and another in the fall in western Washington and one in September and another before snowfall in eastern Washington.

d. Use the correct dosage. Calculate it carefully the first time, then mark the figure on a card posted near your fungicide shelf. Be sure to recalculate rates if you change from one formulation to another.

e. Use only clean water in making up the spray solution. Avoid lake, pond, or river water, which may contain organic matter, clay, and other materials that keep fungicides from killing fungi.

f. Do not mix a fungicide with anything but water, unless you wish to experiment first on a small scale basis under your particular conditions. Addition of other pesticides, iron sulfate, or fertilizers may weaken the fungicide and/or increase the danger of burning.

g. Be certain that the sprayer, hose, and boom are free of rust and residues of herbicides and fertilizers.

h. Don't dilute the spray. Sweep or drag greens to remove dew or rain before spraying.

i. Don't guess at the areas of turf involved. Measure them carefully. Then record the figures on a card posted near the fungicide shelf.

j. Be sure to get good coverage of turf with the fungicide. Apply half the amount of spray while moving in one direction and the remaining half in a direction at right angles.

k. Follow manufacturer's directions carefully. Reread them frequently, particularly when a new supply is purchased. Manufacturers are constantly improving their formulations and updating their recommendations.

l. Keep up to date on new recommendations by getting the latest EM's (Extension Mimeos), (2049 - Disease Control in Lawns and 2050 - Disease Control in Putting Turf) from WSU.

m. Select a conscientious assistant to do the spraying if you can't do the job yourself. Pick someone who can and will do it as carefully as you would. Train you assistant to recognize the major diseases.

n. Continue to upgrade yourself professionally by continued study and reading. Hire college or highly qualified trade school assistants - they will be the turfgrass professional of tomorrow.

REMEMBER: GOOD CULTURE IS THE BEST

PREVENTION FOR DISEASES

REMODELING, EVENTUALLY ESSENTIAL[1]

Ronald Fream[2]

Almost as certainly as the sun rises, at some point in the future of your golf course, the prospects of remodeling will arise.

Remodeling can be classified as modernization, renovation, the correction of existing problems, improvement of playing conditions or any variety of these. Improvements can include aesthetic ones such as ornamental tree planting, the addition of flower beds or ornamental walls, the changing of a river sand for crystal silica in the bunkers and similar "eye wash" activities.

In the context of this present program, I wish to limit the remodeling remarks to those which are most common and most inevitable. This would be the remodeling and renovation works which most frequently result from golf course old age, or similarly from recent but incorrect construction.

There are numerous golf courses that were constructed ten, twenty or fifty years ago which did not have the benefit of modern golf course construction knowledge or methods. There are also golf courses that may have been built within the past ten years or so which were constructed improperly or inadequately either due to insufficient funding, or lack of adequate knowledge, or carelessness.

1/ To be presented to the 30th Annual Northwest Turfgrass Association Conference, Spokane, WA, September 29, 30, and October 1, 1976.

2/ Golf Course Architect, Fream/Storm/Associates, Ltd., Los Gatos, CA.

The problems of improper construction, and concurrently with that inadequate golf architectural design in some cases, are those seen almost universally: small, heavily worn tees, greens unable to withstand increasing rates of play, fairways having more exposed soil than turf, water filled bunkers after even the briefest shower, and drainage problems in general on tees, fairways and at the green sites.

Irrigation systems also show the effects of recent modernization of products when compared to the old hose bib and sprinkler or manual quick coupler systems. An entire seminar could be presented by an authority such as Carl Kuhn on the subject of "irrigation system and pumping plant modernization". Suffice to say here that if any form of golf course remodeling or renovation is contemplated, regardless of the scope of the project, a simultaneous consideration of the alternatives of irrigation system improvement must be undertaken. To rebuild one green, a fairway or a single tee and not consider the long term impact of such works on the irrigation system can lead to cart before the horse situations and needless extra expense.

Remodeling, no matter where or when it is done is expensive. The costs to rebuild a green would be higher than to construct a new green of similar size and construction method. The problems of working on an existing golf course, and maintaining reasonable play while construction works are going on obviously add costs to the work.

It is difficult to offer accurate cost figures which can be applicable over a wide range of sites, climatic and soil conditions, client objectives and local construction cost factors. However, as a guide and reference for green construction, using a first class seedbed mixture of sand and organic humus, drainage gravel and drain line and certified seed, a construction cost in the range of $1.75 to $2.00 per square foot of putting surface is reasonable.

Before any remodeling works are undertaken it is in the long term interest of the owner of the golf course to first consider having a qualified golf course architect prepare a long term master remodeling plan. A master plan or golf course improvement plan can provide a coherent and unified map that will eventually lead to a finished product that "fits". All too often, remodeling works are undertaken with a very specific goal in mind; one hole, one tee, one bunker perhaps, without adequate overview to insure that at some future time, all of the various alterations or improvements anywhere within the golf course will be compatible.

Perhaps the best examples of sporadic remodeling originate with the green committees of private clubs. The new committee chairman wishes to memorialize his term in office, almost regardless of what that year's remodeling projects will do to the future appearance, playability, or maintenance of the course.

Certainly nearly every person who can hold a golf club also fantasizes his equal or superior ability at being a golf course architect. The results of such efforts at golf clubs all over America are common and at times pathetic.

A comprehensive master plan, developed by a professional golf course architect in close collaboration with the green committee, course owner, golf manager, golf superintendent, golf pro and/or other pertinent interested individuals can result in a very functional tool; the foundation, upon which any modernization of the golf course can be undertaken with reasonable assurance that when the works are completed, be that one year, five years or longer, the finished product will fit the specific needs and requirements of the individual golf course and client.

Remodeling and renovation can improve dramatically, the carrying capacity or potential volume of golfer use on many courses, especially municipal facilities. New and larger tees with improved seedbeds, greens of larger size and shape, with agronomically correct seedbed mixtures and improved turfgrasses can offer more enjoyment to the golfers and fewer maintenance problems for the golf course superintendent. The automation of an irrigation system can increase application efficiency and conserve water, reduce labor and allow improved watering during nighttime hours. The addition of drainage facilities throughout a course can extend the playing season in some cases. The addition of ornamental tree and shrub plantings can greatly improve the seasonal appearance and beauty of the course. Cart paths are becoming an ever increasing necessity. The proper alignment and routing of the cart paths may make the difference between those paths which are used and those which are ignored.

Perhaps the most dramatic and sought after goal of remodeling is the improvement in visual aesthetics which can result from creative, imaginative design and proper construction procedures. Many golf courses appear to have been designed by the same rubber stamp! Monotony and boredom are rampant and all too common on many of the typical older courses and not a few of the newer ones also.

The visual beauty of a golf course can be greatly improved through the remodeling design process, a face lift in effect. The resultant improved shapes, surfaces and sizes of greens, and the contouring of mounding and bunkers around the greensites, can create some very beautiful playing settings where small, flat, round greens once existed. Teeing areas need not resemble postage stamps. With proper design increased teeing surface and improved appearance can result. Fairways need not be flat and boring. While improving or correcting drainage problems, mounding and bunkering can be added to emphasize strategic golf shot placement and enhance the visual beauty of a golf hole.

Certainly one of the foremost objectives of any remodeling program is to improve the turfgrass growing conditions. Improved seedbeds, drainage improvements, and the modernization of the irrigation system can all be done with careful consideration of the golf course superintendents requirements.

Remodeling can revitalize and renew a tired, worn out golf course as no other method can. Remodeling may be as certain as taxes, but when it is to be undertaken with professional and thorough planning, creative design, and implementation using modern agronomically correct techniques, the finished works can provide years of satisfied, beautiful and enjoyable golf play.

REMODELING GOLF COURSES[1]

Milt Bauman[2]

There are many reasons for remodeling golf courses. Two of the principle reasons are poor design and poor construction. They generally go hand in hand. I have had the opportunity to do extensive remodeling work at Overlake Golf and Country Club at Medina, Washington, and at Seattle Golf Club, where I am presently employed. I have also done some remodeling work on other golf courses.

Design is the first step in the making of any good golf course. The well designed golf hole should be a good test of golf and also a fair test. A well designed golf hole should take into consideration surface drainage, traffic control, and maintenance problems. Good construction can overcome many problems from poor design, but good construction cannot overcome poor traffic patterns along with surface drainage into the traffic areas.

At Overlake the greens were built out of clay and bog peat. The greens were small and had settled more than they should have. The big job was to obtain internal drainage by cutting ditches and installing tile and gravel. The greens themselves had to have a soil structure that would accept water, and for the most part, they would not. We installed the ditches, tile, and

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2/ Superintendent, Seattle Golf Club, Seattle, WA.

gravel. We used pitrun sand for a base and covered this with 12 inches of a sand greens mix composed of 75% sand and 25% sphagnum peatmoss. The sand and peat were mixed off site. The bulk of the sand was between 1/4 and 1/2 millimeter in size. We enlarged the greens somewhat from the original design and after an architect was retained, we did other extensive remodeling work.

At Seattle Golf Club we have not made any change in design. Likewise, we did not change the soil texture in the greens. This was originally mixed as sand, loamite and peatmoss. We did rebuild most of the aprons and many of the tees. For both green aprons and tees we removed the muck soils to a minimum depth of 24 inches and installed tile and gravel, then backfilled with about two feet of pit sand with excellent drainage properties then resodded the areas. From a design standpoint at Seattle, all of the drainage runs off to the front of the green and into the traffic pattern. This would be a most difficult situation to change without major remodeling. We did not attempt to change this, but only to make the approaches as dry as possible. Many of these problems could have been overcome by designing greens that would have surface drainage release in two or three areas and not any of the surface water draining into the traffic pattern.

Many builders install a greens mix that is exactly the size of the putting surface and use any kind of fill to build the mounds and aprons. The end result is usually mucky, wet, structureless aprons and collars. This presents major problems during the wet season and some of these aprons and collars will not take water, and particularly the mounds, during the dry season. This often results in localized dry spots that are difficult to manage. The aprons and collars should be built out of material that will drain as well as the greens. If you cannot afford a greens mix for a large area, at least carry the mix out far enough to grow grass in the traffic patterns and to reduce surface puddling and compaction and to achieve faster surface infiltration of water.

It costs very little more to do the job right in the first place. Built in problems that necessitate remodeling just about triples the cost of what the new construction was originally, so it is wise to do it right the first time around.

MAINTENANCE OF TREES AND SHRUBS[1] FOR PARKS AND GOLF COURSES

Bernard G. Wesenberg[2]

It is an obvious point that turfgrass and greens are the major point of emphasis for your meetings and conventions. However, I will bet that people management is still your first concern -- a) the crew that works with you, and b) the customers who play on the golf courses. Second, after the people comes the management of grass, and of relatively minor importance is the maintenance of the ornamental plantings.

My first introduction to a golf course was as a caddy at the Butte des Mortes Golf Course at Appleton, Wisconsin. It was rather exclusive with high membership fees. Any foursome of players had at least two to four medical doctors, lawyers, etc. I am sure a part of its prestige as a course was the value they placed on ornamentals. It had a good display of landscaping including maintenance of some appreciable amount of flowering beds around the golf course.

My first point to you is the value of ornamentals. It has been emphasized to you by Dr. Goss that the turf industry in the State of Washington is a very large industry. A similar survey was done on ornamentals, but this was done only from the standpoint of production, that is; the sales through the nurserymen, greenhousemen, and bulb growers businesses. The consideration of

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2/ Extension Horticulturist, Western Washington Research and Extension Center (WSU), Puyallup, WA.

replacement value of street trees, highway landscaping, industrial, and especially the tremendous value of plantings around private residences across our state would truly make an astronomical figure. The major reason for this great cost is that as the landscape plantings increase in size many of them become of such value that they cannot truly be replaced. Large trees and old established shrubs require more time and work to move than almost any purchaser will pay; therefore, established plants are not transplanted. For replacement, new, tiny plants are planted instead. Sometimes for insurance claims, considerable settlements are made because of damage to specimen landscape plantings. Aside from the dollar value, it is sound for all of you to realize that the attractiveness of your golf course is a very important item of appeal to those who spend their time enjoying themselves on the course.

You may be interested that for private homes up to 10 percent of the cost of the overall property may wisely be invested in landscape development. That percentage is very realistically recovered at the time of sale. This may have some application for you, but not necessarily in the same thought sequence, since people don't buy and sell golf courses anyway. The point stands that landscape plantings have considerable value.

If you will allow such regard for your landscape plantings, I think the sound course is that you assign a portion of your time for the attention to the trees, shrubs, and flower plantings on your golf course. If your staff is of sufficient size, some other individual can be given these responsibilities. A list or inventory estimating or counting the good, desirable trees and plants that are now on your golf course is time well spent. These do have appreciable value and should be considered as valuable for maintaining the appearance of the golf course.

The basic point on maintenance is that the plants used for ornamental purposes are truly expected to look good without care or attention. They may require a small amount of care, but in most cases for homes, parks, and probably for golf courses, the ornamental plant material receives almost no attention. In order for this to be realistic, the plants should be properly chosen when they are planted. The main point is that the plants should be dependably hardy to the site and to the exposure. The major single hardiness factor is the ability to stay alive without considerable damage with the expected minimum winter temperature of your location. Similarily, the plants should be relatively resistant to any disease attack or insect problem. I emphasize the extreme difference between landscape plantings and any kind of crop production, or for that matter, your fairways and greens. With ornamentals you have a mixture of many kinds of plants, none of which are being grown for any kind of harvest. They are not intended for yield, and you are not really concerned as to whether they grow three inches, six inches, or three feet in one year. Thus, if dependable plants are used, there should be only occasional difficulties due to the extremes of an unusual weather circumstance, or an unusual disease or insect problem, at which times special attention to spray applications may be necessary.

Along with designating either a part of your time or some other individual's time on the landscape maintenance, it is wise to make a record of any applications of chemicals used on the ornamental plantings. In those application records should be times that fertilizers are applied, any plant problems that did occur, and any weed, insect, or disease control sprays that were applied. This information is valuable for future decisions and judgments.

Flower color may be of interest and concern for some of you, or it may be an item which is very low on your priorities. As a casual point, however, I think it is worth emphasizing that all woody plants - shrubs, trees, -- flower for a relatively short period. Their flowering lasts for two to three weeks of the year. The herbaceous perennials -- chrysanthemums, peonies, primroses, daylilies, etc. -- all also have a similarly short season of bloom, typically two to three weeks. Thus if you want an extended flowering display anywhere on the golf course, it is necessary and essential to plant annuals. It is unlikely that any of you will be concerned about using a greenhouse in which to produce these, but the annuals can be very simply purchased from the commercial outlets. If the annuals are strategically placed in front of either shrub beds, or at points where they are very prominently seen, a relatively small amount of the annuals will get considerable notice, and do a lot for a more splashy appearance of the ornamental plants and for your development.

On tree and shrub maintenance, I want to point out that basically I feel that ornamentals can get along with almost no attention. Specific fertilizer applications are very desirable for new plantings to promote the rate of growth. Once plantings are fairly good sized, fertilizer is not really that necessary. They may not grow as rapidly, but that is of small concern. If you subscribe to my philosophy of minimum or no insect and disease control sprays, there may be incidents where you lose certain plants because they are especially susceptible to something. However, this may be as wise as continuing a spray program to keep up some weak item that could be more suitably replaced by other more properly adapted ornamental plants. Depending on your area and conditions, there may be wisdom for regular insect control on various kinds of trees or shrubs, but truly, it can be minimal as compared to any field, orchard, or garden food production.

A last point is on weed control. Through the Extension Services there are handbooks available covering various specific weed problems. Simazine and Casoron are two selective herbicides that have very wide use in the beds in which woody ornamentals are planted. Be sure you read directions before using either of these chemicals.

My parting shot (concluding point) is that trees and shrubs probably are so 'low maintenance' that you don't pay any attention to them. I am suggesting that this be assigned as a responsibility of one individual. Some thought about the care of this valuable material on your golf course will probably return considerable dividends. When selecting new plant materials for plantings, it would be sound to get advice so that properly adapted plants suitable to your situation can be planted. The garden centers and the nursery businessmen are the most likely resource to help you in that choice of plant materials. All County Extension offices in Oregon and in Washington have Extension Bulletin 592, "Plant Materials for Landscaping" which may be of use to you.

OVERSEEDING ON GOLF COURSES[1]

Richard Malpass[2]

A number of years ago Riverside Golf and Country Club of Portland, Oregon, retained a nationally known architect to prepare a long-range plan for the improvement of the golf course. In his commentary was a remark to the effect that fairways of the golf course were 99.9% annual bluegrass. While his estimate may have been somewhat high, it was not far wrong. Most fairways were annual bluegrass with a slight amount of Highland bentgrass and possibly a little creeping red fescue. Unirrigated roughs were mostly Highland bent with a little tall fescue.

When we came on the scene in 1970 we found many heavy traffic areas almost barren of grass particularly around greens and tees. Golf car traffic was not yet too much of a problem although there were a number of member-owned carts. It is doubtful if any reseeding had been done on the course since 1948 when all turf and trees had been killed by the flood which occured when the dikes broke on the Columbia River.

During the early fall months of 1970 we aerified the areas of sparse turf around the tees and greens with a fairway aerifier and hand seeded with a cyclone seeder using Manhattan perennial ryegrass. This was done again in 1971 in the fall months. We were quite pleased with the results of this overseeding although it certainly

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2/ Superintendent, Riverside Golf and Country Club, Portland, OR and President, GCSAA.

wasn't the most efficient method of seeding. In the fall of 1972 we rented a verticutter-seeder from a local turf equipment supply dealer for two or three days and again reseeded these worn areas. The collars around many greens were reseeded at the same time. The results from this seeding were so outstanding that the next year we were authorized by the Board of Directors to purchase a verticutter-seeder and about $1,500 worth of a grass seed blend containing Manhattan perennial ryegrass, bluegrass, and creeping red fescue. That fall (1973) we seeded eleven fairways. The next year we seeded the remainder of the fairways and again several of those seeded the previous year. We have continued this program and all fairways have been reseeded at least twice, many three times.

We feel that the success of this program has been due to several factors among them the following:

We try to start our seeding about August 15 intending to complete it before September 15. Our reason for this is to give the new grass seedlings the best possible chance to grow before receiving too much competition from annual bluegrass seedlings which germinate with the fall rains and cooler weather. In order to give the new seeding a little better chance, we start withholding irrigation water during the same period in order to throw the *Poa annua* into stress. This, of course, must be done with discretion as too little water could also injure the new seedling grass that we are trying to promote. We have also, as stated previously, used a blend of grasses.

The verticutter is set to cut through the thatch layer and into the soil beneath perhaps one-half inch. It takes a powerful tractor to operate the verticutter as it slices through the thatch and operates the seeder. Generally a large amount of thatch is dislodged and we sweep the fairways after seeding is completed. We have found that the machine operates much better if the turf is dry. Heavy dew or wet turf from recent irrigation can seriously interfere with the proper operation of the machine. Consequently, we usually seeded in the afternoon hours. The drier the area to be seeded the more successful the seeding.

We have confined our seeding to the early fall as we have not had similar success with spring seeding. We feel the reason being that a spring seeding has too much competition from existing grasses. Too, a spring seeding would possibly not be as well established going into the summer stress periods.

When we started the reseeding program we informed members that it would be at least one year before they would see results and that after two years it should be obvious to everyone that we were achieving the results that we were striving for. This has proven to be the case. All of you have probably seen the advertisement for Manhattan depecting Pat Fitzsimmons hitting a ball off a beautiful fairway. This picture was taken in the fall of 1975 on the 18th fairway of Riverside Golf and Country Club. Results you want? Results we got and the picture proves it.

We would not forget to tell you that the new seeding is much more drought resistant than the former annual bluegrass. We are among the last to start irrigation in the spring and among the first to cease irrigation in the fall. Additionally, the grass retains its color with less fertilization. It goes without telling that the wear resistance is much greater. Even with nearly 100 member-owned golf cars and a rental fleet in addition, the grass shows little wear.

In our opinion, most older courses would benefit from a reseeding program. Athletic fields, school campuses, and other turfed installations sustaining heavy traffic could well use an annual reseeding. We have told our members that we will never get through reseeding. Some must be done every year to repair the damage done from heavy traffic.

OVERSEEDING PROGRAMS THAT REALLY WORK[1]

Roy L. Goss[2]

Have you ever wondered that perhaps your overseeding programs were exercises in futility and perhaps a means of disposing of a lot of grass seed to help the grass seed producers, processors and retailers because you didn't see any results? A great number of turfgrass managers have repeatedly told me over the years, "I don't think I am getting anywhere with my overseeding program. I think I still have as much *Poa annua* as ever, in fact I think it's gaining."

On the other hand, many people have been successful in overseeding programs. Let us review some of the factors regarding overseeding programs.

WHY DO OVERSEEDING PROGRAMS FAIL

1. Overseeding at the wrong time. Soil temperatures can effect germination rate, seedling vigor and ultimately determine the success or failure of overseedings made in early spring or too late in the fall. Overseeding should be practiced at the optimum time of germination and seedling growth which is definitely in the best part of the growing season.

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2/ Agronomist/Extension Agronomist, Western Washington Research and Extension Center (WSU), Puyallup, WA.

2. Too intensive management. It is much more difficult to establish seedlings on a putting green cut at 3/16 or 1/4 inch than it is an athletic turf, playground or home lawn that is being cut somewhere between 3/4 and 1½ inches high. Most failures on putting greens are due to the fact that the seedlings germinate and are clipped off at or below the growing point, thus the seedling dies.

3. Intensive traffic. Perhaps many of the seedlings do not survive when intensive use is made of the area of foot and vehicular traffic which would include mowers and other mechanical operations.

4. Inadequate seedbed preparation. This could include lack of aerification, verticutting or topdressing following seeding.

5. Improper watering techniques following seedings. It must be remembered that bentgrass seeds are almost as fine as dust and if covered too deeply, they will not emerge and left on the surface, they will dry out. It is very necessary to maintain adequate surface moisture to insure germination and rooting and this requires light but frequent waterings during the germination and establishment period.

There are many other factors that could be cited as to the possible failures of overseeding programs, but these are a few that are dominant.

HOW TO MAKE OVERSEEDINGS WORK

A. Athletic Fields and Playgrounds. Extreme traffic on playgrounds and athletic fields results in compacted surfaces and a mat of dead, trampled grass, leaves, stems, crowns and roots. This presents a barrier to water movement and rooting. Grass seed broadcast over matted grass has a very poor chance of either germinating or establishing. In order to achieve the best establishment under these circumstances, one should remove the dead matted material either with a sod cutter, power rake, verticut or other mechanized equipment until bare soil is showing. Any surface irregularities can be remedied at this time and the new seed planted. Athletic and playfields that are not completely annialated in certain wear areas can also be overseeded with power equipment such as the renovator/overseeding machines available on the market. Every school district and park department of any size should have one of these machines in their equipment inventory. These machines positively place the seed through soil openers into the soil (unless the thatch and mat are too deep) so that positive germination will occur provided that other management practices of watering, etc. are carried out.

Another technique that works to a reasonable degree is to broadcast seed over wear areas, particularly on football fields and let the players trample the grass seed in during the last game or two of the season. Obviously, this system will not work if the playing area is a mudhole or is in need of extensive repair.

Careful consideration should be given to the area to be overseeded with regard to nutritional programs. If bluegrass is to be established, one must carefully consider the pH of the soil and the calcium levels. Obviously, adequate attention should be given to the nitrogen, phosphorus and potassium programs as well. When the soil is bare through renovation processes, it is the best time to incorporate lime and phosphorus into the root zone.

B. Putting Greens. This is probably the most difficult area to establish any significant gain in desirable turfgrass populations through overseeding. It is my opinion, and shared by many others, that little survival will occur when the grass is mowed at 3/16 or 1/4 inch. If you don't believe it, plant some grass on bare soil and set your mower at 3/16 or 1/4 inch and mow it when it emerges. Obviously, some will survive, but most will not. In order to achieve any degree of survival, I suggest the following program:

1. Aerify the area to be overseeded.

2. Vertical mow or scarify the surface in some way to allow better contact of the seeds with the soil or even thin thatch layers.

3. Broadcast the seed followed with topdressing to provide some cover and enhance germination.

4. Practice light frequent irrigation to insure field capacity moisture in the immediate surface.

5. Raise the mowing height to 5/16 inch (preferably higher if possible) during the germination and early seedling growth stages.

6. After 4 to 5 weeks, gradually reduce the mowing height by increments possibly of 1/32 inch per week while continuing with light sand topdressing. It is very important to continue the topdressing operation during the cutdown period. This effectively covers the crowns of the grass some and effectively raises the mower a little higher off the original surface.

7. Don't be afriad to use generous amounts of the fine leaved turf type ryegrasses along with bentgrass for overseeding putting greens or heavy wear areas around the greens. I have seen some very successful overseedings with the turf type ryegrasses on putting greens, and believe me, the ryegrasses are vastly superior to no grass at all on a putting green. The ryegrasses will withstand mowing heights of 1/4 inch and will provide considerable support and protection to the very fine low vigor bentgrass during the establishment period.

8. Consider using renovator/overseeding machines on putting greens while continuing with topdressings and increase mowing height.

9. Adequately protect young seedlings with light rate fungicidal programs if overseeding is practiced during periods of normal disease attack.

Areas that need to be reseeded can be handled in a similar manner and by observing some of the following precautions.

1. If thatch layers are too thick, they should be removed. Sometimes this justifies the use of a sod cutter and start over.

2. If the areas are only minor, then power raking to remove dead accumulated material followed by either broadcasting or the use of renovator/overseeders will prove to be very effective.

3. The same suggestions regarding nutritional considerations should be observed.

Lawns are much easier to handle since they do not have the traffic considerations as a rule. Small individual areas can be especially seeded, and there should be little excuse for not establishing new turf in those areas. We do recommend the use of turf type ryegrasses as part of the seed mixture in overseeding lawns in western Washington. In eastern Washington overseeding can be accomplished with bluegrasses, fescues or mixtures of bluegrasses and fescues and little need for the use of turf type ryegrasses in that area. There is some question also of the survival of the turf type ryegrasses in the more severe climatic regions of eastern Washington.

I have worked with a number of golf course superintendents who have successfully established new turf in damaged putting greens and tees. One particular case, all 18 greens were seeded with Manhattan perennial ryegrass because of poor germination and establishment of bentgrass on sand greens. The poor establishment was due to a lack of knowledge on the parts of the owners in the development of new putting surfaces. Due to a scheduled or hopefully scheduled opening date, the only recourse was to seed with Manhattan ryegrass and continually overseed with one of the creeping bentgrasses. All 18 greens were successfully established, they met their opening date and they received numerous compliments upon their putting surface and quality while not even knowing they were putting on perennial ryegrass. Due to the fact that perennial ryegrass, even our most improved turf type ryegrasses, do not provide quite the density that we get from bentgrasses, this leaves excellent opportunities for placement of bentgrass seed against the soil. Due to some shade protection, we obtain a better germination rate and provided we follow the other precautions shown in this paper, excellent establishment can be expected.

In conclusion, it is best to time an overseeding operation with a period of time when the least amount of traffic can be expected and the least amount of disruption to use of the intended area. Some reseeding can be done on schools as late as the latter part of October when weather conditions will not allow the most intensive use, particularly of playfields. Golf courses can practice much of their overseeding in late summer and early fall when intensive use of these areas starts to fall off. Less criticism will be experienced if the turfgrass manager carefully explains his program and receives the complete cooperation of his administration. Tell them what they will expect and what you think the program will do. You will generally be much more successful.

TURFGRASS IRON PROBLEMS AND SOLUTIONS[1]

J. D. Butler[2] and M. A. Harivandi

A problem inherent to the production of high quality turfgrass in drier areas of western U. S. is that of iron chlorosis. Mineral soils in Colorado may contain from 0.5 to 3.0% total iron. However, the amount of total iron in the soil does not truly reflect the amount of iron available for plant use.

Soils with high pH's and lime content (calcareous soils) are often deficient in plant available iron. Plants grown on such soils are subject to "lime induced" chlorosis. Iron availability is at a minimum in soils with a pH of 7.5 - 8.0.

Iron deficiencies may be caused or made worse through heavy phosphorus fertilization. Nitrogen fertilization may induce or accentuate iron chlorosis of turfgrass. High soil moisture, perhaps from overwatering (which causes lack of oxygen), may favor iron deficiencies. Also, an imbalance of metallic ions, such as high availability of copper or manganese in relation to iron, can induce iron deficiencies.

1/ To be presented to the 30th Annual Northwest Turfgrass Association Conference, Spokane, WA, September 29, 30, and October 1, 1976.

2/ Extension Associate Professor, Dept. of Horticulture, Colorado State University, Fort Collins, CO.

Assess the Problem

A yellowing of the turf may indicate problems such as deficiencies of certain nutrients, the presence of certain insects or diseases, and extended periods of cloudy weather. In the West it is not unusual for a turfgrass professional to confuse an expressed plant need for nitrogen, or perhaps even sulfur, for the need for iron or vice versa. If the turf is weedy and lacks density the problem is likely to be a need for nitrogen fertilization; while a dramatic and often patchy yellowing of the grass often indicates an iron deficiency. An accute shortage of available iron may be expressed by a bleached, almost white, appearance of the turf. If the iron deficiency is severe, turfgrass may die.

The foliage of turf that shows iron deficiency is often quite flaccid. And mowing, especially with reel mowers, may produce ragged and matted turf. Observations also indicate that bentgrass which shows iron deficiency is subject to winter injury.

If there is doubt as to the cause of a nutritional deficiency, it is possible to determine the nutrient(s) needed through trial application of various fertilizers. The effect of applying iron containing materials, such as ferrous sulfate and ferrous ammonium normally gives a dramatic green-up in 1-2 days.

In the West a routine soil test may provide information on available iron, The DTPA soil test developed by Lindsey and Norvell at Colorado State University has proven to be a sensitive test for soil-available iron. Soil test levels of 10-15 ppm of iron are normally considered adequate for most cool season turfgrasses. However, because of certain conditions it is difficult to pinpoint the exact amount of available soil iron necessary to produce an acceptable turf. At 10-15 ppm available iron, chlorosis may develop, but at such levels chlorosis is not expected to be extreme; and turf quality, especially for certain grasses, would normally be satisfactory. It may also be possible to determine iron needs through tissue testing for chlorophyll and/or iron.

Solve the Problem

In more arid regions of the West, iron chlorosis of Kentucky bluegrass, perennial ryegrass, red fescue and bentgrass occurs rather frequently. Of these, the bentgrasses seem to be the least prone to iron chlorosis. The other three do not seem to differ much, under the same growing conditions, in their susceptibility to iron chlorosis. Tall fescue, smooth brome, and western wheatgrass do not appear to be nearly as prone to iron chlorosis as Kentucky bluegrass.

A dramatic difference can be observed in Kentucky bluegrass cultivar susceptibility to iron chlorosis. However, cultivars of Kentucky bluegrass that perform well under moderately low levels of soil available iron may not do well at low levels of soil available iron. Table 1 gives an indication of the length of time during a season that iron chlorosis can persist as a problem of Kentucky bluegrass turf. Under the conditions existing in this cultivar test, as indicated by data in the table, performance did not vary much from one year to the other.

At another location where soil available iron may fall below 5 ppm dramatic differences in cultivar resistance occurs. In this area, of the cultivars included in the test, the performance of P-84, P-59 and RAM 1 Kentucky bluegrasses has been good.

In general, the severity of iron chlorosis increases as the growing season advances. In Colorado the problem normally becomes acute in August and September. In the spring in Colorado the turfgrass will usually have its normal color, even those cultivars which will be showing extreme chlorosis in a few months. Thus, the need for supplemental iron applications may depend, not only on the kind of grass grown, but the time of year. Late applications of iron may not be necessary in Colorado, since the turf usually tends to be green without supplemental iron at that time.

TABLE 1. Iron chlorosis of Kentucky bluegrass cultivars grown at the W. D. Holley P.E.R.C., C.S.U., Ft. Collins, Colorado.

	Cultivar	8/16/72	11/6/72	9/11/73	Average
1.	Pennstar	1.0*+	1.7*+	1.3*+	1.3*
2.	Fylking	1.3	2.3	2.7	2.1
3.	Adelphi	1.7	1.3	1.0	1.3
4.	Prato	2.3	2.3	3.7	2.8
5.	S-21	3.7	4.0	4.0	3.9
6.	Windsor	2.0	1.3	2.0	1.8
7.	South Dakota Common	2.3	2.0	1.7	2.0
8.	Nugget	1.7	2.0	3.0	2.2
9.	Primo	2.3	1.7	3.0	2.3
10.	Geary	3.0	3.0	3.3	3.1
11.	Delta	4.0	4.0	4.0	4.0
12.	Newport	2.0	2.3	2.3	2.2
13.	Park	3.7	4.0	3.7	3.8
14.	Melle	3.0	3.0	2.7	2.9
15.	Ill. Expt.	1.0	1.0	1.3	1.1
16.	Sodco	1.3	1.3	2.3	1.6
17.	Kenblue	2.3	2.3	2.0	2.2
18.	Arboretum	2.7	3.3	3.3	3.1
19.	Merion	1.3	1.7	2.0	1.7
20.	Code 95	2.7	2.0	2.7	2.5
21.	Sydsport	1.3	1.3	2.7	1.8
22.	Baron	1.7	2.0	3.3	2.3
23.	Warren's A-20	1.0	1.0	1.0	1.0
24.	Warren's A-34	3.0	2.0	3.7	2.9

*Levels of iron chlorosis + Mean of 3 replications

1 = none
2 = slight
3 = moderate
4 = severe

Iron Applications

Several different commercial iron-containing materials are available for use on turfgrass and other landscape plants. In turfgrass fertility programs in the West, the importance of iron as a needed plant nutrient may be ranked just after nitrogen.

Both foliar and granular applications of iron are used in turfgrass maintenance programs. In Colorado, several commercial turf fertilizers that contain significant amounts - often from 2 to 5% - of iron are marketed. These fertilizers are widely used for bentgrass and bluegrass maintenance both by the professional and the homeowner.

Ferrous sulfate is the commonly used iron supplement, both for dry and liquid application, for turfgrass in Colorado. Ferrous ammonium sulfate, iron chelates, sewage sludge, organic extracts, etc. are also utilized to supply iron for turf. Ferrous sulfate and ferrous ammonium sulfate have generally proven satisfactory, although other commercially available iron containing materials may or may not have satisfactorily controlled iron chlorosis. The source and amount of iron applied, as well as the time and method of application, may influence results.

The amount of an iron material to use to correct an iron problem is often unknown, and unsatisfactory results can occur from the use of insufficient amounts of material. Amounts of iron applied per 1000 sq. ft. may range from less than 0.1 lb to more than 1.0 lb of actual iron. Since the recommendations for iron usage to correct iron problems are often quite variable, it would be wise to determine, through trial applications, the amount and frequency of application necessary for satisfactory results. In some instances there seems to be little if any benefit from applying iron.

Foliar applications of from 2 to 8 ounces of ferrous sulfate (material) have been noted as a means of getting green-up. Such applications may give a rapid (2 - 3 days) green-up, but such green-ups, whether from a foliar or dry application, may be short-term. Amounts applied as dry material may be high by foliar standards. Granular applications of ½ to 1 lb of actual iron from ferrous sulfate or ferrous ammonium sulfate may be used on turf. But since these materials may cause injury, light frequent applications may be desirable, especially since green-up may be temporary. However in some instances, a long green-up may occur through the use of iron containing materials.

1975-76 SNOWMOLD STUDIES[1]

R. E. Ensign[2]

In the late fall of 1975 five (5) selected chemicals and combinations were applied to Green #9 (Seaside bentgrass) on the University of Idaho golf course for the purpose of evaluating them for the control of "snow mold" diseases. *Fusarium nivale* (*Fusarium* patch or pink snowmold), and *Typhula incarnata* (grey snowmold) are the two major snowmold organisms infecting bentgrass in this area.

The chemical treatments were:

1.	Bay 6447 (2570)	4 oz/1000 sq. ft.
2.	Bay 6447 (2570)	16 oz
3.	Rhodia 26019	4 oz
4.	Rhodia 26019	16 oz
5.	Tersan SP	8 oz
6.	Tersan SP + Tersan 1991 8 oz + 2 oz	
7.	Rhodia 26019 + SP 4 oz + 8 oz	
8.	Terraclor	9 oz

Bay MEB 6447 is an experimental Chemagro chemical compound (1-(4-chlorophenoxy)-3, 3-dimethyl-1-(1H-1, 2, 4-Triazol-1-yl)-2-butanone) which shows a high degree of systemic activity and effectiveness against a number of fungi, especially mildew.

1/ To be presented to the 30th Annual Northwest Turfgrass Association Conference, Spokane, WA, September 29, 30, and October 1, 1976.

2/ Professor of Agronomy (Turf-Forages), University of Idaho, Moscow, ID.

Rhodia 26019 1-isopropol carbamoyl-3(3,5-dichloro phenyl) hydantoin is another experimental product which has shown excellent control of *Fusarium* on the coast.

Plot Plan

Sulfur has shown fungicidal effects on many plant diseases. One purpose of this experiment was to evaluate effectiveness of sulfur with and without other chemicals for control of "snowmold".

On one-half of the green sulfur in the form of ammonium sulfate was applied at the rate of 1 lb of S/1000 ft^2 one month (October 25) before the chemical treatments were applied. On the other half crystalline sulfur was applied at the rate of 5 lb of S/1000 ft^2. On November 21, 1975, at the onset of *Fusarium* infection and before *Typhula* was evident, the chemicals listed above were applied. Four (4) replications of 5' x 15' plots were applied to each one half of the green, thus 8 replications of chemicals were used.

Climatic Conditions

The 1975-76 fall and winter season was favorable for the development of the snowmold pathogens. Check plots showed 75-100% of the area infected with snowmold. *Fusarium* was the dominant fungi. There was evidence of light infection just prior to treatment applications. Our area experienced above average precipitation, mostly rain, until late December. Forty-two days of intermittent snow cover was recorded between December 28, 1975 to March 12, 1976; the longest continuous period was 20 days in late December to mid-January.

Results

The results of the test from several readings taken from mid-February to mid-March are recorded in the following table.

These data indicate the best snowmold control was obtained on plots treated with either a combination of Tersan SP + Tersan 1991 (Tr 6) or Rhodia 26019 + Tersan

SP (Tr 7). Good control was also obtained from Tersan SP, Rhodia 26019 (16oz) and Terraclor (9oz). The 4-ounce rate of Rhodia 26019 and either rate of Bay 6447 were less effective for snowmold control in this test.

Differences between ammonium sulfate and the crystalline sulfur main plots were variable. It appeared infection was more evident on the crystalline plots. Grass on the latter plots was bleached and was difficult to read due to a low level of green-up and lack of nitrogen.

The oxidation of sulfur occurs above 20°C so the effectiveness of sulfur as a fungicide at the time applied in this test is open to question.

TABLE 1. Percentage of area infected with "snowmold" organisms for several fungicide treatments applied over two rates of sulfur.

	Treatments	Ammonium Sulfate			Crystalline Sulfur			
		Fusarium (%)	Typhula (%)	Av. (%)	Fusarium (%)	Typhula (%)	Av. (%)	Overall Average*
1.	Bay 6447 (4oz)	42	9	51	44	11	55	52
2.	Bay 6447 (16oz)	16	5	21	42	14	56	39
3.	Rhodia 26019 (4oz)	13	8	20	27	9	36	31
4.	Rhodia 26019 (16oz)	3	4	7	11	9	20	14
5.	Tersan SP (8 oz)	6	6	11	13	8	20	12
6.	Tersan SP + Tersan 1991 8 oz 2oz	3	4	7	5	5	10	8
7.	Rhodia 26019 + SP	3	2	5	8	6	14	7
8.	Terraclor (9oz)	8	6	14	15	8	23	15
	Check	70	30		70	30		

1976 IDAHO TURFGRASS TRIALS[1]

Ron Ensign[2]

Moscow Trials

Since 1972 several turfgrass species and varieties have been evaluated for turf quality on the Plant Science Farm. The entries include 46 bluegrasses, 12 fine leaf fescues, 4 perennial ryegrasses, 2 turf timothy, and 6 bentgrasses. In 1976 all grasses were mowed at 1, 2 and 3 inch mowing heights with the exception of the bentgrasses which were regularly mowed at ½ inch. The species have been evaluated for turf-lawn use conditions.

Numerous readings were taken during the 1976 growing season and the records to early September. A summary of these readings follows:

Overall Quality (texture, color, appearance) 10 High 9/1/76

	9.0		9.0
Fylking	↓	Prato	↓
Glade		Ram #1	
Nugget		Majestic	
Newport		Victa	
Pennstar	9.0	Baron	8.0

Overall quality is variable over the season since the color, texture and appearance change somewhat.

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Spring Regrowth

Early		Moderate		Late	
Adelphi	3/27	Baron	4/8	Nugget	4/20
Garfield	↓	Pennstar	↓		
Arboretum		Cougar	4/15		
Park					
Sydsport					
Touchdown	4/2				

Nugget is most noticable for very late regrowth. The fine leaf fescues and bentgrasses are usually slightly earlier in green up than are the Kentucky bluegrasses.

Turf Color During Season (Top 10)

Spring		Summer		Fall	
Aquilla	9.0	Adelphi	9.0	Cougar	9.0
Continental	↓	Ram #1	↓	Fylking	↓
Adelphi		Glade		Glade	
Baron		Victa		Nugget	
Ram #1		P-164		Majestic	
Rugby		Majestic		Baron	
Glade		Baron		Newport	
Parade		Cougar		Pennstar	
Galaxy		Newport		Prato	
Sodco	8.0	Nugget	7.0	Victa	8.0

There is some variation in ranking for color among seasons although most varieties exhibit a relatively constant color throughout the year.

Turf Color at Various Mowing Heights

9 = Dark Green

1" level		2" level		3" level	
Fylking	8.3	Fylking	8.7	Ram #1	8.7
Victa	↓	Victa	↓	Adelphi	↓
Newport		Ram #1		Victa	
Ram #1		Adelphi		Majestic	
Aquilla		Glade		Baron	
Glade		Newport		Fylking	
Pennstar		P-164		Glade	
Sydsport		Aquilla		P-164	
Belt Turf		Majestic		Aquilla	
Continental	8.0	Baron	8.3	Bonnieblue	7.1

The average color readings for 43 Kentucky bluegrass varieties at the various mowing heights - 1976.

1" level = 6.4
2" level = 7.0
3" level = 6.7

At the 2" level the grasses are most uniform and the greatest range in color is at the 3" level. The best overall average color appears to be at the 2" mowing height. The fescue and perennial ryegrasses will not withstand as close mowing as the better bluegrasses. A more detailed summary ratings of the various turf varieties can be obtained from the Author.

Parma Trials

In 1975 replicated turf trials were established at the University of Idaho, Parma Research and Extension Center. This is located in southwest Idaho where summer temperatures are warm and the soils are generally higher in pH (8.0 + pH). Winter temperatures are also generally higher than in northern Idaho.

The trials consisted of 15 Kentucky bluegrasses; a blend of 3 bluegrasses plus a Creeping Red Fescue; Barfalla Chewing Fescue; C-26 Hard Fescue; P-14944 Tall Fescue + Creeping Red Fescue: and NK-200 Perennial ryegrass. The major objective of the trials was to evaluate these species and varieties under rather high stress conditions.

Results of six readings during 1976 may be summarized as follows:

Entry	Overall Quality* 1½" Cut	Turf Color** Early 1½"	Summer 2½"	Late 1½"	Summer 2½"
Arboretum	5.7	5.3	6.7	5.7	6.0
Baron	7.7	8.3	8.7	7.3	7.3
Belt Turf	7.0	8.0	7.7	6.3	6.3
Cougar	7.0	7.3	6.7	6.3	6.7
Delta	6.3	6.0	7.3	8.0	5.7
Garfield	6.3	6.7	7.0	5.7	6.0
K-1-187	7.0	5.3	7.7	6.3	5.7
Merion	8.0	8.7	8.3	6.3	5.3
Newport	7.0	5.0	8.7	7.0	6.3
Nugget	7.7	8.3	9.0	7.7	7.3
Park	6.7	6.7	7.7	6.7	5.3
Pennstar	8.0	7.3	8.3	6.7	6.3
South Dakota	6.0	4.3	7.0	6.0	5.3
Touchdown	7.0	7.3	7.0	8.0	6.3
Victa	7.7	5.3	8.3	8.0	8.0
Blend-¼ Sydsport, ¼ Baron, ¼ Garfield, ¼ Creeping Red Fescue	6.0	7.3	7.3	5.3	5.3
Barfalla Chewing F.	2.3	4.0	6.7	3.3	5.3
P-14944 Tall F + Creep. Red Fescue	2.6	3.0	6.7	6.7	7.3
NK-200 Perennial Rye	2.7	5.7	6.7	5.3	8.0
C-26 (Biljart) HardF	5.0	3.7	6.7	6.7	6.0

* 9 = best

** 1 = yellowish

** 9 = dark green

Summary

Varieties rated tops in overall quality (color, texture, general appearance) were: Merion, Pennstar, Nugget, Baron, Victa.

The Kentucky bluegrass - fescue blend was about equal to Garfield but less than the best bluegrass in overall quality.

In turf color the top varieties for both cutting heights were:

Early Summer:	Nugget	Late Summer:	Victa
	Merion		Nugget
	Baron		Baron
	Pennstar		NK-200 Per. Rye
	Blend		

In general the high (2½") mowing height for early summer was superior to the low cut in desirable color. In the late summer, however, better color readings were obtained from the low cut (1½") for some varieties such as Delta, Nugget, Touchdown, and C-26 Hard Fescue.

Additional years testing are needed to evaluate longevity under these conditions.

MEASUREMENTS OF BIODETHATCH EFFECT ON[1] THATCH ACCUMULATION UNDER BENT AND BLUEGRASS TURF

Alvin G. Law[2]

Thatch is an ever present problem to the turf manager and the improved turfgrasses, generally, produce the most thatch. In most definitions "thatch" becomes "mat" if left undisturbed and uncontrolled. At this stage mat is associated with a spongy, puffy condition that results in scalping by the mower and finally, irregular dead spots on the green. Excessive thatch may result from infrequent mowing, mowing too high, too much nitrogen, poorly drained acidic soils, efficient control of earthworms and soil micro-organisms, and the use of improved varieties of turfgrasses. Excessive thatch not only spoils the turf surface, but it harbors diseases, weed seeds, root feeding insects, restricts water and nutrient movement in the soil and generally complicates the management picture. There are vast differences in the thatch producing characteristics of different bluegrass or bentgrass varieties. Amongst the bluegrasses, Fylking, Nugget, and Pennstar are characteristically heavy thatch producers (Table 1). Penncross bent and other vigorous creeping bents are also strong thatch producers.

Efforts to control excessive thatch accumulation have resulted in the development of an extensive arsenal of special equipment including power rakes, verticutters, slicers, aerifiers and topdressing machines. Used in

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1/ To be presented to the 30th Annual Northwest Turfgrass Association Conference, Spokane, WA, September 29, 30, and October 1, 1976.

2/ Professor of Agronomy, Washington State University, Pullman, WA.

various combinations and intensities these enable the turf manager to live with a reasonable amount of thatch. The combination of management practices that control thatch is almost endless and research to define the optimum practice is not complete. For example, on cool season grasses we have indications that spring aerification plus verticutting followed by bi-monthly light topdressings will do the necessary control jobs. We do not know yet the optimum number of topdressings or the best fertilizer practices or how often to aerify or verticut.

"Some" thatch is good. On the green it aids in holding the approach shot. In fairways, lawns, and such general purpose turf, thatch gives the surface some resiliency and protection from severe weather. On these latter sites care to avoid killing the earthworm population with insecticides will go a long way toward controlling excessive thatch accumulation.

Over the years researchers have applied sugars, fertilizers, limestone, gypsum, wetting agents, growth regulators, in fact almost everything but the kitchen sink, in an effort to speed up decomposition of the thatch. Recently there is available a biological material[3/] that could increase the population of organic matter decomposing flora in the soil. We applied this material in the spring of 1976 at recommended rates to a five year old bentgrass turf (practice green ASWSU Golf Course, Pullman, WA) and to an established bluegrass variety nursery. Subsequent thatch measurements from the bentgrass are shown in Table 2. We measured thatch by taking five plugs per location to a depth of five centimeters, washing out the soil, drying the resultant organic matter, weighing, then burning the material in a muffle furnace at 1000°C to remove the organic matter, reweighing and subtracting the second weight from the initial weight so that the loss in weight was a measure of the thatch. Each plug was two centimeters in diameter. This method reduces the variability due to differences in washing out the soil.

3/ Furnished for these trials by U.S. Steel Agriculture Chemicals.

We compared thatch accumulation under bentgrass fertilized with ammonium sulfate with that fertilized with urea both with and without biodethatch applications. There has been, to this point, no visual difference between the plots with and without biodethatch. Our measurements (Table 1) show a 42% and a 17% reduction of thatch on the plots receiving the biodethatch treatment on the ammonium sulfate and urea areas compared to the non-treated plots. On the ammonium sulfate plots this was a significant reduction. On the urea plots the reduction in thatch accumulation (17%) was not a statistically significant figure even though the treated areas were consistently less in total thatch than the non-treated plots.

Biodethatch was applied July 7 to an established bluegrass variety trial in its fifth year of production. Plugs taken August 23 showed no difference between the biodethatch and the check treatments. It is felt that the material should be applied no later than May 20 for best results in the Pullman area. We hope to continue these investigations into subsequent seasons.

Table 1. Relative Thatch Accumulation Under Bluegrass Varieties Managed for General Purpose Turf.

Variety	Replication I	Replication II	Replication III	Average
	g	g	g	g
Merion	1.99	1.50	1.99	1.82 c[1/]
Cougar	2.30	2.17	1.85	2.10 bc
Delta	1.65	1.75	3.90	2.43 b
Sodco	2.90	2.53	2.69	2.70 b
Pennstar	2.76	3.02	3.14	2.97 b
Nugget	3.72	3.38	3.67	3.59 a
Fylking	5.20	2.68	3.54	3.80 a

[1/] Averages with same letters are not significantly different at the .01% level of probability.

Table 2. Effect of Biodethatch on Thatch Residue of Bentgrass. 1976

Replication	Treatment[1/]			
	A	B	C	D
	g	g	g	g
1	.45	1.90	1.65	1.60
2	1.50	3.48	1.75	1.67
3	1.70	1.95	1.90	1.13
4	1.85	2.20	1.85	1.53
Av.	1.38 b[2/]	2.38 a	1.79 ab	1.48 b

[1/]A. Ammonium Sulfate (10# N per season) + biodethatch July 7, 1976

B. Ammonium Sulfate (10# N per season) no biodethatch

C. Urea (10# N per season) no biodethatch

D. Urea (10# N perseason) + biodethatch on April 14 and July 7, 1976

[2/]Averages with the same letter are not significantly different at the .01% of probability

NITRIFICATION INHIBITORS ON TURFGRASS[1]

R. L. Warner and A. G. Law[2]

In order to maintain good quality turf, frequent applications of nitrogen and water are essential. Under normal conditions, the primary form of soil nitrogen available to the plant is nitrate, regardless of whether the nitrogen fertilizer is applied as nitrate, ammonium, or urea. In warm moist soils ammonium is rapidly converted to nitrate. Unfortunately nitrate can be readily leached down into the soil profile and may be leached beyond the effective rooting zone of turfgrasses. Recently nitrapyrin [2-chloro-6-(trichloromethyl) pyridine] also known as N-Serve (Dow Chemical Company) has been found to inhibit nitrification. Keeping applied nitrogen as ammonium in the soil could be advantageous in that more efficient use of nitrogen could be achieved since ammonium is not readily leached from the soil profile.

We evaluated the effectiveness of nitrapyrin as a nitrification inhibitor on turfgrasses by measuring nitrate content of Newport Kentucky bluegrass clippings. In late May ammonium sulfate was applied at rates of 0, 5, and 10 pounds of N per 1000 square feet. The fertilizer treatments were then split by applying nitrapyrin at rates of 0, 10, and 20 pounds per acre in

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1/ To be presented at the 30th Annual Northwest Turfgrass Association Conference, Spokane, WA, September 29, 30, and October 1, 1976.

2/ Associate Professor and Professor of Agronomy and Soils, Washington State University, Pullman, WA.

1974 and of 0, 20, and 100 pounds per acre in 1975. Following application of the fertilizer and nitrapyrin the plots were thoroughly sprinkle irrigated. The plots were irrigated throughout the summer as necessary. At approximately weekly intervals the plots were visually evaluated for color, mowed, and the clippings collected and dried. The dried clippings were ground and analyzed for nitrate content. Nitrate content of the clippings was used as an indicator of soil nitrogen status and of nitrapyrin effectiveness.

The nitrate content of the clippings appears to be a good indicator of nitrogen status of Kentucky bluegrass. Nitrate content was lowest in clippings from the non-fertilized treatments and greatest in the clippings from the high fertilizer treatment (Table 1). In August and September the nitrate content of the clippings from the plots receiving 5 pounds of N per 1000 square feet decreased to a level near that of the non-fertilized control. At this stage, these plots were nearly as pale green as the non-fertilized control plots. The plots receiving 10 pounds of N per 1000 square feet stayed deep green all summer and clippings from these plots had considerable nitrate even at the end of the summer. Apparently the nitrate content of the clippings is a good indicator of soil nitrate status.

The use of nitrapyrin did not significantly alter nitrate content of the clippings from any of the treatments (Table 1) indicating that nitrification of the added nitrogen was not inhibited. Since the 20 pound per acre rate was ineffective in 1974 we tried 100 pounds per acre in 1975. The 100 pound rate did not reduce nitrate in the clippings, but did cause considerable damage to the turf. We conclude that nitrapyrin applied as a liquid suspension to established turf is ineffective as a nitrification inhibitor. Nitrapyrin had no effect on visual appearance of the turf except to cause burning at excessively high rates and did not result in more efficient use of nitrogen. Nitrapyrin has been shown to be an effective nitrification inhibitor when it is incorporated into the soil with the ammonium. This, of course, is impractical with turfgrasses.

TABLE 1. Effect of nitrogen and nitrapyrin on nitrate content of Newport Kentucky bluegrass clippings.

YEAR	NITROGEN[1] (lb/1000 ft^2)	NITRAPYRIN (lb/A)	NITRATE CONTENT (ppm NO_3^--N)[2] June	July	Aug.-Sept.
1974	0	0	58	52	55
		10	56	60	58
		20	46	42	48
	5	0	802	331	134
		10	595	219	105
		20	552	264	108
	10	0	951	628	257
		10	892	687	294
		20	921	839	359
1975	0	0	133	256	67
		20	126	258	61
		100	132	247	57
	5	0	903	614	66
		20	717	503	76
		100	640	578	80
	10	0	955	1406	525
		20	939	1436	537
		100	802	1267	640

[1] As ammonium sulfate

[2] Mean of 3 to 7 sampling dates

FUNGICIDAL TESTS FOR CONTROL OF[1] FUSARIUM PATCH (F. NIVALE)

C. J. Gould and R. L. Goss[2]

Fourteen treatments containing both new and standard fungicides were compared for their effectiveness in controlling *Fusarium* patch during 1975/76. The experiment was run on putting green turf containing a mixture of Highland bentgrass and *Poa annua* at the Western Washington Research and Extension Center, Puyallup, Washington.

The test was intentionally delayed until the experimental area became heavily infected, which occurred in late September of 1975. Applications were started on October 2 and repeated at approximately three-week intervals, since this interval gives a better separation of good and mediocre materials than does the usual two-week interval. Most fungicides were applied in 10 gal of water per 1000 square feet to six replications of 25 square feet each. Two materials were applied dry. Rates and dates are shown in the table. Tersan 1991 and Fore were applied alternately every other time in one treatment. In another treatment, five applications were made with Bay 6447 at 3 oz after which the treatment was changed to 2 oz of 6447 plus 2.7 oz of Tersan 75.

Fusarium patch remained serious from the end of September until the following February - an unusually long time. Fortunately, all treatments rapidly brought the disease under control. Outstanding control was

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2/ Plant Pathologist and Agronomist/Extension Agronomist, Western Washington Research and Extension Center, (WSU) Puyallup, WA.

again obtained with Rhodia's RP 26019, Duosan, Fore and an alternating schedule of Fore and Tersan 1991. However, in January, the Tersan 1991 began losing its 'punch' and by February the plots treated with it were no better than the untreated area. Presumably, a strain of the *Fusarium* had developed which was resistant to benomyl, as has happened with many other pathogens.

Fusarium patch began appearing again in the test plots in late September, 1976. By October 8 the disease was present in all treated plots except the RP 26019 (8 and 16 oz), Bay Meb 6447 (2 and 3) and the alternating 1991/Fore. The average percent diseased areas were as follows in the same sequence listed in the table: 2.5 (untreated), 1.3, .8, .3, 0, 0, .2, .7, 2.8, 8.8, 12.8, 0, 1.7, 0 and 0. No treatments had been applied since May 19.

There was not much effect by various treatments on color or density so the plots were only rated once for these characteristics and once on the percentage of bentgrass.

Corticium red thread developed in the plots in late spring. Although the last application was made on May 19, several fungicides appreciably reduced the amount of red thread.

We appreciate the financial support from the Northwest Turfgrass Association and the following companies which made this experiment possible: Chemagro Ag. Div. of Mobay; Mallinckrodt, Inc.; Rhodia, Inc. Ag. Div.; Olin Mathieson Chem. Corp.; and O. M. Scott and Sons.

FUNGICIDAL TESTS for CONTROL of FUSARIUM PATCH DURING 1975/76 at W.W.R.E.C. (PUYALLUP, WA)

by C.J. Gould and R.L. Goss

Fungicide[a]	oz/1000 ft^2 in 10 gal water or dry (b)	At start Oct 2 1975	Average Percent Area Infected by F. nivale: Oct 22 1975	Nov 14 1975	Dec 11 1975	Jan 6 1976	Jan 20 1976	Feb 2 1976	Feb 23 1976	Mar 16 1976	Avg Oct 22-Mar 16	Rating[d] Color Jan 22 1976	Rating[d] Density Jan 22 1976	% Bent-grass May 21 1976	% Cort. Red Thread Jul 12 1976
None		65.5	23.17	27.0	31.8	19.8	36.7	35.8	11.7	15.3	25.2	6.2	6.8	23.0	30.0
Tersan 1991	2	84.0	3.83	4.7	5.5	2.7	21.7	33.8	9.8	8.5	11.3	7.0	8.0	20.8	14.5
Fore	8	58.3	2.0	1.7	.2	.3	3.5	.7	0	0	1.1	8.2	8.8	31.3	5.2
RP 26019	4	60.3	2.17	2.0	.2	.7	1.7	.2	0	.3	.9	8.3	8.8	24.2	6.3
RP 26019	8	67.6	2.3	1.3	0	.5	2.5	.2	.5	1.3	1.1	8.0	8.5	24.2	5.0
RP 26019	16	67.83	1.7	1.3	0	.8	2.8	.5	.3	.3	1.0	7.7	8.7	29.2	2.2
Scotts F-7351	88[b]	58.5	4.8	3.2	1.0	2.0	5.7	5.5	1.3	1.7	3.2	5.8	7.8	26.7	2.3
Duosan	5	76.83	3.5	1.7	.5	.8	3.5	.7	.2	.3	1.4	8.3	8.7	27.7	6.7
MF-582	3	66.16	3.5	3.2	1.0	1.0	2.5	.7	.8	2.2	1.9	7.0	8.3	18.3	14.5
Terraclor 75% wp	4	69.16	4.5	2.8	1.7	.8	4.7	.3	.8	1.2	2.1	7.0	8.5	22.5	16.3
Terraclor 10% gran	30[b]	56.5	2.0	1.8	0	.7	4.2	.7	.8	1.8	1.5	6.5	8.5	20.8	24.2
1991/Fore Alter.	2/8	65.5	3.5	2.2	.7	1.0	2.5	.8	0	1.0	1.5	8.7	8.5	32.5	20.7
BAY MEB 6447	1	62.0	4.0	5.8	.8	2.3	6.2	1.5	1.5	2.3	3.1	7.8	8.3	27.5	5.2
BAY MEB 6447	2	51.0	8.3	6.0	5.5	3.0	6.3	2.0	1.5	2.3	4.4	8.2	7.8	25.8	1.5
BAY MEB 6447	2 + 2.7[c]	51.0	10.0	5.7	1.2	2.5	10.8	2.0	.8	2.0	4.4	7.8	7.8	23.0	2.7

[a] Applications on Oct 2 and 22 (1975), Nov 12, Dec 5 and 23, Jan 12 (1976), Feb 2 and 23, March 15, April 5 and 26, and May 19.

[b] Dry applications

[c] BAY 6447 @ 3 oz changed on Jan 12 to 2 oz plus 2.7 oz Tersan 75 in 10 gal water per 1000 ft^2

[d] Rating from 1 (low) to 10 (best).

FUSARIUM PATCH — DISEASE RESISTANCE[1]

Bentgrass Variety Resistance Tests (Gould, Goss and Brauen[2])

Four more varieties were added, bringing the total number under test to 160 at Farm #1 (WWREC). Several varieties have appeared sufficiently promising to justify expanded testing at Farm 5 (see report on Bentgrass Management Studies by Dr. Goss). Among those showing good resistance to F. *nivale* in the small plots are Boral, Congressional, Dudeck's ARC-1, Emerald, Huffine's MCC-3, Kingstown, Kozelnicky's TG040, Nimisila, Penncross, Rusta and Szego's Z-2000. A mimeographed progress report on all varieties is available upon request. We appreciate the continued support of this investigation by the USGA Green Section Research and Education Fund, Inc.

SNOWMOLDS (FUSARIUM AND TYPHULA)1/

Bentgrass Disease Resistance Trials (Gould, Goss, Law, and Brauen)2/

Most of the varieties now being tested at Puyallup for resistance to *Fusarium* have also been planted at Hangman Valley Golf Club (Spokane) to determine their resistance to *Fusarium* and *Typhula* and their general suitability under eastern Washington conditions. In

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2/ C. J. Gould (Plant Pathologist), R. L. Goss and S. E. Brauen (Agronomists) at Western Washington Research and Extension Center (WSU), Puyallup, WA, and Prof. A. G. Law (Agronomist), Washington State University, Pullman, WA.

general, the stolonized types seem to be more susceptible to *Typhula* than do the seeded types, but none are highly resistant. Those most resistant to *Typhula* at the present time appear to be Bardot, Boral, Congressional, Contrast, Kingstown, Metropolitan, Mommersteeg's AT4, Saatzucht ACA-61, Skogley's (AC-5, AP-1, APD1-1 and Hyannasport Velvet), Svertge's N-010, Tendenz, Toronto, Yale Selection, and Vaartnou's (HV-T-2, HV-T-3 and HV-TC-4).

Nutrition Test (Goss, Gould and Law)

This test was started in the fall of 1974 at the Spokane Golf and Country Club to study the effect of different sources, rates and time of application of nitrogen and certain other elements on development of snowmold. Unfortunately, so much ice damage occurred last winter that results to date are negligible. This experiment has been supported by the Northwest Turfgrass Association.

Survey (Gould)

Typhula incarnata snowmold appeared in October of 1975 for the first time in our bentgrass variety plots at Puyallup. Oddly, it only infected one variety - a selection (UCR-30) that was sent to us several years ago from southern California. The diseased areas resembled brown patch more than they did the typical gray snowmold, but typical fruiting bodies of the *Typhula* fungus were present.

DISEASE RESISTANCE IN BLUEGRASSES, FESCUES AND RYEGRASSES

We are cooperating with Drs. Brauen and Goss by periodically rating the above grasses for resistance to various pathogens in plots at Farm 5. Two "new" diseases have appeared in the bluegrass plots during the past two years. One is a *Septoria*, to which most varieties were resistant. The other disease is a smut (*Entyloma*). Unfortunately, most bluegrass varieties were susceptible to it. The only previous severe outbreak in Washington occurred at Pullman in 1951. Therefore, we are hoping that this smut will not become a chronic problem.

TURFGRASS AGRONOMIC RESEARCH REPORT[1]

Roy L. Goss[2]

SULFUR AND NUTRITIONAL STUDIES

Two avenues are open to the turfgrass manager for providing sulfur to turfgrasses. One is the use of elemental wettable sulfur and the other is ammonium sulfate nitrogen fertilizer. The choice of material will depend on your program. Sulfur has been proven to be effective in the control of *Poa annua*, *Ophiobolus* patch disease, black algae and aids in the reduction of the severity of attacks from *Fusarium* patch disease. Turfgrass areas that are free from *Poa annua* can probably be maintained in this condition from the use of ammonium sulfate provided that ammonium sulfate is used as the major portion of the nitrogen program. Occasional use of ammonium sulfate will not provide adequate sulfur to aid in the prevention of *Poa annua* invasion although it will supply needed sulfur for nutritional purposes. If *Poa annua* is already a problem and does not constitute more than 60% of the total turfgrass stand, the best avenue is with elemental wettable sulfur. We cannot predict under all soil conditions the most judicial timing of applications although our tests have shown that rates up to 150 lb elemental wettable sulfur per acre (approximately 3½ lb per 1000 sq. ft. annually) applied throughout early spring has gradually reduced *Poa annua* to the point of near extinction. One pound of wettable sulfur

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can be applied per 1000 sq. ft. at 3-week intervals provided that the last application is not later than April 15. If it is not practical to make these applications by this date, lighter applications of 1/2 lb per 1000 sq. ft. can be applied up to the middle of June. Fall applications (September-October) can also be made.

Caution should be exercised in the combination use of high rates of sulfur (3½ lb per 1000 or more) with bensulide (Betasan, Presan, Prefar). We have some indication that the combination of these two materials can result in severe turf damage, particularly under poorly drained conditions. It is doubtful that the recommended rate of both materials will normally create problems, but if the rates are not carefully calibrated and accurately applied, problems may result. Under circumstances where regular applications of bensulide is practiced, the best avenue would be to use ammonium sulfate as the fertilizer along with occasional applications of other materials (complete formulas, etc.) to supplement the ammonium sulfate.

NUTRITIONAL INVESTIGATIONS ON SAND

A putting green 10,000 sq. ft. in area was established to Emerald creeping bentgrass in July, 1975. After nine months of maintenance, nutritional treatments were initiated in May, 1976. These treatments include urea, ammonium sulfate and Milorganite as the nitrogen suppliers at rates of 10 lb of nitrogen per 1000 sq. ft. per year. Ammonium sulfate has two added rates of 8 and 12 lb of nitrogen. The urea plots receive 1/2 and 2 lb of phosphorus which is equivalent to 1.15 and 4.6 lb P_2O_5 phosphorus per 1000 sq. ft. per season. No additional phosphorus is applied to the Milorganite plots since adequate phosphorus is supplied through this material. All nitrogen plots uniformly receive 3 lb K per 1000 sq. ft. per year (equivalent to 3.6 lb K_2O potassium per 1000 sq. ft. per year). Each of these nitrogen treatments in addition receive sulfur at 1, 2.5, 3.5, and 4.5 lb elemental wettable sulfur per year. These applications are uniformly distributed throughout the year with the exception of one set of plots in the urea treatment which will receive 2.5, 3.5, and 4.5 lb of sulfur per 1000 sq. ft. all in the early spring. We are attempting to determine the interrelationships between nitrogen, phosphorus, potassium and sulfur on sand culture. We have sufficient information of the activity of sulfur on a sandy loam soil, but need response data on sand.

Since the nutritional treatments have only been in effect for 4 months, no data will be reported at this time.

In the future, additional plots will be established to determine the interaction between bensulide and sulfur maintained at uniform N, P and K levels on sand culture. We hope to determine the phytotoxic factors as well as leach rate and effectiveness of these treatments on sand.

BENTGRASS ADVANCED MANAGEMENT OBSERVATIONS

Selections from 157 bentgrass varieties or cultivars were made on the basis of the greatest resistance to *Fusarium* patch disease and turfgrass color and texture. Twenty-four of these selections were established at Farm 5 in 10' x 10' plots in September, 1973, to be managed as golf course putting green turf. Fourteen of the selections were vegetatively propagated by stolons and 10 are seeded types. One-half of each plot has continuously received 12 lb of nitrogen per 1000 sq. ft. per season plus phosphorus and potassium in a 3-1-2 ratio. One-half of each plot was cross-checked with alternating schedules of fungicides and the other half left fungicidally untreated. In this manner we could observe the response of the varieties to high and low fertilizations and further observe the acceptability of the varieties to *Fusarium* patch disease with and without fungicides. Table 1 shows ratings in early 1975, April, 1975 and May, 1976. Although the plots are rated for color and texture, only the color ratings were shown in this Table. There are textural differences among these varieties although this was one of the major criteria for selection. If they did not have good texture, it would not be reasonable to take them into advance management studies. Therefore, the textural ratings are not shown in this Table.

TABLE 1. Bentgrass Advanced management trials

Variety	1-22-75 Hi N**	1-22-75 Low N***	4-11-75 Hi N	4-11-75 Low N	5-10-76 Hi N	5-10-76 Low N
	EVALUATION DATES AND RATINGS*					
Stolonized						
Arlington	5.3	3.8	8.5	3.5	8.3	6.3
Nimisila	5.0	3.3	8.0	5.0	9.0	7.3
Northland	3.5	2.5	7.8	4.8	9.3	7.8
Waukanda	4.5	2.3	8.0	5.0	8.8	7.5
Yale	5.0	3.3	7.8	5.0	9.8	7.8
Keen 36	7.5	5.8	7.5	5.0	9.0	6.3
Arrowood	7.0	5.0	8.0	5.0	8.8	6.8
MCC 3	7.0	5.3	7.8	6.0	8.3	5.8
Smith 721	5.0	3.5	7.8	5.0	8.3	6.0
Smith 732	4.3	2.5	6.8	3.8	8.0	6.0
Smith 736	4.5	2.5	6.8	4.2	9.0	7.0
UCR 30	5.0	3.8	8.2	5.8	8.5	7.0
Penn 5	5.0	3.0	8.0	5.0	8.8	7.0
Hayden Lake	4.3	3.0	7.0	4.2	9.0	7.5
Seeded						
Bardot	6.0	3.8	9.2	5.2	9.0	7.0
Boral	5.0	3.3	8.2	4.8	8.5	5.8
Highland	8.0	6.8	8.8	5.0	9.0	6.3
Kingstown	5.5	4.3	9.0	4.0	9.8	6.8
Novobent	5.0	4.8	7.2	3.8	9.3	6.5
Penncross	6.3	3.5	8.2	4.5	9.0	6.3
Prominent	6.0	3.3	7.2	4.0	8.5	5.3
Emerald	6.3	4.0	7.5	4.2	9.0	6.0
Tracenta	4.8	4.0	8.8	4.5	9.0	6.8
A-75	6.3	3.5	7.8	5.0	9.0	6.3

* Rating scale 1 - 10. 1 = Brown 10 = Darkest Green

** High N = 12#/1000 ft^2/year from urea

*** Low N = 6#/1000 ft^2/year from urea

Most of the stolonized or vegetatively propagated varieties exhibit strong winter dormancy characteristics and in general show lower ratings for 1-22-75 than most of the seeded varieties. Recovery from winter dormancy was generally good by April 11, 1975, with some of the varieties showing a little faster green-up.

In general, the 12 lb rate of nitrogen produced a better color response in all varieties as compared to the 6 lb rate of nitrogen at all rating dates. In some cases little or no differences were exhibited between high and low nitrogen effects during the major growing season. This is an important characteristic since we are looking for varieties that will exhibit good agronomic characteristics at lower nitrogen levels. We are looking ahead for times when fertilizer shortages and prices may be much more critical than they are now.

These management studies have been conducted only with nitrogen, phosphorus and potassium fertilization along with aerification and topdressing. Beginning in 1977, these plots will receive applications of iron, sulfur and magnesium to determine if better color can be enhanced on the low nitrogen treatments from the use of these materials. If this is true, then we can use these varieties effectively at reduced nitrogen rates and perhaps avoid many problems.

In general, *Poa annua* populations are higher in the high nitrogen treatments as compared to the low although some varieties exhibit little difference in *Poa annua* invasion. Scalping ratings were taken in 1976 and most high nitrogen plots of the stolonized varieties exhibited varying degrees of scalping due to the vigorous growth nature of these vegetatively propagated varieties. This was to be expected. Little or no scalping occurred in the low nitrogen treated areas of the plots. Liekwise, thatch accumulation is increasing faster in the high nitrogen plots as compared to the low nitrogen plots although varietal differences are appearing.

Contrary to most opinions, the velvet bentgrasses respond better to higher nitrogen than to low nitrogen during most seasons of the year and the color is definitely superior during the winter months at higher nitrogen levels. Textural characteristics of the velvet bentgrasses are also improved with nitrogen levels over 6 lb N per 1000 sq. ft. per season.

The plots still remain relatively free of *Fusarium* although differences in disease attacks have been noted by C. J. Gould.

These plots will be continued for one or two more years to complete the advanced management studies.