Chemical and Cultural Control of Turfgrass Diseases

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The fungi which are presently recognized as parasites on turfgrasses have been widely discussed. We are primarily concerned here with diseases in the Midwest, but these considerations will generally apply throughout any temperate zone of the world.

The plant pathologist is involved in the recognition of disease-causing fungi, their epidemiology and control, primarily by chemical means. The agronomist is interested in general recognition and control, primarily through cultural means. Through the years turf growers have come to realize that chemical disease control and disease control through cultural manipulation are about equal in importance. It is intimated here that turf managers can be called neither pathologists nor agronomists. When dealing with turf, consider all facets of a problem and then pursue a course which promises the greatest results.

Results when dealing with disease control of turf are consistent, inconsistent, ambiguous, complete, incomplete, enlightening and frequently quite maddening. This, of course, points out the incompleteness of our knowledge and understanding in this field.

Listed below are diseases in a possible order of importance in the Midwestern area and suggested methods for chemical control. More specific chemical control information is available in numerous publications from turf fungicide manufacturers.

COOL SEASON GRASSES

Fusarium sp. (Fusarium patch; pink snow mold)

Visible symptoms of attacks by this fungus are most readily detected either under melting snow or in areas of free moisture resulting from melting snow. Dead areas usually from ¼ to 3 inches in diameter have a characteristic pinkish or reddish periphery.

One of the reasons for the seriousness of this fungus is that it frequently is not "most readily detected." The author has found microscopic evidence of this fungus and apparent damage to turf, primarily bents and **Poa annua,** during all 12 months of the year. Small spots the size of a paper match head develop on diseased turf especially when the environment is cool and damp and shade and tree root competition a factor. The best way to define this symptom is a "salt and pepper effect." More often than not these symptoms go unnoticed until the mower man or the golf course superintendent begins to notice that "something is wrong." By this time considerable leaf surface (also perhaps crown and root) has been lost and severe damage may have occurred.

Obviously, spring and fall are the seasons when **Fusarium** sp. will be the most damaging. Fungicide applications should be regularly made in early spring as a guard against this serious pathogen. Conceivably **Fusarium** sp. could be indirectly associated with the severity of parasites which follow later in the season by initially reducing the natural vigor and resistence of turf.

During the warmer and even drier months Fusarium sp. can be microscopically detected in diseased and/or dead turf areas along with other fungus organisms. The extent of damage is not definitely understood, but surely this fungus is intimately associated in a complex with other leaf disease-causing organisms, and involved in the unexplored area of root maladies. Mercurials, both organic and inorganic, and mixtures of these and broad spectrum turf fungicides seem to give the most positive and long lasting control.

Helminthosporium sp. (Leaf spot, melting out)

Visible symptoms of attack by this fungus are characteristic dead spots on individual leaf blades and/or dead areas varying in size from ¼" to indefinite. Individual dead spots on leaves usually have tan colored centers surrounded by blackened borders. **Helminthosporium** sp. is known to be parasitic on all the grasses with which we deal.

Here again, one of the dangers of this fungus is its subtlety. It often goes undetected for a period of time and faulty diagnosis is common. One of the reasons it is listed among the most important or severe pathogens is its tendency to kill stems and crowns. No doubt it plays a starring role in the previously mentioned, little explored area of root maladies.

Damage from **Helminthosporium** sp. has been detected year around but tends to be most pronounced during cool, humid weather. However, attacks have been severe during hot, dry periods on high, well-drained areas. Apparently species differentiation is a factor here. The author believes **Helminthosporium** sp. is the most omnipresent and omnivorous genus of fungi with which we deal. The fact that hundreds of species of this genus of fungus are recognized tends to verify this.

Chemical controls for this malady are not consistent. Here again, this no doubt is dependent upon the particular species in question. At times a mixture of zinc ethylene bisdithiocarbamate (Zineb) and iron sulfate offers the most positive control. At other times mecurials and mixtures of them and broad spectrum turf fungicides are the most effective. Antibiotic fungicides also offer positive control either alone or in combination.

Pythium sp. (Cottony blight, grease spot)

Visible symptoms of attack by this fungus characteristically follow presence of free moisture and usually higher temperature. Diseased spots which vary in size from ½" to include an entire green (or larger) have a black-greasy appearance which later turns straw (dead grass) color.

Perhaps many will question the consideration of this fungus in importance before various other disease causing organisms. Its importance is not because it appears so regularly in the Midwest, but because when it does appear there seems to be only limited chemical control available. Reports of partial to complete control are frequent but no regular or constant control has yet been developed. Daily applications of broad spectrum turf fungicides or a mixture of Captan and antibiotics are the most frequently used chemicals. Concerted efforts must be made to dry the diseased area in any way possible such as through the use of sand or lime and temporarily improving surface drainage with hollow-tined forks, etc.

Rhizoctonia solani (Brown patch);
Sclerotinia homoeocarpa (Dollar spot);
Typhula sp. (Snow mold)

In many respects these pathogens are quite similar and they react similarly to chemical control treatments. Visible symptoms of attacks by these fungi are quite similar. The characteristic variation is in temperature requirements: snow mold—cold; dollar spot—temperate; brown patch—hot. (Physiologic races of Rhizoctonia have been found which will thrive under moderate temperatures.) The fungi which causes these diseases all require free moisture and in general wet, humid conditions in order to attack and be damaging. They are all easily controlled by chemical means, which reduced them from the most damaging turf disease causer to a secondary role.

A mixture of inorganic mercuries continues to give the most positive and long lasting control. About the only time this chemical mixture fails to give satisfactory control is when excess moisture is present for an extended period of time. Thiram, phenyl mercuric acetate and other chemicals also offer control.

Gloeocercospora sorghi (Copper spot); **Corticium fuciforme** (Red thread)

Visible symptoms of attacks by these fungi are quite similar. Copper spot is just that, copperish colored spots 2" or 3" in diameter appear speckled over the affected area. Red thread does not appear as regular spots but rather irregular and reddish strands of fungus are visible. Environmental conditions are similar; humid and cool to mild.

These diseases rarely appear in the Midwestern area. Occasionally they are present in the Detroit area and rarely in the Chicago area. Perhaps this is true because exact environmental conditions are lacking. Also, these organisms would attack in spring or fall; Cadmium compounds are effective long lasting controls for these maladies and are generally used at this time of year in these areas.

WARM SEASON GRASSES

Considerably less has been determined and thus written about fungus diseases of the warm season grasses. Zoysia and bermudagrass are the species involved as far as golf turf in the Midwest is concerned.

Some years ago Dr. Frank Howard, Pathologist at the University of Rhode Island, commented that "the reason little is said about diseases of warm season grasses is that they are relatively newly introduced into this country, thus the diseases have not caught up with them yet." To a considerable extent this is still true. However, it is beginning to appear that a number of fungi are becoming increasingly more damaging to bermudagrass or are beginning to "catch-up" with it. It is believed that "winter kill" of bermudagrass (primarily U-3) is largely the result of attacks by parasitic fungi when bermudagrass is in its dormant stage. Under microscopic examination **Helminthosporium** sp. and **Fusarium** sp. have been found repeatedly on dormant stems, leaves, roots and rhizomes of U-3.

As far as summer diseases of these grasses are concerned, they still seem to be relatively minor. **Helminthosporium** sp. appears to be increasing in incidence and severity on U-3 bermudagrass. Possibly U-3 grows so rapidly during hot weather that it simply out-produces the disease.

Control measures for disease of these grasses are the same for corresponding diseases on cool season grasses at this time. Perhaps other controls will be developed in the future.

Cultural Control

The turf specialist will note that the leaf spot type of diseases such as **Curvularia** sp., **Colletotrichum** sp., **Septoria** sp., **Phyllosticta** sp. and others have been omitted. It is believed that by and large these are not primary turf pathogens but are secondary or damaging only when the grass has been weakened through some other influence. These influences can be anything which weakens turf: attacks by other fungi, traffic, shade, tree root competition, excess of mat and thatch or organic matter, lack of air circulation, mechanical damage, damage from excesses or fertilizers-herbicides-fungicides, presence of insects and shortage of plant nutrients. Therefore, even though most of these secondary organisms can be checked or controlled by the use of chemicals, they will rarely be troublesome if primary parasites are controlled and the various cultural controls are practiced.

The practice of cultural control also affects the incidence and severity of the primary pathogens but cannot stop them completely. One item is consistent in the epidemiology of the primary parasitic fungi (likewise the secondary). This is the presence of free moisture. It has been determined that proper drainage is an excellent fungicide. The most important concept of effective cultural disease control, and one which is regularly ignored, is the assurance of adequate surface and sub-surface drainage. Of the fungi known to attack grass, apparently all require free moisture in order to penetrate the above ground plant parts. Few of these fungi will develop to damaging proportions if surface and soil water is not in excess. Under waterlogged conditions all of the known parasitic fungi can and do develop into serious problems with which it is difficult to cope. Therefore if water drainage is assured, our primary cultural disease control concept is a guarantee. A considerable amount has been done in this regard; greens and other areas now can be constructed so that adequate and permanent drainage is assured.

The next most important cultural control concept is considered to be traffic, primarily cart and foot. Without the golfer it would be relatively easy to maintain golf courses and control the diseases thereon. However, we must face the fact that golf courses are present for the enjoyment and abuse of the golfer and plan accordingly. Turf, damaged as a result of excessive traffic, is susceptible to severe attacks from both primary and secondary organisms. Not only must proper and adequate fungicides be applied but the golf course superintendent must make all efforts to direct traffic over as much of the course as possible thus dispersing it away from localized heavy traffic areas. This is only partially possible and consequently we resort to such things as installation of asphalt cart paths, the building of larger greens and tees (and courses for this matter), the placing of traps closer to greens thus discouraging traffic (foot and cart) and heavy equipment from abusing such restricted areas and the placing of signs and ingenious traffic directing devices in susceptible heavy traffic areas. It is becoming increasingly more apparent that the club must allow its superintendent more uninterrupted time in order to complete his work if they expect him to give them a presentable course. This increase in traffic is reaching alarming proportions. Many clubs are now closing the course to all play on Mondays, as an example.

Other important cultural considerations are dependent upon common sense.

1. Apply proper amounts of plant nutrients. Fungi vary in their pathogenic severity according to availability of nutrients to the grass. Brown patch and pythium diseases are more troublesome when nutrient levels are high. Therefore, the practice of reducing fertilizer rates during hot weather is generally and properly practiced.

Dollar spot is less of a problem when nutrient levels are high. However, Fusarium patch can be more of a problem when nutrients are in excess. As previously stated, possibly Fusarium patch is one of the most damaging diseases in the Midwestern area. Careful use of nitrogen in cooler months, regardless of the dollar spot picture, is a safeguard.

There is so little proven through scientific endeavor along this line that the assumptions and practices followed have been determined through observation by golf course superintendents. This is a subject about which more information is needed.

2. Remove trees in order to decrease shade and tree root competition. If entire trees are not removed, prune tree roots and limbs as necessary. Not only are fungi more damaging to tender shaded grass but evaporation of surface moisture is reduced in shaded areas which increases activity of fungi.

3. All of the fungi discussed are known to be facultative organisms. That is, they can subsist on both living and dead material. If a thick layer of mat and thatch or organic matter is present disease-causing organisms are also present—either in a growing or dormant stage in this layer of organic matter. When turf loses its resistance to these omnipresent disease-causing organisms because environmental conditions favor the fungi or when turf is weakened through some cultural aspect such as excessive traffic, trees, etc., the fungi are then capable of attacking and causing disease.

A thick layer of organic matter also interferes with water movement down to and through the soil. This layer will sometimes absorb and hold free moisture while under other conditions it will shed applied water and become dry.

Thus the entire irrigation or water relationship is confounded. However, our interest here rests in the accumulation and presence of surface moisture. As we previously discussed, fungi benefit greatly as a result of this moisture.

Spiking, aeration, aerothatching, and rebuilding greens are often done in an effort to reduce this organic layer and thus effect cultural disease control. Basic soil consistency is a consideration here and was discussed under moisture.

CONCLUSION

All turf management practices are either directly or indirectly associated with incidence of disease. As can be seen, chemical control and cultural control of disease-causing fungi are intrinsically interwoven. Cultural control goes a long way in keeping turfgrass disease free (or disease reduced) and unless proper management practices are pursued, even the best chemical controls often fail to stop disease spread. On the other hand, chemical control measures are frequently and regularly necessary especially during periods when adverse environmental conditions prevail, even though the best known cultural practices are followed.

The frustrating aspects of disease control mentioned earlier arise primarily as a result of the lack of basic knowledge. As examples, why will a green, even though located in a similar area or adjacent to other greens, be constantly susceptible to disease while its neighbors remain relatively disease free. The author has seen examples of courses located in the same general area; one course receives the best possible management known, yet disease is a problem even though fungicides are regularly and frequently used. The other course receives far inferior management and less frequent and regular fungicide applications, yet diseases are much less of a problem and in general, turf is healthier. Of course, these are exceptions. Nonetheless, they exist.

COMING EVENTS

February 26-March 1
Cornell Turfgrass Conference
Cornell University
Ithaca, N. Y.

March 5-6-7
Midwest Regional Turfgrass Conference
Memorial Center, Purdue University
Lafayette, Indiana

March 8-9
Massachusetts Turfgrass Conference
University of Massachusetts
Amherst, Mass.

March 13-14-15
Iowa Turfgrass Conference
Memorial Union Building
Iowa State University
Ames, Iowa

March 22-23
Michigan Turfgrass Conference
Michigan State University
East Lansing, Mich.

Potassium — That Mysterious Macronutrient

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Of the various soil minerals known to be essential to plant growth, potassium was among the first to be recognized. One of the first observations of potassium-plant relationships was that potassium is required in relatively large quantities by plants. Yet, since those early observations, progress has been slow in understanding the specific part potassium plays in plant growth and development. Through scientific investigations and practical observations we have learned that plant uptake of potassium is often higher than any other mineral and that a deficiency of potassium will give a very marked decrease in growth and, if the potassium level is low enough, even death of the plant. Since the beginning of the 20th century, emphasis on quality of crop production, especially in turf management, has increased to a prime factor. Here, too, potassium and plant quality are very closely related. It seems only profitable, then, to survey briefly what is known of the potassium-plant relationships.

Function of Potassium in Plants

Voluminous amounts of investigations on potassium-plant relationships have clearly indicated that unlike nitrogen, phosphorus, calcium, and magnesium, potassium is not a permanent component of any organic compound or structural part of plants. Its total apparent existence is in the form of soluble inorganic and organic salts, the greater portion being the inorganic forms.

Recent investigations have indicated that potassium affects the metabolic activities of plants in several ways, most of which appear to be enzymatic. Lawton and Cook report that evidence now available shows that potassium affects the following processes: (1) synthesis of carbohydrates, (2) translocation of carbohydrates, (3) reduction of nitrates and synthesis of proteins, particularly in meristem tissues, and (4) normal cell division. It is also suggested that potassium plays a part in maintaining turgor in plant cells as well as increasing disease resistance. Research further indicates to some investigators that potassium may affect photosynthesis through its influence on chlorophyll.

Concerning carbohydrate synthesis, it has been reported that a decrease in available potassium is associated with a decrease in carbohydrate content of the plant and that high potassium content is necessary for high carbohydrate synthesis. It has been suggested that potassium may play a major part in the formation of more complex sugars and starches from the simple sugars in plants—a lack of potassium appeared to cause an increase in simple sugars as compared to total carbohydrate.

Practically coupled with potassium-carbohydrate studies has been the investigations of potassium as related to the structure of stems and cell walls. It is generally held that adequate supplies of potassium are necessary for the formation of stiff straw or stalk. Researchers have reported that when carbohydrates are present in high amounts, stem structures are likely to be strongest. Such a report strongly supports the potassium-stiff straw relationship. But if carbohydrates are used up in protein synthesis as when high amounts of available nitrogen are present, stems and plant tissue may not be stiff even though there is an abundant amount of potassium present in the plant.

There are a few workers who have suggested that the presence of potassium and calcium in the plant sap increases the uptake of nitrate nitrogen. These same investigators state further that such activity does not seem to hold true with all species of plants.

There is considerable belief, however, that potassium definitely influences the synthesis of proteins in plants. Some investigators believe there is a direct relationship between potassium and protein synthesis while others hold that the relationship is an indirect one. The overall effect agreed upon is that potassium-deficient plants are generally lower than normal in protein content. Along this same line it is suggested that with high nitrogen supply and deficiency of potassium there may result a toxic condition to plants from a too high accumulation of ammonia in the plant.

A number of reports have been made that potassium is in some way associated with cell division and actively growing plant tissues. Often it has been found that in potassium deficient plants the potassium is moved from older tissues to the actively dividing cells of the meristematic tissues. The effects of this phenomenon are observed in grasses by a yellowing of the margins and tips of grass blades. In such a case the potassium, being deficient in the plant, has migrated to the base of the leaves where intercalary meristematic tissues exist. There is still a great deal of doubt as to the function of potassium in cell division, but the feeling is that it is associated with protein synthesis.

Adequate levels of potassium in the plant have been reported to maintain and in some cases increase disease resistence in the plant. Here again just how potassium causes this effect is not known. A general belief is that it is brought about by the ability of potassium to regulate chemical reactions in the cells of the plant. When potassium is deficient, there usually exists excess nitrate and phosphorus, thinner cell walls in epidermal tissues, reduced production of amino acids because nitrate reduction is suppressed, a marked decrease or halt in the accumulation of carbohydrates, a failure to produce new cells for want of essential amino acids for the protoplasm, and slower growth of meristematic tissues that would permit replacement of diseased tissues. Under such conditions caused by potassium deficiency, disease organisms can more easily enter the thin cell walls, obtain the abundantly available nitrogen necessary for their growth, and more easily damage plant tissues which the plant is unable to replace at a competitive rate.

Potassium is also given partial credit for the maintenance of proper turgor in plant cells. Turgor is the state of living cells being plump and swollen as a result of internal water pressure. In this respect it is reported that potassium affects the cell sap and helps to regulate the degree of swelling and the water economy of cells.

Concerning potassium and photosynthesis, some workers suggest that potassium has an indirect effect. It is known that photosynthesis takes place in the chlorophyll molecule, and that CO2 as well as water and light are needed for the process. Some scientists feel that potassium enables the chlorophyll molecule to accept CO2 more readily, which in turn affects the photosynthesis process—the process from which plant food is derived. It is also thought that potassium, perhaps by way of activating enzymes, plays a definite role in the manufacture of the chlorophyll molecule.

A. G. Kennelly has been quoted as summarizing the role of potassium in plants as follows: "Potassium is important in the general health of the plant, particularly in developing sturdiness and disease resistance. It helps to promote the growth of woody tissues and usually improves texture, color, and quality."

Supply of Potassium to the Plant

The plant receives its potassium from the soil. It is generally known that heavy soils or soils high in clay content have the ability to hold more available potassium than light soils or those high in sand content. The available potassium is supplied to the soil from the weathering of potassium minerals, which contain unavailable potassium. Generally the unavailable potassium makes up approximately 99% of the total potassium in the soil. In many cases the amount of such minerals in the soil and the rate of weathering of these minerals is great enough to supply adequate amounts of available potassium to the plant. However, when the weathering of enough minerals is too slow or the available potassium is lost at too rapid a rate by plant removel, leaching, and erosion, potassium must be added to the soil in the form of fertilizer.

The available potassium is taken into the plant by the root. There is widespread belief that the root cells immediately associated with the uptake of potassium and other minerals as well must exert a considerable amount of energy in order to absorb the potassium.

It has been well recognized that soil aeration is necessary for normal root growth and nutrient absorption by roots. And it has been observed that poor aeration apparently has more pronounced inhibitory effects on potassium than on any other elements. The effects of aeration on potassium absorption are primarily on the plant roots and not on the status of potassium in the soil. The effects of a lack or adequate aeration are due to either a lack of oxygen to the roots, or a toxic effect of too much carbon dioxide on the roots, or both. This point still remains a mystery. Excess soil moisture and soil compaction affect the absorption of potassium in that they limit soil aeration. Unless a soil can be adequately drained and relieved of compaction, areation will be limited.

A number of investigators have found that very low soil moisture considerably reduces the absorption of potassium by the plant. This effect is a result of both the dehydration of the plant and a reduced availability of the soil potassium.

Most workers have concluded that mineral nutrient absorption is reduced under low environmental temperatures. It has been found that within the range of 50° F. and 77° F. potassium absorption changed directly as the temperature changed.

Potassium Fertilization of Turfgrass Areas

There are a number of potassium fertilizer materials. The most widely used material, however, is potassium chloride, commonly called muriate of potash, which contains from 50 to 60 per cent

K2O. This fertilizer can be applied alone or in a fertilizer mixture with phosphorus and/or nitrogen materials.

The amount of potassium fertilizer to apply and the time to apply it will depend on several factors. These factors are: (1) The amount of available potassium in the soil. If, at any time during the growing period of the turf the available potassium is not sufficient, potassium will need to be added in a quantity high enough to adequately raise the potassium level. (2) The kind and amount of clay in the soil. Some types of clays hold more potassium than others, and some clay types hold potassium in a more available form than others. If a soil is high in clay, it will be able to hold more potassium than a soil which is primarily sandy. A sandy soil will need small but frequent applications of potassium whereas a soil high in clay may be able to provide sufficient potassium with larger but less frequent potassium applications. (3) The type of watering program. Where the watering program is heavy, potassium will tend to leach out of the soil more readily than where the watering program is light. (4) Whether or not clippings are removed. Grass clippings contain a considerable amount of nitrogen, phosphorus, and potassium. O. J. Noer has reported that clippings removed from a golf green in Memphis, Tennessee contained nitrogen, phosphoric acid, and potash in the approximate ratio of 3-1-2, respectively. If the clippings are removed instead of being allowed to remain on the turf, potassium will be depleted more rapidly. (5) The kind of grass grown. All turfgrass species and varieties need available supplies of essential nutrients. However, some turfgrasses are cool season types and others are warm season types, and because of this difference the various types require greater amounts of nutrients at different times of the year. (6) The particular management of the turf. In general a turf that is mowed close and frequently will need more potash than one that is mowed higher and less frequently. A turf area that is designed to be kept in an active growing state the year round by either overseeding warm season grasses or by the use of permanent cool season grasses will more than likely need to be fertilized with potash more frequently and with an overall increase in amount of potash. On the other hand a turf area that is allowed to go dormant or partially so in the winter will not need an addition of potassium during the winter. In many cases the winter dormant period gives the potassium minerals time to weather, the result of which is at least a partial replenishment of the available potassium in the soil. If such weathering is inadequate to supply all the needed available potassium for the following growing season, applications of potassium will need to be made in the spring and anytime thereafter if the available potassium supply becomes short. It is also a good policy to have sufficient quantities of available potassium in the soil in the fall in order that the turf can become "hardened" for the cold winter temperatures. It is felt that plants well supplied in potassium and not overly tender due to high applications of nitrogen in the fall will be more capable of surviving freezing temperatures of the winter. There is also the possibility of getting too much available potassium in the soil. Plants are apparently unable to regulate the uptake of potassium; and if the soil supply is high enough, a so called luxury consumption may result. Under such conditions, the high potassium content in the grass plant may cause an excessive amount of stiffness in the stems and leaves as well as other undesirable or harmful effects. (7) The general weather conditions of the area. If there is a great amount of rainfall there is apt to be a need for more available potassium in the soil to replace that lost by leaching.

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