SYMPOSIUM ON LEAF SPOT MANAGEMENT

HELMINTHOSPORIUM DISEASES FEATURED AT CONFERENCE

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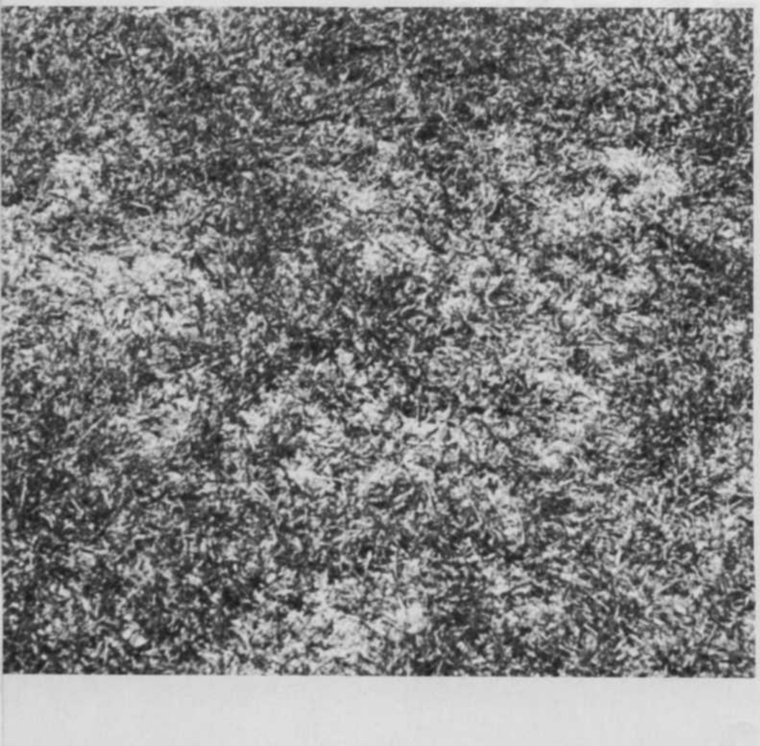
Symptoms are in two phases, leaf spot in cool seasons (above) and melting out in warmer weather (below).



Helminthosporium leaf, crown, and root diseases are among the most common and serious diseases of all cool season turfgrass species. This disease complex is caused by several species of *Helminthosporium* fungi, including *H. vagans, H. sorokinianum, H. giganteum* (zonate eyespot), and *H. dictysides* (*Helminthosporium* blight). Generally, *Helminthosporium vagans* causes the most serious damage to cool season turfs such as Kentucky bluegrass, but *H. sorokinianum* (summer leaf spot) can also cause severe problems.

Leaf spot severity is determined principally by the turfgrass species or cultivar grown, length of favorable conditions for disease infection and development, and cultural practices utilized. Leaf spot symptoms are generally considered to be expressed by one of two phases. During cool, moist periods (i.e. spring and fall) the leaf spot stage is most evident. While, later when warmer weather conditions prevail, symptoms are expressed by general thinning or melting-out of the turf. The melting-out phase can appear as large irregularly-shaped patches that look like turf suffering from heat, drought stress or both. It should be pointed out that correct identification of the disease problem is extremely important. Usually leaf spot symptoms, crown and root discoloration, are associated with the melting-out phase. If these symptoms are not present, then the turf manager should carefully examine the site for other potential pests that may cause similar effects on the turf such as billbug, sod webworm, or white grubs.

In January, 1980, a Symposium on "*Helminthosporium* leaf spot" was held in conjunction with the 18th Nebraska Turfgrass Conference. The following papers give a contemporary view of the leaf spot problem in turf by discussing disease development and symptom expression, disease management, and development of resistant cultivars. These papers offer the reader an insight into aspects that enhance and discourage leaf spot development; factors that influence the typical disease symptom expression; cultural practices that enhance or suppress disease infestation; and the difficulties involved in selecting and breeding leaf spot resistant cultivars. Turf managers should realize that resistant cultivars are not readily accessible, but that their development takes a considerable expenditure of time and money.

The reader should also be aware that many aspects discussed in the following papers, regarding leaf spot, are also relevant to other turfgrass disease problems in terms of their development, management and manipulation through cultivar improvement. **WTT**

CONTROL FACTORS OF LEAF SPOT AND THEIR AFFECT ON SYMPTOMS

By Clinton F. Hodges, Professor of Horticulture and Plant Pathology, Department of Horticulture, Iowa State University

Turfgrass pathologists have endeavored to characterize symptoms of turfgrass diseases so that turf managers can diagnose specific diseases and their casual pathogens in the field. Such efforts have served the turf manager reasonably well for the more common diseases. However, increasing knowledge of environmental and cultural factors on disease symptoms continues to provide examples of variation in disease development and symptoms. Variations in disease development and symptom expression induced by environmental and cultural factors can be the cause of considerable consternation. This is becoming evident among species of the genus *Helminthosporium* and especially for *H. sorokinianum Drechslera sorokiniana).* In time, however, understanding the various effects of environment and cultural aspects on disease expression by *H. sorokinianum* may be used to the turf manager's advantage. The purpose of this presentation is to summarize our knowledge of factors that can modify the symptomatology of leaf spot (*H. sorokinianum*) on Kentucky bluegrass.

Natural selection and observant turf specialists developed the earliest resistant varieties of Kentucky bluegrass for all turf managers.

Cultivar resistance and time

The use of fungicides is the primary means by which turfgrass diseases are controlled. Resistant cultivars and appropriate cultural practices also contribute to the control of some diseases.

The multitude of Kentucky bluegrass cultivars released in recent years has increased the hope among turfmen that resistance to various diseases will be improved. Resistance to diseases of Kentucky bluegrass induced by species of *Helminthosporium* leaf spot, however, must be approached with caution. Of 30 cultivars grown from seed (and vegetative parts) at the Iowa State University Horticulture Research Station, only five cultivars (Adelphi, Merion, Olymprisp, Rugby, and S. Dakota Cert.) had less than 30% of their leaves infected by *H. sorokinianum* in the spring of their fourth year of growth.

Most cultivars show increasing levels of leaf spot damage with each successive year's growth. In this regard, observations of S. Dakota Certified in subsequent years placed it among cultivars most susceptible to leaf spot.

It seems that the longer any cultivar is grown, the greater the incidence of leaf spot. The pathogen *H. sorokinianum* is a very aggressive parasite that attacks numerous species of grasses ranging from cereals to turfgrasses. The pathogen lives on dead tissue of the lesion it produces on the leaf and may produce a phytotoxin that is responsible for killing leaf tissue. It is very difficult to achieve high levels of resistance in cultivars against pathogens of this type. Under such circumstances, any cultivar that shows less than 30% of its leaves to be infected by *H. sorokinianum* after 4 to 5 years growth may be representative of higher levels of resistance to this pathogen.

Leaf age and symptoms

The leaf spot symptoms of *H. sorokinianum* are generally described as starting with small, circular, dark brown to purplish black spots that gradually enlarge and develop tan or brown centers. These lesions also may be surrounded by a zone of chlorotic tissue. This symptomatology is most common on the youngest leaves of the shoot in spring and fall, but such symptoms are greatly modified by progressively older leaves on the shoot.

Kentucky bluegrasses generally maintain 3 to 4 leaves per shoot; the two youngest leaves most commonly show typical leaf spot symptoms, while the two oldest leaves often have enlarged spots accompanied by chlorotic streaking on leaves. Occassionally, a single small leaf spot at the leaf blade base, or at the cut ends of older leaves, can result in the entire leaf turning yellow. Such symptoms on older leaves can be confusing in field diagnosis, particularly if younger leaves show few typical leaf spots. Variations of this type in symptom development have, on occasion, lead pathologists to believe that perhaps different species of *Helminthosporium* were involved. It is known, however, that *H. sorokinianum* can produce a wide range of leaf symptoms that develop in response to physiological age of the infected leaf.

It is becoming increasingly clear that leaf age must be considered in all evaluations of *H. sorokinianum* symptoms. Severity of symptoms produced by this pathogen increase on each older leaf.

Environment and symptoms

Development of *H. sorokinianum* leaf spot on Kentucky bluegrass is markedly influenced by environmental factors. Recent research has established that lesion development is influenced by photoperiod and light quality. Individual lesions increase in size on leaves as day length becomes shorter; and, as day length increases lesions become smaller. Under shorter day length, brown to purplish black portions of lesion increases in size as does yellowing that surrounds lesions and complete yellowing of infected leaves is accelerated. Day length also interacts with leaf age; as day length shortens, symptoms become more acute on each older infected leaf.

These observations suggest that leaf spot symptoms should be less severe in spring with increasing day length and more severe in fall with decreasing day length. This is, in fact, a common observation for *H. sorokinianum* on Kentucky bluegrass.

Quality of light reaching infected leaves also can influence appearance of leaf spot symptoms. Infected leaves exposed to increased levels of far-red light have larger lesions and more general yellowing than infected leaves exposed to normal levels of far-red light. As light passes through upper, younger leaves of a plant the proportion of far-red reaching older, lower leaves increases. This phenomenon may, in part, explain why older infected leaves tend to become completely yellow in the fall and early winter. During this time of year shorter daylength and the far-red light reaching leaves will tend to increase the rate at which they age and at the same time increase disease severity on infected leaves.

Effects of temperature and water (rainfall or irrigation) on *H. sorokinianum* leaf spot development are difficult to separate. Leaf spot is most active during the cool periods of spring and fall. As temperature (possibly combined with wind velocity) increases and rainfall decreases in summer months, number and size of leaf spots decreases. However, our field studies have shown that if the summer is relatively wet, or if irrigation is provided, leaf spot may occur on 13 to 60% of leaves throughout summer months depending on susceptibility of the cultivar. Midsummer leaf spot seems to be more closely regulated by moisture than by temperature.

Cultural practices and symptoms

Nitrogen fertilization often increases the severity of *H. sorokinianum* leaf spot on Kentucky bluegrass. When nitrogen stimulates leaf spot it is usually reflected by an increase in size of lesion and by some general yellowing of infected leaves.

Studies recently completed in our laboratory indicate that nitrogen and leaf age interact to influence leaf spot severity (i.e. the youngest leaves of nitrogen fertilized plants may have less disease than those of nonfertilized plants, but disease is increased on the oldest leaves by nitrogen fertilization). This suggests that the subject of nitrogen fertilization and leaf spot severity is related to the physiological age of leaves and that influence of nitrogen on disease may be modified by leaf age.

Herbicides represent another cultural tool that shows some potential for influencing severity of *H. sorokinianum* leaf spot on Kentucky bluegrass. Such commonly used herbicides as 2,4-D, MCPP, and dicamba may enhance leaf spot development. Like other environmental and cultural factors that enhance leaf spot, leaf age is directly involved in the interaction. Increase in diseased tissue on youngest leaves is minimal and severity of disease increases on each older leaf. In some instances, one small lesion on an older leaf of a plant exposed to MCPP or dicamba can result in a rapid straw-colored blighting of the entire leaf. It is believed that auxin-like herbicides (2,4-D, MCPP, dicamba) may increase the rate of aging in older leaves and predispose them to more severe disease.

> Nitrogen and leaf age interact to influence leaf spot severity. Some herbicides enhance development of leaf spot as well.

Seasonal appearance of leaf spot

It is now known that leaf age, environment, and cultural factors can influence severity and appearance of *H. sorokinianum* leaf spot symptoms. On the basis of these observations, it is of interest to speculate on how these various factors might influence leaf spot during the various seasons of the year. The following outline is a speculative summation of how leaf age, environment, and culture practices might interact with leaf spot.

Spring

A. Appearance of Symptoms

1. Leaf spots small in early spring.
2. Leaf spots larger with some leaf yellowing in mid-spring.
3. Leaf spots smaller by late spring to early summer unless irrigation is provided.

B. Factors involved

1. The rapid flush of leaves in the early spring results in a very youthful shoot which inhibits leaf spot development. By mid-spring normal senescence of leaves on individual shoots has increased and such leaves show the larger lesions and the more severe yellowing symptoms.
2. By late spring increasing day length and reduced moisture levels (assuming irrigation is not provided) results in fewer leaf infection and less severe infections.
3. Applications of nitrogen or herbicides (auxin types) between mid-spring and early summer could increase severity of leaf spot. However, it is also possible that

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DISEASE MANAGEMENT IS BASED ON FIVE GENERAL AREAS OF EFFORT

By W.C. Stienstra, Associate Professor and Extension Specialist, Department of Plant Pathology, University of Minnesota.

In plant pathology disease control, I prefer the term Disease Management. Disease management is based on five general methods or traditional areas of effort.

First, resistant lines: this is and has been a major form of plant disease control or management with all plants. It is depended upon for disease control or management in crops such as cereals, corn, beans, hay and many others. In many of the more intensive crops, disease resistance is necessary to manage and produce even with the use of fungicides. The introduction of leaf spot resistance (i.e. Merion Kentucky bluegrass) changed the turf world. Today's term is "a revolution occurred." Resistant plants are, I believe, the "natural state" and we should (1) do all we can to utilize genetic material and (2) provide favorable environments for plant growth to express genetic potential.

Pathologists in general and myself specifically have not involved themselves to the extent they should in defining optimum conditions for turf growth.

The second general method of disease management is exclusion (i.e. quarantine). The best known quarantine for plant disease is at international ports of entry where ships, planes, cars, trucks and people are crossing from one country into another. Quarantine is also accomplished on a smaller scale as in foundation seed, commercial greenhouses, and many other cases where valuable stocks and certain crops are grown in confined areas with good sanitation procedures.

In turf leaf spot management, exclusion or quarantine has limited value.

The third general method is eradication (i.e. the attempt to remove the disease organism after it has entered an area). This is very difficult on a field scale once the organism has become established. However, in some confined areas this can be accomplished. The profits obtained from such a program often are quite high. This technique again has limited use in turf leaf spot management.

The fourth general method is sanitation, a term meaning clean up of an area to reduce chances of infection. Persistence of the individual plant manager in watching and using all procedures makes the difference between success and failure. This is important in turf leaf spot management.

The fifth general method is protection, the use of chemicals (i.e. fungicides). There may be too great a reliance on chemical protectants since they are easily used, readily available and response is expected where disease threatens. Fungicides are needed in disease management and are very useful in turf leaf spot control.

The five general methods of disease management are resistance, exclusion, eradication, sanitation, and protection. What management factors should the turf managers use when developing practical methods of leaf spot management in turf? *Helminthosporium* Leaf spot is one of the most common and serious disease complexes attacking cool season turfgrasses in the U.S. Leaf spot can be very destructive during wet humid weather or in areas where the turf is sprinkled frequently especially in early evening. The more often grass is wet and the longer it remains wet, the greater are the chance of disease. *Helminthosporium* fungi are responsible for the gradual browning, thinning and melting out of Kentucky bluegrass cultivars and other susceptible grasses. As the disease progresses, large irregular turfgrass areas are yellowed, browned and finally killed. Once *Helminthosporium* fungi become established in a turfgrass stand, they remain an ever present problem.

The disease cycle of all species of *Helminthosporium* fungi is essentially the same. They survive from year to year as mycelium in dead grass tissues or in infected leaves, crowns, roots and rhizomes. Under moist conditions, tremendous numbers of spores are produced on this debris and carried to new leaf growth by air currents, mowers and foot and vehicular traffic. The spores germinate in a film of moisture and infect the leaves. Spore germination and infection of leaves can take place within a matter of hours when conditions are favorable. New spores are produced on these infected leaves within a few days which in turn spread to new leaf parts and neighboring plants. Thus the cycle is repeated. New leaf infections may occur as long as conditions remain moist and the temperatures are favorable for germination and growth.

Best management of leaf spot begins by providing an adequate soil zone for turfgrass root growth.

Best management of *Helminthosporium* leaf spot begins by providing an adequate soil zone for turfgrass root growth. Turf areas developed with planned surface drainage and adequate internal drainage will produce a vigorous network of plants (leaves, roots and rhizomes). Plants growing under these conditions will respond best to adverse environmental stresses.

When managing to prevent disease problems, it is important to remember the disease formula (i.e. you must have the host, the causal agent and a favorable environment for disease to develop). A vigorously growing plant is best suited to express its genetic resistance and to survive the period of disease stress and to recover faster.

Best management of *Helminthosporium* leaf spot continues with the selection and use of resistant varieties. Leaf spot resistance in the form of Merion Kentucky bluegrass so changed the turf industry that now we recognize other summer diseases of turf. Before Merion, summer disease problems were always caused by *Helminthosporium*. *Helminthosporium*-incited diseases rank among the most important fungus disorders of turfgrasses. Characterized by leaf blighting, leaf abscissium, root, rhizome, stolon and crown rots, it is not uncommon in certain seasons for this group of diseases to become the limiting factor in turfgrass production.

The best control of *Helminthosporium* leaf spot is obtained through the use of resistant varieties. Many lines exhibit nearly complete resistance to *Helminthosporium* under field conditions. Select high quality, disease resistant seed or sod that is locally adapted or a mix of locally tested grass varieties resistant to one or more *Helminthosporium* diseases.

But what if you already have a turf area, and do not want to begin a major rebuilding program? What should you consider in a *Helminthosporium* leaf spot sanitation program?

First - mow the bluegrass or for that matter, rye and fescue at the recommended height. *Helminthosporium* leaf spot is most damaging when close mowing occurs, so avoid close clipping at all times and especially when the leaf spot stage is a serious threat and when conditions are favorable for disease development. Mow the grass frequently, removing no more than one third of the leaf surface with a single mowing. Removal of clippings may further reduce the available food base for *Helminthosporium* leaf spot development.

Second - water turf areas as needed, wetting the soil to a depth of 4-6 inches. Repeat every week if nature does not supply adequate amounts. Apply supplemental water during or immediately after light showers during any dry periods. The value and importance of the soil can and should be noted here. Soil that is slow to wet and soil that has an inadequate water holding capacity forces you into frequent light sprinklings, and water-logging the soil surface, which promotes disease development.

Third - fertilize based on soil tests and nutritional needs of the plant. Avoid heavy applications of water soluble fertilizers, when *Helminthosporium* leaf spot disease is expected. Fertilize to maintain a uniform level of soil nutrients in the root zone, following the local recommendations for the grasses being grown. Consider fertilizer needs beyond having the greenest turf in the area.

Fourth - reduce thatch accumulation or mat to less than one centimeter by using a power rake or an aerifier. These operations are usually accomplished in the spring, fall or both when turf growth and recovery are rapid for cool season species. Thatch reduction is a process not completed in one treatment, just as thatch accumulation occurs over the entire growing season. Management of thatch accumulation and its removal is needed in most turf areas.

Development of resistant lines is a major form of plant disease control and utilizes known resistant material

Fifth - consider modifying the local environment. Is the turf growing under dense shade, in areas with restricted air movement? Could trees or shrubs be removed or pruned? If so, will more light penetrate to the turf and will greater air movement over the turf speed the drying process thus reducing disease conditions?

Sixth - If *Helminthosporium* diseases are not adequately managed by cultural treatments, fungicide sprays may be needed on a responsive-preventative schedule. A responsive - preventative schedule means fungicide applications begin with the development of the disease and continues every seven to fourteen days during the period when conditions permit disease development. This spray program requires disease awareness, disease diagnosis, time, money, and for the average individual may not be practical. If only a few sprays will be applied, to be most effective, most of the time, the applications should occur in the spring, fall or both when cool wet growing conditions are common. If spraying is delayed until leaf blighting is severe, or thinning is obvious, the results will be poor.

Spraying fungicides or "all the world loves a universal green paint" is the "take two aspirins and call me in the morning" philosophy. Spraying, the easy, accepted, and indeed expected disease response, often may not be well understood. We can cite chapter and verse on preventative schedules, curative schedules, manufacturer directions, package label rates, application intervals, compatibility, safe use, pressure, volume, time of day, uniformity, nozzles, nozzle spacing, temperature, moisture, grass condition, grass potential, chemical persistence, spreaders, stickers, rainfall, past fungicide use and resistant isolates.

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Management *from page 59*

Fungicide disease control basically involves products that are (1) lethal to the fungus, or (2) inhibit fungal germination, growth or multiplication. Some fungicides are "broad spectrum", inhibiting a wide range of pathogens and other are "narrow spectrum", having a specific activity for only a few fungi.

Helminthosporium leaf spot fungicides prevent infection by the fungus rather than cure the disease. Thus effective fungicide control occurs only on plant parts to which fungicides are applied and only for the period fungicides remain on the plant. Contact fungicides must be applied at regular intervals to maintain protection on turfgrass leaf surface. Since control is achieved by a protective coat of fungitoxic chemical on the plant surface the fungicide must be applied uniformly. New, unprotected shoot growth is constantly being formed within the turf stand. These limitations must be recognized whenever you use fungicides to manage plant diseases. Certainly fungicides do help in a turf leaf spot management program but they will not replace a poor leaf spot management program or substitute for no leaf spot program at all.

In summary, of the general disease management methods, three are suitable for *Helminthosporium* leaf spot management consideration. These are resistant lines, sanitation and protection, while exclusion and eradication have limited value. The guts of a leaf spot management program is proper cultural management. Turf managers where *Helminthosporium* leaf spot is a threat should consider the effects of modified mowing, watering, and fertilizing practices. Further, they should consider de-thatching and if needed, modifying the turf environment. Lastly, apply fungicides as needed. If the results of these efforts are unsatisfactory, renovate by over seeding with resistant cultivars or reestablish completely including necessary soil and site preparations. **WTT**

Factors *from page 53*

early spring application nitrogen and auxin-like herbicides might temporarily retard leaf spot symptoms by promoting youthfulness in rapidly growing leaves.

Summer

A. Appearance of Symptoms.

1. Minimal appearance of small leaf spots under a normal, relatively dry summer environment.
2. Moderate to heavy leaf spot symptoms during wet summers or with irrigation.

B. Factors Involved.

1. Increasing day length and temperature, and reduced levels of moisture would normally reduce invections and decrease disease development on individual leaves. These factors would keep leaf spots relatively small.
2. Excessive rainfall or irrigation during summer will compensate for higher temperatures and increase infections. Applications of nitrogen and herbicides under these circumstances would further enhance disease severity. Some preliminary evidence suggests that high temperature stress combined with nitrogen and (or) herbicides may greatly enhance leaf spot symptoms on irrigated turf during the summer months.

Fall

A. Appearance of Symptoms.

1. Early fall number and size of leaf spots increases.
2. Late fall to early winter leaf spot symptoms become severe, including yellowing and blighting of entire leaves. Turf may appear to have a yellow undercover.

B. Factors involved.

1. Increasing moisture, shorter day lengths, and lower temperatures increase number of infections and enhance senescence of leaves. Enhanced senescence predisposes leaves to more severe disease development.
2. By late fall and early winter decreasing day length becomes a primary factor in enhancing leaf aging, and older infected leaves respond by blighting.
3. Nitrogen applied in late summer or early fall may have some delaying effect on senescence and for a period slow yellowing of older infected leaves.
4. Late summer to early fall applications of herbicides may enhance yellowing of older infected leaves by increasing the rate at which the leaf reaches senescence.

Winter

A. Appearance of Symptoms.

1. No leaf spot symptoms on dormant grasses. Winter may be the most important season for fungal colonization of dead tissues.
2. Grasses remaining green under snow cover and especially unfrozen soil will continue to show leaf spotting, yellowing, and blighting typical of late fall.

B. Factors Involved.

1. Provided adequate moisture is available, mycelium will grow slowly down to 36 degree F. Such growth could be important to colonization of dead tissue and an increase in spore production the following spring.
2. The potential availability of nitrogen, especially slow release forms, during winter months could provide an important nutrient source for pathogens and aid colonization of dead tissue.
3. Kentucky bluegrass will often remain green under snow cover, especially if the ground is unfrozen, and if nitrogen fertilizer is applied in the late fall. Under such circumstance leaf spotting and yellowing will persist as long as temperatures are 36 degrees F. or above.

PLANT SELECTION, HYBRIDIZATION PRODUCE NEW VARIETIES

By Gerard W. Pepin, Research Director, International Seeds, Inc., Halsey, OR

Starting with Merion, many leaf spot resistant cultivars have been developed. Almost all of the new bluegrass releases have good leaf spot resistance. The nature of the genetic resistance is not known. The resistant cultivars are generally low growing, broad leaved plants while the susceptible varieties are usually tall growing, fine leaved, stemmy types.

A number of fungicides can be used to control *Helminthosporium* leaf spot. Some of the better known broad spectrum fungicides commonly used are Actidione Thiram or TGF, Daconil 2787, Dyrene, Kromad and others. Unfortunately, fungicides are expensive and time consuming to apply. The best control is the planting of leaf spot resistant cultivars and there is a long list to choose from. However, under severe conditions, even the genetic resistance of the best cultivars can break down and fungicide application may be necessary.

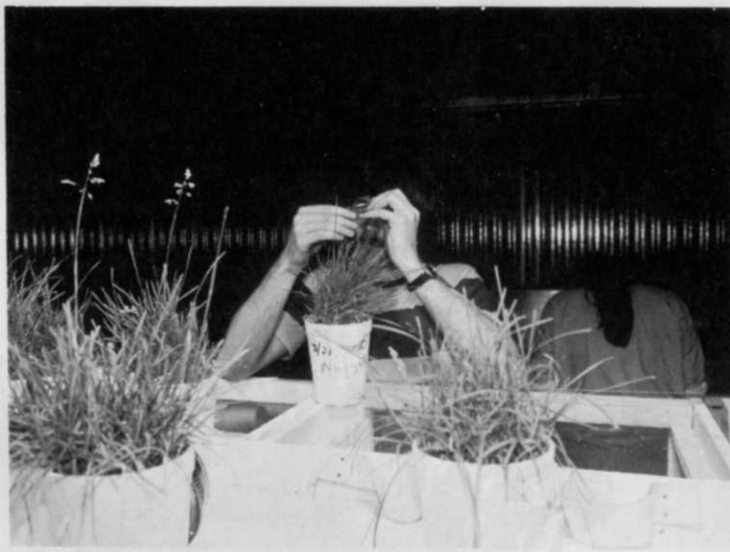
Plant breeders have been very successful in developing leaf spot resistant varieties. Two basic techniques have been used in bluegrass breeding: plant selection and hybridization.

Plant selection is the most basic breeding technique in existence. It simply involves the selection of superior plants that occur naturally, prosper and spread under close cut turf conditions. Often these plants can spread to enormous size; the plant selection that became Touchdown was over 50 feet in diameter. Some of the better known plant selections are Merion, Baron, Fylking, Glade, Windsor, Victa and Parade.

Bluegrass hybridization is a much more recent breeding technique. It has only been used for the past ten to 15 years but has resulted in the development of a number of improved leaf spot resistant varieties such as Adelphi, Bonnie-blue, Bristol and Majestic.

Hybridization is difficult in Kentucky bluegrass due to its unusual type of reproduction and seed formation. Kentucky bluegrass is facultatively apomictic, which means that most of the seed it produces bypasses the normal sexual reproduction cycle of grasses. This seed is an identical genetic copy of its mother plant. Only a small percentage of seed produced will be genetically different from the mother plant.

From a breeding standpoint, this unusual type of seed formation is both good and bad. It is good in that exact duplicates of superior plants can be produced year after year with no variation and no danger of losing a variety due to genetic shift. It is bad in that crossing is quite difficult because few hybrids are produced. Most of the seed derived from crossing will be identical to the mother plant and thus useless to a breeder. For every 1,000 plants derived from a cross perhaps only 20 to 50 hybrids might be produced. Since only one of a thousand hybrids might show commercial promise, huge numbers of plants have to be grown from seed produced by crossing two parent plants.



Seed research entails huge numbers new crosses to study for resistance.

Kentucky bluegrasses are usually crossed in the greenhouse during the spring. In the summer the crossed seed is germinated and individual spaced-plants are set out in the field. The next summer the mature plants are observed and the hybrids identified. Seed of the best appearing hybrids is harvested, cleaned, and used to plant a small turf plot of many standard varieties and the new hybrids are carefully compared with the check varieties. The resistance to various types of *Helminthosporium* leaf spot and melting-out of the hybrids is closely observed. It is essential that new hybrid variety intended for fine turf use has good leaf spot resistance.

The success rate among new bluegrass hybrids is very low. Perhaps only one in 500 or 1,000 hybrids will combine the characteristics of good turf quality, good disease resistance and good seed production necessary in new, improved varieties.

Despite the difficulties, several active bluegrass breeding programs are continuing in the U.S. and Europe. It is from these programs that a continuing source of new varieties will be forthcoming. The perfect variety will never be achieved, but hopefully breeders can keep developing varieties that get closer to that ideal. **WTT**