FUSARIUM BLIGHT: A RESEARCH PROGRESS REPORT

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Fusarium blight of Kentucky bluegrass (*Poa pratensis* L.) continues to be a severe problem in southeastern New York, and it is, therefore, given considerable research emphasis in the Cornell University turfgrass disease research program. This report summarizes some recent findings.

All plant diseases are dependent upon the presence of the pathogens, the presence of susceptible host plants, and the existence of environmental conditions that are more favorable to the pathogen's activity than to the growth of the host or of the pathogen's microbial competitors. Each of these parameters is being studied in our program.

THE PATHOGEN

Fusarium species are a normal and ubiquitous component of the turfgrass microflora, and are, therefore, almost always associated with healthy as well as with dying grass. The diversity of *Fusarium* species in turf is large (Smiley and Craven, 1979), and many species are capable of infecting living tissue. But infection of living plants is not always of immediate consequence since apparently healthy plants that have fusaria occupying their crown and root tissues do not always succumb to disease. The disease-causing activity of the fusaria in living tissues becomes amplified if the plant undergoes a stress that causes a general weakening of the plant. Fusaria readily begin the decomposition process of the weakened plants in which they live, a similar process to that of the primary decomposition of plants that have died without being diseased. Turfgrasses continually produce new tissue, and the older parts are continually senescing and being decomposed. *Fusarium* species are important components of this natural recycling of nutrient elements.

In some instances, fusaria are not the dominant fungi in tissues of plants which exhibit the typical symptoms of Fusarium blight. Species of *Rhizoctonia*, *Curvularia*, or *Drechslera* (= *Helminthosporium*) are occasionally the dominant or the only detectable fungi which can be isolated from the diseased plants, but usually only one of these fungi will be dominant in a particular diseased stand. In most instances, fusaria are present, yet we must ask why the other fungi are apparently capable of causing the same symptoms as fusaria in the Fusarium blight disease. Perhaps it is because there is nothing magical about *Fusarium*, except that it is most prevalent on grass at the time the disease occurs. It is known that *Drechslera* and *Curvularia* dominate the composition of leaf-surface fungi in the spring and fall, and *Fusarium* species are most prevalent in the summer. *Rhizoctonia* is a soil inhabitant that is active over a wide temperature range. The occurrence of any disease during the summer is, therefore, likely to include fusaria as primary or secondary invaders of weakened leaf and crown tissue. Perhaps the overall symptoms of this disease are more indicative of plant growth patterns and of plant stress than of the activity of a particular pathogen, and therefore, the actual pathogen which attacks the weakened plant is unimportant. This hypothesis will be carefully examined in future investigations.

Several of our recent studies have indicated that Fusarium blight has been most severe on plots where the lowest numbers of fusaria were counted in soil, and where the lowest percentages of *Fusarium*-colonized plant crowns occurred prior to disease symptom development. The meaning of these results, shown in Figure 1, is still unclear. Tentative explanations, which have not been tested experimentally, are: 1) the *Fusarium*-colonized plants may have been altered in their chemical composition such that they were less severely stressed when the environmental conditions or the management program caused a general weakening of the overall plant population; or 2) the higher population of fusaria in some plots decomposed plant tissue more rapidly and thus less decomposable organic litter was in that turf when the environmental stresses occurred. These concepts must be studied further.

It may be concluded that the pathogenic fusaria are almost always present in turf, but if they are not, equally-effective pathogens surely are, and they can all cause the characteristic diseased condition of grass which we know as Fusarium blight.

THE HOST

Although greenhouse tests have suggested that creeping bentgrass is susceptible to Fusarium blight, this has rarely been observed in the field. Transforming bluegrass fairways to bentgrass fairways has, in fact, been accelerated on one New York golf course where the blight reduces the bluegrass competition so that the bentgrass can become established more rapidly. The bentgrass has not been affected by this disease.

Information is now available about the relative susceptibility of seeded Kentucky bluegrass cultivars to Fusarium blight (Funk, 1976; Turgeon, 1976; and Gibeault et al., 1977); however, little is known about the comparative susceptibilities of cultivars when they are established from sod. The reasons why seeded cultivars differ in their susceptibility to Fusarium blight, and why the patch symptoms occur as they do are also unknown. These aspects of the disease are being investigated in an attempt to develop more efficient control measures.

It is my hypothesis that the patch (frog-eyes, crescents, or solid patches) symptoms may be a reflection of the bluegrass growth habit. The question becomes one of defining a plant that originated from a single seed, as it ages and becomes more complex. The biology of tiller and rhizome growth, and of apomictic reproduction are being studied. It is known, for instance, that from 0 to about 20% of the seeds in a seed lot of any one cultivar are genetically different from the other 80 to 100% which are genetically identical to one another. Could the plants arising from the off-type seed be more prone to Fusarium blight, and the differences in susceptibilities among cultivars reflect the heterogeneity of seed lots?

The climate, soils, and geography of each cultivar's origin are also being investigated for possible linkages with the cultivar's susceptibility to Fusarium blight. A superficial and thus preliminary survey suggests that the most suceptible cultivars were derived from parents or selections taken from more northerly latitudes, from shaded areas, or from higher elevations. These factors will be considered to determine if they can be used to predict a cultivar's potential susceptibility to this disease. If so, breeders would have new guidelines to include in their search for resistant cultivars.

THE ENVIRONMENT

Fusarium blight is known to become most prevalent on heavily-fertilized turf, on turf that is cut too low, on older turf unless it is established from sod rather than from seed, on fully-sunlit sites, and on turf near heat-accumulating sources such as sidewalks, streets, or buildings. The disease has also been thought to be associated with drought stress, with low soil pH, and with heavy accumulations of thatch. Each of the latter three factors is contradictory to the results of recent research findings.

A survey of weather records for 1966 and for 1973 to 1978 (Smiley, Craven, and O'Knefski, 1979) indicated that Fusarium blight always occurred soon after major rainfall events, regardless of the presence or absence of subsequent droughty periods. There was also no apparent relationship between the disease and summer temperatures. These results, illustrated in Figure 2, are consistent with the occurrence of the disease on seemingly well-watered lawns and fairways, and with the severe occurrence of the disease in 1976, which was one of the wettest summers in recent history. Since the disease followed major rainfalls even on irrigated turfgrasses, the length of the wetting period may be of major importance since irrigation cycles are brief in comparison to the wetting cycles of large storms.

Smiley and Craven (1977) observed that no relationship existed between Fusarium blight and either the thatch-plus-soil pH or the depth of thatch at the Mill River Club on Long Island, where the Kentucky bluegrass fairways are about 12 years old. However, we have now obtained much different results on a sodded bluegrass plot at Ithaca. The most disease on the sodded plot occurred where pH values were highest, and where the thatch layer was thinnest.

Decomposition of thatch is most rapid when the soil and thatch are not acidic, when they are well aerified, when the temperature is high, and when they are alternately moistened and dried. Decomposer organisms, including the fusaria, are favored by these conditions. Decomposition becomes intense when dry thatch is remoistened, and a large quantity of potentially toxic organic chemicals are released from the debris, especially when aeration is poor. Anaerobic and near-anaerobic conditions have been measured in thatch on sunny days following major rainstorm or irrigation events (Smiley, Craven, and O'Knefski, 1979). It is of interest to determine whether plant-derived toxins or whether poor aeration of thatch, each of which would inhibit root functions, could be involved in the pre-disposition of bluegrass to Fusarium blight.

The benzimidazole fungicides (benomyl, methyl thiophanate and ethyl thio-phanate) were shown to be ineffective against Fusarium blight on several golf courses in New York and in Pennsylvania in the early 1970s. Smiley and Howard (1976) observed that the majority of fusaria on one such golf course were tolerant of the benzimidazole fungicides, and pathologists in Pennsylvania made similar observations. We attributed the inefficiency of these chemicals, which are still the only commercially-available controls, to the presence of the tolerant strains of _Fusarium_. But recent observations on these golf courses indicate that these fungicides are now beginning to control this disease again, even though the tolerant fusaria are still prevalent. It is now also evident that just prior to the years of uncontrollable disease, each of the golf courses in question had been treated with tricalcium arsenate herbicide to control _Poa annua_ (Smiley, Craven, and O'Knefski, 1979). The degree of disease uncontrollability appears to be in proportion to the amount of herbicide applied over the previous years, and it was shown experimentally that this chemical greatly reduces the oxidation of thatch and increases the occurrence of Fusarium blight. Smiley and Howard's explanation of the inefficiency of benzimidazole fungicides on these sites appears to have been based on insufficient knowledge, and the later studies now cause us to question not only whether the benzimidazole-tolerant fusaria are important for disease development, but also whether the presence of fusaria is at all necessary for disease to occur.

The benzimidazole and new experimental fungicides that control Fusarium blight are all systemically-translocated, and all can alter the appearance of the turfgrass stand. The best suppressors of this disease are the fungicides that most visibly alter the turfgrass color and the leaf shape, size, angle, and growth rate. It can be assumed that each of these fungicides also alters the physiology of the plants, that is, that each has growth regulant activities. The benzimidazole fungicides have been proved to be plant hormones (Mishra and Samal, 1973). They are similar to the cytokinens which regulate plant senescence, and which are necessary for plants to survive stressful environmental conditions. By supplying these fungicides to plants, the plants would be able to withstand greater-than-normal stresses of excess radiation, excess heat, drought, and anaerobiosis. It, therefore, becomes imperative to determine whether the disease-controlling effect of the benzimidazoles is due to fungicidal activity, to the alleviation of plant stress, or to a combination of both. Moreover, the benzimidazoles differ in their hormonal efficiency: benomyl is slightly more efficient than methyl thiophanate, and both are considerably more efficient than ethyl thiophanate and thiabendazole. The same sequence and magnitudes occur for these fungicides in their ability to control Fusarium blight and several other diseases. Much more research on the influence of fungicides on the physiology of plants is required to answer the questions raised by the relationships summarized here.

CONCLUSION

The absolute importance of the environment and the irregularities found in the relationship between Fusarium species and Fusarium blight lead me to question the importance of Fusaria as a primary cause of this disease. The cause and the control of the disease can be explained without implicating the fusaria, although it is certainly recognized that these fungi are potentially pathogenic and are always present in turfgrasses. By questioning whether fusaria are always (or ever) involved as primary pathogens, I feel that research progress can be accelerated to solve the many mysteries that lie unanswered concerning the Fusarium blight of Kentucky bluegrasses.

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Figure 1A - Fusarium blight and the numbers of Fusarium roseum propagules in fungicide-treated (●) or untreated (✱) plots on Kentucky bluegrass fairways at the Mill River Club, Oyster Bay, NY.

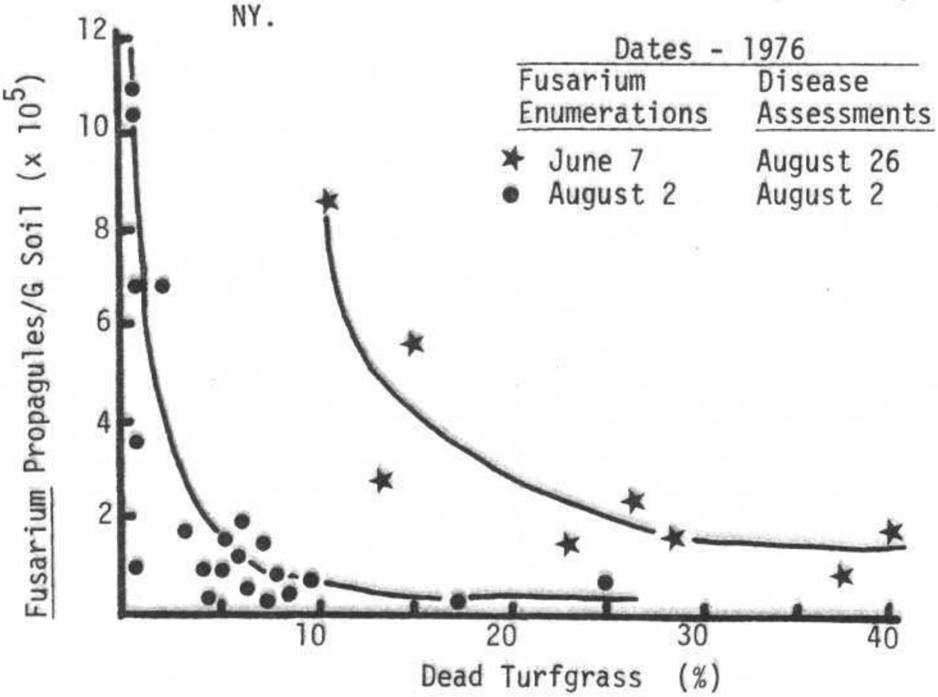

Figure 1B - Fusarium blight and the percentage of Kentucky bluegrass crowns colonized by Fusarium roseum on fungicide-treated plots at Ithaca.

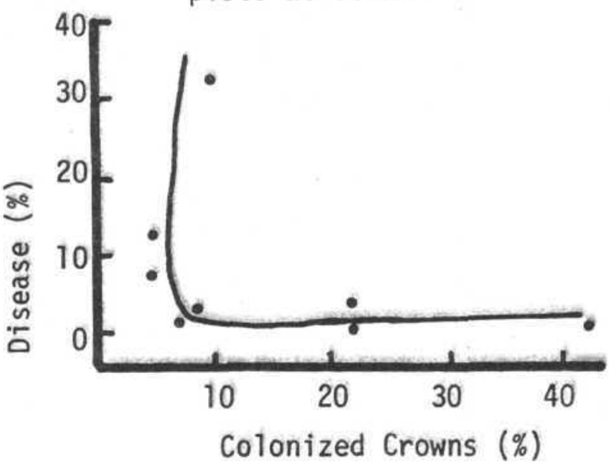

Figure 2. -- Occurrences of Fusarium blight (★) with respect to the cumulative inches of precipitation and the maximum and minimum daily air temperatures (at 4 inches above sod) on Long Island (1973 to 1978), at Ithaca, NY, and at Amherst, MA. Disease data from Amherst are from J. A. Keohane, 1967. Environmental studies of Fusarium blight in Merion Kentucky bluegrass. M.Sc. Thesis, Univ. of MA. Climatological data are from U.S. Environmental Data Service.