PLANT DISEASES AS POTENTIAL LIMITING FACTORS FOR FORAGE PRODUCTION ON ANIMAL WASTE DISPOSAL SITES

R. G. Pratt*
'USDA, ARS, Mid South Area, Waste Management & Forage Research Unit,
Mississippi State, Mississippi

INTRODUCTION

A major problem in production of large numbers of swine, poultry, or cattle in concentrated facilities is the disposal, without pollution of the environment, of large quantities of waste products that are generated daily. The principal polluting substances present at high levels in animal waste products are compounds of nitrogen and phosphorus. The primary environmental effects of these pollutants, which are also major plant nutrients, are the induction of toxic nitrate levels in ground water used for drinking, and over-fertilization of lakes, rivers, and estuaries that leads to their rapid eutrophication and ecological deterioration (Sharpley et al. 1998).

Current methods for disposal of excess nutrients from concentrated animal production facilities in the southeastern USA, which are intended to avoid environmental pollution, usually are based upon their application to forage crops as fertilizers. Nitrogen and phosphorus from animal wastes are absorbed by forages during their growth and removed from application sites during harvest of hay. This type of biological nutrient disposal system requires production of maximal quantities of forage on waste disposal sites in order to achieve maximal nutrient removal. Therefore, any factors that reduce yields of forage and hay crops on animal waste disposal sites, or prevent effective growth responses of forages to applied nutrients, must be regarded as potential limiting factors for the successful use of forage-based nutrient disposal systems.

During the past two years, symptoms of disease have been observed on bermudagrass and other forage species on swine and poultry waste application sites. In some instances, diseases were present at low frequencies in stands and did not appear likely to have caused significant yield reductions or other losses. In other situations where symptoms were more severe, diseases appeared to be significant factors that may have reduced yields in portions of stands and caused major shifts in forage species compositicn.

This paper presents a summary and overview of previous studies of plant diseases and pathogens on swine application sites; results of these studies will be described in greater detail in the near future (Pratt 2000). It also presents preliminary results of similar studies on poultry waste sites, and studies that involve sampling times and host ranges of pathogens. These results also are intended to be described in greater detail in later reports.

MATERIALS AND METHODS

Sampling Procedures

Three swine waste disposal sites were observed for fungal disease symptoms on bermudagrass and other species initially in 1998 and repeatedly in 1999; two poultry sites also were observed repeatedly in 1999. Samples of tissue were collected from randomly selected symptomatic plants in areas up to several acres at each site and stored in sealed plastic bags with a moist paper towel at 10c priortoassay. Initially in 1998, samples of symptomatic leaves, stems, crowns and roots were collected and assayed. In 1999, samples consisted almost entirely of leaf issues after it was determined that the same pathogens were present there as in stems, crowns, and roots.

Identification and Isolation of Pathogens

Symptomatic tissues were washed, surface-disinfested in 70% ethanol for 10' and 1% sodium hypochlorite for 20-60". rewashed, blotted, and plated on water agar. Plates were incubated on a lab bench for 7-10 days. Spores of pathogens that developed on hyphae from infected tissues were observed directly on plates with a compound microscope, and species were identified by comparing morphological features of spores with those of pathogens as described in keys and monographs (Couch 1995; Sivanesan 1987; Smiley et al. 1992). Isolates were obtained by direct transfer of spores to agar growth media with a flamed needle.

Evaluation of Pathogenicity

Spores of dematiaceous fungi were produced by growing isolates for 2-3 weeks on a mixture of wheat and oat grain in flasks (Pratt 1992). Infested grain then was air-dried and fragmented by comminuting in a food blender, and aliquots were scattered over plates of water agar. After 7-10 days, numerous spores were usually produced on mycelium that developed from the infested grain particles. These were collected in a liquid suspension, filtered through cheesecloth, and diluted or concentrated by settling as needed to obtain a mean concentration of 2×10^5 per ml as determined by six hemacytometer counts. For each experiment, leaves and stems of common bermudagrass plants grown for 7-8 weeks in the greenhouse in 8-oz styrofoam cups were sprayed with spore suspensions (20 cc per cup), and five replicate cups of each treatment were arranged in a randomized complete block design on a plant growth bench under fluorescent growth lights.

Additional details of procedures for sampling, identifying and isolating pathogens, and evaluation pathogenicity will be described (Pratt 2000).

RESULTS

Symptoms of Disease in the Field

Symptoms of disease on bermudagrass were observed on all sites examined during 1998 and 1999. Similar symptoms were sometimes observed on other forage grasses. Severity of symptoms differed greatly between sites and usually intensified in late summer and early fall. In stands with slight disease, symptoms were largely restricted to dark-colored lesions on lower leaves, and these did not appear likely to have caused significant losses in forage production. When symptoms were more severe, lesions were present on all tissues and stems and crowns were often killed. This resulted in diffuse patches of stunted and dead plants in stands. Often little new growth developed from areas with severe symptoms following hay harvest.

In some areas of bermudagrass stands that manifested moderate to severe disease symptoms in 1998, heavy colonization by Johnsongrass, yellow foxtail, signalgrass, and other volunteer species was observed in 1999.

Identity, Frequency, and Pathogenicity of Fungal Species from Bermudagrass

Eight species of dematiaceous fungal pathogens were identified on diseased bermudagrass from swine and poultry waste application sites (Table 1). *Exserohilum rostratum* and *Bipolaris spicifera* were usually most common when dieback and death of plants occurred; *B. cynodontis* and *Curvularia* spp. were often most common when symptoms were largely restricted to leaves. Some shifts in frequency of pathogens were observed at different biweekly sampling periods in 1999. On two poultry waste sites, there was a general trend toward increased frequency and biodiversity of pathogens from August to October. However, in most instances the predominant pathogens on each site remained among the most frequent at all sampling periods.

In repeated inoculation experiments, consistent differences in virulence of six species of dematiaceous fungal pathogens from swine sites were observed based upon percentages of tissues in which symptoms were induced (Pratt 2000). *Exserohilum rostratum* and *B. stenospila* were most virulent, *B. cynodontis* was slightly less virulent, and *Curvularia* spp. were least virulent. Later experiments established that virulence of *B. hawaiiensis*, found only on poultry sites, was similar to that of *B. spicifera* (Table 1).

Although disease symptoms observed on bermudagrass to date have been attributed to the eight species of dematiaceous pathogens (Table 1), less frequent sporulation by *Colletotrichum*, *Nigrospora*, and *Phoma* also was observed on leaves of symptomatic bermudagrass. Involvement of these other genera of potential pathogens in symptom development, or their capacity to cause disease independently in bermudagrass on waste disposal sites, has not been established.

Disease Symptoms on Other Forage Grasses

Symptoms similar to those observed on bermudagrass were usually slight or absent on Johnsongrass, foxtail, and broadleaf signalgrass.

However, when these species volunteered in the presence of severely diseased bermudagrass, then they also often manifested symptoms of stunting and necrosis on leaves. Many of the same pathogens isolated from bermudagrass were then isolated from symptomatic Johnsongrass, foxtail, and signalgrass.

Other diseases that normally occur on *Sorghum* spp. (Frederiksen 1986) were observed on Johnsongrass on several sites. These included zonate leafspot, anthracnose, leaf blight, and rough leafspot. Zonate leafspot (*Gloeocercospora sorghi*) was the most conspicuous of these diseases and appeared to have the greatest potential for causing losses in forage production.

DISCUSSION

Observations and results of these studies indicate that plant diseases are potential limiting factors for production of forage by bermudagrass and other species on swine and poultry waste application sites. Plant diseases, therefore, might potentially interfere with nutrient removal from waste application sites if forage production is greatly reduced. A second possible consequence of plant diseases is that they may influence forage species composition by enabling volunteer species to colonize diseased areas and become dominant components of the stand.

Symptoms similar to those on bermudagrass were also observed on Johnsongrass, foxtail, and broadleaf signalgrass, but only when these species volunteered in the midst of severely diseased bermudagrass. This suggests that bermudagrass is the primary host of these dematiaceous fungal pathogens, and that the other species are secondary hosts that normally develop symptoms only in the presence of severely diseased bermudagrass.

Control practices have not yet been established or evaluated for the dematiaceous fungal pathogens of bermudagrass and other forages on animal waste application sites. However, several agronomic practices or variations should be investigated for potential control effects; these include wintertime burning of stands, cutting height and frequency for hay production, frequency and timing of irrigation, and possibly supplemental fertilization (Matocha and Smith 1980). Alternatively, the use of other forage species, that are overall more resistant to the dematiaceous fungal pathogens than is bermudagrass, may be a desirable or necessary practice for sustaining high forage production in the most severely diseased stands.

The best solutions to the disease problems on bermudagrass would be to develop new varieties with resistance to the principal pathogens. This does appear to be a reasonable and attainable goal. However, it will require concerted breeding efforts to screen populations by artificial inoculations, identify and cross the most resistant genotypes, and rescreen and reselect progeny until end products with suitable levels of resistance are produced.

REFERENCES

Couch, H.B. 1995. Diseases of turfgrasses. Malabar, FL: Krieger Publishing Co.

Frederiksen, R.A., ed. 1986. Compendium of sorghum diseases. St. Paul, MN: APS Press.

Matocha, J.E., and L. Smith. 1980. Influence of potassium on Helminthosporium cynodontis and dry matter yields of Coastal bermudagrass. Agronomy Journal. 72:565-567.

Pratt, R.G. 1992. Morphology and host specialization of Sclerotinia trifoliorum from small hop clover. Plant Disease. 76:661-664.

Pratt, R.G. 2000. Diseases caused by dematiaceous fungal pathogens as potential limiting factors for production of bermudagrass on swine effluent application sites. Agronomy Journal. (In press).

Sharpley, A., J.J. Meisinger, A. Breeuwesma, J.T. Sims, T.C. Daniel, and J.S. Schepers. 1998. Impacts of animal manure management on ground and surface water quality. In Animal waste utilization: effective use of manure as a soil resource, edited by J.L. Hatfield and B.A. Steward, 173-242. Ann Arbor, MI: Sleeping Bear Press.

Sivanesan, A. 1987. Graminicolous species of Bipolaris, Curvularia, Drechslera, Exserohilum and their teleomorphs. Mycological Paper No. 158. Kew, Surrey, UK: Commonwealth Mycological Institute.

Smiley, R.W., P.H. Dernoeden, and B.B. Clarke, eds. 1992. Compendium of turfgrass diseases. St. Paul, MN: APS Press.

Table 1. Occurrence, relative frequency, and virulence of dematiaceous fungal pathogens isolated from bermudagrass and other forage species on swine and poultry waste application sites

Pathogen	Occurrence on swine (S) or poultry (P) sites	Relative frequency[1]	Relative virulence[2]
Exserohilum rostratum	S,P	R-VF	H
Bipolaris cynodontis	S,P	R-VF	M-H
B. hawaiiensis	P	R	M
B. spicifera	S,P	R-F	M
B. stenospila	S,P	R-O	H
Curvularia lunata	S,P	O-VF	W-M
C. geniculata	S,P	O-F	W
Drechslera gigantea	S	F	undetermined

[1] VF = very frequent, F = frequent, O = occasional, R = rare.
[2] Virulence to bermudagrass as determined by inoculations of greenhouse-grown plants at similar spore concentrations and estimates of percentages of tissue in which symptoms are induced. H = highly virulent, M = moderately virulent, W = weakly virulent.