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Graminicolous Fungi of Virginia: Fungi Associated with Cereals

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ABSTRACT

The fungi listed and annotated in this paper include those reported in publications and collected and identified by the authors within the Commonwealth of Virginia on the cereal grasses, barley, corn, oats, rye, grain sorghum, and wheat. Fungi on two or more hosts are usually listed as plurivorous fungi; those restricted to one host in Virginia are listed as specific fungi. Species better known by their anamorphic binomials are dually listed. An alphabetical summary of all species is included.

INTRODUCTION

Many fungi have been reported to occur on grasses in Virginia, but these reports are widely scattered in check lists, experiment station publications, and scientific journals. It would be difficult for anyone seeking information on graminicolous fungi to survey completely the pertinent literature. The recent compendium, "Fungi on Plants and Plant Products in the United States," (Farr et al., 1989) provides the most comprehensive list available. If a fungus has been reported in the literature to occur in Virginia, it will probably be listed by Farr et al. However, a number of fungi are known to occur on cereals and other grasses in Virginia which have not been the subject of publications and, therefore, are not listed by them. In addition, since 1989, we have collected and identified fungi on many grasses growing in diverse ecological sites that have never been reported in a particular host-fungus relationship in Virginia and, in some cases, the United States. It is our purpose to provide an annotated list by host of the graminicolous fungi of Virginia. Pertinent literature will be cited and where deemed helpful, synonymy will be included.

Since this endeavor may result in a lengthy publication, we have considered presenting the list in segments, namely, fungi on cereals, on turfgrasses, on forage grasses and on wild or uncultivated grasses. Division into these categories may create some complications because a number of host species can be included in two or more categories. For example, *Cynodon dactylon*, *Poa pratense*, and *Festuca arundinacea* may be included in three categories and *Dactylis glomerata* and *Phleum pratense* may be included in two categories. However, we have decided to follow the scheme of Farr et al., namely, to list the noncereal grasses in alphabetical order and provide a summarizing index to the fungus species included. This will make our findings more readily useful to pathologists and mycologists.

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Nomenclature provides us with some challenges. Groups of grasses (formerly Gramineae, now Poaceae) and fungi are being studied continually and changes especially in genera occur such that only professional taxonomists have ready access to the most recent binomials. Therefore, to simplify our problem, generally we will use the binomials listed by Farr et al. (1989) for both grasses and fungi; exceptions will be noted. Our aim, however, is to identify a particular host-fungus association and not to get bogged down in recognition or rejection of nomenclatorial changes. It will be necessary, in some cases, especially with fungi, to provide synonymy, anamorphs and teleomorphs (even sometimes suspected) in our annotations.

This project emerged from recognition of literature deficiencies while teaching various courses at Virginia Polytechnic Institute and State University (VPI & SU) such as Diseases of Field Crops, Clinical Plant Pathology, and Plant Disease Fungi; aiding in diagnosis of grass and cereal disease in the Plant Clinic; encountering new or unfamiliar diseases while carrying out research projects; a lack of recognition of the graminicolous fungi in the natural history of Virginia; and finally satisfying curiosity about the identity of graminicolous fungi encountered on various excursions. An annotated list of fungi associated with cereal grasses will be presented first.

THE CEREALS

The cereals cultivated in Virginia include oats, *Avena sativa* L.; barley, *Hordeum vulgare* L.; rye, *Secale cereale* L.; sorghum, *Sorghum bicolor* (L.) Moench.; wheat, *Triticum aestivum* L.; and corn or maize, *Zea mays* L. Varieties or subspecies of these species such as *Z. mays* subsp. *saccharata*, sweet corn; *Z. mays* subsp. *indentata*, dent corn; and *Z. mays* subsp. *everta*, popcorn, are grown in Virginia. A number of species of barley, oats, and wheat have been grown in experimental nurseries in Virginia but they have not been hosts to any unusual fungi; therefore, only the crop species cultivated in Virginia will be included in our lists.

THE FUNGI

Some fungi are plurivorous; some are specific. To conserve space, we will first list the plurivorous fungi of cereals; then we will list the fungi specific for each host species. Within each list, fungi will appear in taxonomic rank; an alphabetical summary will be provided.

A. Plurivorous fungi.

Myxomycota:

Polymyxa graminis Ledingham. This fungus colonizes roots of numerous grasses. It is economically important because it harbors and transmits the viruses causing wheat soil-borne mosaic (WSBMV), wheat spindle streak mosaic (WSSMV) and oat soil-borne mosaic (OSBMV) (Roane, 1960; Tolin & Roane, 1969). These virus diseases were known in Virginia many years before the fungus was associated with them. The fungus has been identified in roots of the following collected in 1981-82- 83: barley from Frederick, Northumberland, Nottoway, and Westmoreland Cos.; oats and rye from Richmond Co.; wheat from Caroline, Charles City, Dinwiddie, Essex, Gloucester, King and Queen, Richmond, and Westmoreland Cos. and the cities of Chesapeake, Virginia Beach, and Suffolk; corn

from Hanover, Richmond, and Sussex Cos. The two wheat viruses, WSBMV and WSSMV, are widespread in the Coastal Plain and Piedmont, and OSBMV is known from Charlotte, Richmond, and Mecklenberg Cos. Therefore, *P. graminis* must be widely distributed in the eastern half of Virginia. Its presence in barley, rye, and corn in the United States was first reported in 1983; its presence in oats in Virginia was also first reported in 1983 (Roane & Roane, 1983).

Mastigomycotina - Oomycetes:

Sclerophthora macrospora (Sacc.) Thirum., G. C. Shaw, and Naras. is widespread on grasses in the northern hemisphere. We have identified it from collections of the following: oats, from Henrico and Richmond Cos.; barley, Henrico; wheat, Henrico; corn, City of Suffolk (Nansemond Co.), and Wythe Co. The Henrico collections were from a single field of small grain "succotash" on the State Prison Farm (Roane & Fenne, 1955). In corn, the fungus causes "crazy top", a disease that was known for many years before the causal agent was determined (Ullstrup, 1952). The Suffolk collection came from a field at Chuckatuck having a mixture of corn and sorghum. Nearly all the corn had crazy top but no sorghum plants displayed symptoms although sorghum is a known host of the fungus (Roane, 1960). Although Farr et al. (1989) list it as occurring on rye in Virginia, we have not seen it.

Ascomycotina:

Claviceps purpurea (Fr.:Fr.) Tul., the cause of ergot, occurs on numerous grasses worldwide. In Virginia, even though it commonly occurs on rye, collections on rye have been made only from Accomack and Montgomery Cos.; on barley it occurred regularly on spring sown plants in a genetic study at Blacksburg, Montgomery Co. (1960-1968); we have a single specimen on wheat in the classroom collected from somewhere in Virginia. Ergot pseudosclerotia contain powerful toxins which cause a variety of symptoms in animals (Christensen et al., 1977). However, several useful drugs may be extracted from pseudosclerotia.

Cochliobolus sativus (Ito & Kuribayashi) Drechsl. ex Dastur, the teleomorph of *Bipolaris sorokiniana* (Sacc.) Shoemaker, better known in older literature as *Helminthosporium sativum* Pammel, King and Bakke, is found most often in Virginia as a defoliating fungus of barley. However, it has been collected from seedling blighted wheat in Virginia. The teleomorph may be produced in culture but is not found in nature.

Erysiphe graminis DC. (now *Blumeria graminis* (DC.) E. O. Speer), the powdery mildew fungus, occurs on numerous grasses worldwide. There are four *formae speciales*, *avenae*, *hordei*, *secalis*, and *tritici*, all of which occur in Virginia. Only f.sp. *avenae* is unusual in that it produces no cleistothecia. Powdery mildew occurs in most barley and wheat fields but it is less common on rye. We have a collection on rye only from Montgomery Co. Because it is so common, we have neglected to deposit it in our collection.

Gaeumannomyces graminis (Sacc.) Arx & D. Olivier, the cause of "take-all" of cereals and grasses, occurs sporadically throughout Virginia, primarily in wheat fields. It is well-known as a wheat pathogen in eastern United States and the VPI & SU Plant Clinic records document numerous occurrences on wheat. Although

it has not been reported on barley in Virginia previously, collections have been made from barley fields in Augusta in 1954, Montgomery Co. in 1956.

Gibberella zeae (Schwein.) Petch (anamorph, *Fusarium graminearum* Schwabe) is the cause of seedling blight, stalk and ear rot of corn, seedling blight and scab of small grains. The perithecia of the fungus occur in superficial clusters, giving the appearance that a scab has been formed. This fungus is broadly distributed (Anonymous, 1960; Farr et al., 1989); in Virginia, it occurs frequently causing head blight and scab of wheat, rye, and barley and occasionally a node rot of barley (Westmoreland Co., photographic record). Scab and head blight are more severe following corn in crop rotations or in fields adjacent to corn stalks and stubble from the previous summer. In corn, it is widespread as a cause of red stalk and ear rot, probably occurring to some degree in all corn fields. Perithecia commonly occur on overwintering corn stalks; *G. fujikuroi* (Sawada) Ito & K. Kimura also overwinters in this manner and is macroscopically identical to *G. zeae*. It produces 2-celled ascospores, but *G. zeae* produces 4-celled ascospores. Scabby grain may contain powerful toxins such as vomitoxin, T-2, and zearalenone, which cause various symptoms including poor weight gain in cattle and swine (Christensen et al., 1977). A destructive scab epidemic occurred in wheat and barley in Virginia in 1972 (Roane & Starling, 1976).

Pyrenophora tritici-repentis (Died.) Drechsl., anamorph, *Drechslera tritici-repentis* (Died.) Shoemaker, causes tan or yellow leaf spot of rye and wheat. The ascomycetous stage occurs on dead and fallen straws in late summer and overwinters there. Leaf spots have been collected from rye at three locations in Montgomery Co. On file are leaf collections from wheat in Montgomery and Dinwiddie Cos.; it has also been found on wheat from Charles City, Richmond, and Westmoreland Cos. (E. L. Stromberg, personal communication).

Basidiomycotina - Ustilaginales:

The smut fungi which occur regularly on small grains in Virginia have very confusing synonymy; we will follow the nomenclature given by Fischer in the "Manual of North America Smut Fungi" (1953).

Ustilago avenae (Pers.) Rostr. causes a black loose smut of oats and barley. The finely echinulate spores are borne superficially on the seed. Infection takes place during seed germination.

Ustilago nuda (Jens.) Rostr. causes brown loose smut of barley, rye, and wheat. Spores are finely echinulate; infection occurs during flowering and the embryo is colonized.

Ustilago hordei (Pers.) Lagerh. (Fischer, 1953) causes covered smut of oats and barley. Spores are smooth; they are surface-borne on the seed and infection occurs during seed germination. Farr et al. (1989) list this fungus as *U. segetum* (Bull.:Pers.) Roussel.

All three fungi have been found in Virginia on hosts noted above but *U. nuda* is of most common occurrence on wheat and barley.

Basidiomycotina - Uredinales:

Puccinia graminis Pers., the black stem rust fungus, occurs on barley, oats, rye, wheat, and several grasses in Virginia. It is more common in western Virginia where

native barberry, *Berberis canadensis* Mill., its aecial host, occurs (Harvill et al., 1986), but in some years it spreads into Virginia from outbreaks of rust on wheat in states south of Virginia. The fungus occurs as six *formae speciales* of which *avenae*, *secalis*, and *tritici* occur on oats, rye, and wheat, respectively. *Puccinia graminis* f.sp. *secalis* and *tritici* will infect and colonize barley but stem rust on barley is rare in Virginia. Formerly, wheat and oats were widely grown in southwest Virginia; there, barberry was virtually eliminated from grain producing areas by 1975. Now, however, grain is produced mainly in the Piedmont and Coastal Plain. As a result, there are few recent reports of cereal stem rust in Virginia and, consequently, the barberry eradication project has been discontinued.

Deuteromycotina - Hyphomycetes:

Several fungi colonize senescent plant parts of all cereals under consideration here. They are generally saprophytes and are usually found together as co-colonizers. These include *Alternaria alternata* (Fr.) Keissl., *Cladosporium herbarum* (Pers.:Fr.) Link., *Epicoccum nigrum* Link, and *Heterosporium avenae* Oudem. These fungi have either dark colored spores or hyphae (or both); hence, their colonies are described as "sooty molds". Other dark colored species may on occasions be co-colonizers but these are found most commonly.

Aspergillus candidus Link, *A. flavus* Link:Fr., *A glaucus* Link:Fr., and *A. niger* Tiegh. are listed by Farr et al. (1989) to occur in Virginia on corn and wheat, probably in storage. All species commonly invade corn ears, kernels and sometimes cause seed rot in soil. Frequently, *A. flavus* occurs on corn in the field and is a rapid colonizer of exposed moist endosperm; therefore, harvested grain must be dried quickly. This fungus is feared because it produces aflatoxins which are carcinogenic mycotoxins; thus, it frequently is a cause of rejection by grain buyers (Christensen et al., 1977). We encounter these *Aspergillus* species in plating and germination experiments with corn and wheat.

Hymenula cerealis Ell. and Everh. (= *Cephalosporium gramineum* Nisikado and Ikata) was first found in the western states and recognized as *C. gramineum*; hence, the disease associated with it became "Cephalosporium" stripe. Cephalosporium stripe on wheat was found in 1975 (Roane & Starling, 1976) and again in 1979 (Jones et al., 1980) in Montgomery and Augusta Cos., respectively. We found it on rye in 1977 and 1979 in Montgomery Co. (Jones et al., 1980). These are the only reports of this disease from Virginia and surrounding states.

Rhynchosporium secalis (Oudem.) J. J. Davis causes scald of barley and rye. It is common on barley in Virginia but since it is sometimes controlled by growing resistant cultivars, seed treatment and crop rotation, it is not present in all fields. On rye we have collected it in Montgomery and Accomack Cos. from Experiment Station plantings.

Deuteromycotina - Coelomycetes:

Ascochyta spp. are pycnidiate fungi found on many grasses.

Ascochyta brachypodii (Sydow) Sprague and A. G. Johnson has broader spores than those of *A. sorghi*. It was collected on oat leaves from Richmond Co. in 1983 and on barley leaves from Northumberland Co. in 1992. Spores measured 18-20 X 4-5 μm. Those of *A. sorghi* are 11-21 X 1.6-4.0 μm, characteristically less than 4.0

μm wide (Sprague, 1950). Farr et al. (1989) do not list barley as a host. These are new records for *A. brachypodii* in the eastern United States.

Ascochyta hordei K. Hara produces pale yellow 1-septate spores sometimes constricted at the septum, 15-27 X 4.5-7.1 μm (mostly 20 X 5 μm). We have found it on wheat from Amelia, Montgomery, Northumberland, and Westmoreland Cos.; on barley from Amelia, Essex, King William, and Northumberland Cos., and in Montgomery Co. at several locations; and on rye from Cumberland Co. These are first reports of *A. hordei* in Virginia.

Ascochyta sorghi Sacc. produces hyaline spores 11-21 X 1.6-4.0 μm; widths are mostly 2.5-4.0 μm. Sprague and Johnson (1950) combined *A. graminicola* with *A. sorghi*. We have found *A. sorghi* on barley from Amelia Co. and from several locations in Montgomery Co.; on rye from Cumberland Co.; and on wheat from Caroline, Charles City, Montgomery, and Pittsylvania Cos. The Montgomery collection of 1973 was the first identified from wheat in eastern United States (Roane et al., 1974).

Colletotrichum graminicola (Ces.) G. W. Wils. is characterized by setose acervuli and falcate spores. It causes anthracnose and occurs on many grasses statewide, usually as a saprophyte but often as a pathogen. It occurs on all of the cereal grasses grown in Virginia. A collection on barley has been made from Montgomery Co.; on oats from Montgomery, Pulaski, and Rockingham Cos.; on rye from Isle of Wight Co.; on wheat from Goochland Co.; and on corn at several locations in Lancaster, Montgomery, Northumberland, and Richmond Cos. The fungus often produces lesions on corn seedling leaves but not on the upper leaves during the period of rapid growth. Later, it reappears on senescing leaves and stalks, sometimes causing premature dying and breakage. A 10-acre spring-sown field of oats at Belspring in Pulaski Co. was observed to have anthracnose on 100 percent of the plants examined at the milk to soft dough stage of grain development. Later the oats were completely lodged; the grain was of no value. This was the most damaging incident of anthracnose ever observed on a small grain crop in Virginia.

The reports above suggest that anthracnose is of spotty occurrence. Most likely, it could be found in all grain fields if a search were made.

Deuteromycetes - Other:

Rhizoctonia solani Kuehn - Three species of *Rhizoctonia* are listed by Farr et al. (1989) as occurring on grasses. Each has a distinct teleomorph. However, without applying intricate techniques, it is difficult to tell from an anamorph which species one has encountered. Therefore, *R. cerealis* Van der Hoeven, *R. solani* and *R. zeae* Voorhees will be lumped together under *R. solani*, the oldest of the three binomials. The teleomorph is *Thanatephorus cucumeris* (A. B. Frank) Donk. *Rhizoctonia* spp. cause root rots and the sharp eyespot of grasses. Sharp eyespot was first found on barley in 1957 (Roane & Starling, 1958); since then we have found *R. solani* causing sharp eyespot of barley in yield trial nurseries in Accomack, Augusta, Charlotte, Chesterfield, Montgomery, Orange and Richmond Cos. and the City of Suffolk (formerly Nansemond Co.). It has been detected in numerous commercial barley fields but no records for them are available. Sharp eyespot is frequently detected when small patches of barley plants have "whiteheads" as a result of Rhizoctonia infection. Sharp eyespot has been found on oats in

Montgomery Co. and on wheat in nurseries at locations listed above for barley and on commercial wheat from Essex Co. In 1994, wheat specimens with sharp eyespot were received by the Plant Clinic from Chesapeake, Dinwiddie, and Westmoreland Cos. In the past, it has been most prevalent as a barley disease in Virginia. Our report of 1958 (Roane & Starling) was the first to indicate sharp eyespot occurred east of the Mississippi River.

B. Fungi specific on host species.

Avena sativa L. - oats

Mastigomycotina:

Pythium graminicola Subramanian - Sprague (1950) is erroneously cited by Farr et al. (1989) as having reported this fungus from Virginia. Although the fungus is widespread, we cannot verify this report.

Ascomycotina:

Claviceps purpurea (Fr:Fr) Tul. occurs in the Eastern States (Farr et al., 1989) but there is no record of its occurrence on oats in Virginia.

Cochliobolus victoriae R. R. Nelson, anamorph, *Bipolaris victoriae* (Meehan and Murphy) Shoemaker was common on oats in Virginia from 1950 until the early 1960's when resistant oat varieties replaced susceptible ones. No victoria blight has been observed on oats in Virginia since 1965. The teleomorph apparently does not occur in nature but may be produced in the laboratory by pairing compatible cultures.

Phaeosphaeria avenaria (G. F. Weber) O. Eriksson, most often recognized by its anamorph, *Septoria avenae* Frank, is listed by Farr et al. (1989) as being in this region. We have been unable to locate it; therefore, it is of questionable occurrence in Virginia.

Pyrenophora avenae Ito and Kuribayashi is better known in its anamorphic stage, *Drechslera avenae* (Eidam) Scharif, formerly *Helminthosporium avenae* Eidam, as the cause of oat leaf blotch, the commonest leaf disease of oats in Virginia. Collections are on file from Bedford and Montgomery Cos. Perithecia form on overwintering straw.

Basidiomycotina:

Puccinia coronata Corda, the crown rust fungus, gets its name from the teliospores which are adorned by projections suggesting a small crown. Although we have no collections of the fungus on oats, it is well known in Virginia. The aecial hosts in Virginia are buckthorns, *Rhammus caroliniana* Walt. and *R. cathartica* L.

Deuteromycotina - Hyphomycetes:

Bipolaris sorokiniana (Sacc.) Shoemaker the anamorph of *Cochliobolus sativus*, is listed by Farr et al. (1989) on oats from the eastern states. We have not collected it.

Fusarium avenaceum (Fr.:Fr.) Sacc. was isolated from oat roots collected from experimental nurseries in Montgomery Co. in 1949 (Roane, 1949).

Hordeum vulgare L. - barley

Ascomycotina:

Several common ascomycetous fungi on barley occur in Virginia only in hyphomycetous stages (anamorphs); their ascomycetous (teleomorphs) stages occur rarely in nature; therefore, they are described in most lists under Hyphomycetes. Most of those from Virginia were listed under plurivorous fungi.

Pyrenophora teres Drechsl., anamorph *Drechslera teres* (Sacc.) Shoemaker, is a seedborne fungus and, consequently, is widely distributed. It occurs to some degree on foliage in all barley fields in Virginia. The teleomorph occurs on oversummering and overwintering straw and is quite easy to find. Although there are numerous records of its occurrence on file at the VPI & SU Plant Clinic, and we have collected it frequently for classroom use, we have no accessions in our collection of Virginia graminicolous fungi.

Basidomycotina - Uredinales:

Puccinia hordei Otth is the only rust commonly found on barley in Virginia. Its appearance is predisposed by the distribution of susceptible cultivars; until recently, resistant cultivars were widely grown in Virginia. A new race has invalidated this resistance. The rust commonly occurring on wheat in Virginia, *P. recondita* Rob. ex Desmaz, is reported as occurring on barley in Virginia (Anonymous, 1960); however, we do not know the original source of that report nor have we ever found it. *Puccinia hordei* can produce its spermagonial and aecial stages (O, I) on *Ornithogalum umbellatum* L., star of Bethlehem, which is widely scattered in the State but we have been unable to find these stages on naturally occurring *O. umbellatum*, even where the rust occurred on barley in adjacent fields (Roane & Starling, 1958). We have produced these stages by overlaying a bed of *O. umbellatum* with straw bearing telia of *P. hordei*. Collections of stages II and III are on file from Northumberland and Montgomery Cos.

Basidiomycotina - Ustilaginales:

Although the following *Ustilago* species were listed under plurivorous fungi, further comment is warranted here. *Ustilago nuda* (Jensen) Rostr. - Three barley head smut fungi have occurred in Virginia, of which *U. nuda*, causing brown loose or deep loose smut, is the most common. This is a "flower infecting" smut which survives as dormant mycelium in infected embryos. It has been controlled through use of hot water seed treatments and chemical seed dressings which are absorbed by germinating seeds and which thereafter function as systemic fungicides to inhibit the further development of the mycelium in the embryo.

The other smut fungi, *U. avenae* (Pers.) Rostr., causing semi-loose or black loose smut and *U. hordei* (Pers.) Lagerh., causing covered smut, are "seedling infecting" fungi. Their spores are killed or infection is inhibited more easily by chemical seed dressings than are those of *U. nuda*. Seedsmen devote much effort to the control of smuts in seed stocks.

Deuteromycotina - Hyphomycetes:

Drechslera graminea (Rabenh.) Shoemaker causes barley stripe. This disease is seedborne and therefore is controlled by fungicidal seed dressings. It occurs

when control measures are not implemented and can destroy 50% or more of the plants from a given seed lot. It occurs sporadically throughout barley producing areas of Virginia.

Deuteromycotina - Coelomycetes:

Septoria passerinii Sacc. causes leaf blotch and is widespread in Virginia. We have collections from five experiment station test locations around the State and specimens are frequently submitted to the VPI & SU Plant Clinic for diagnosis. The morphology is similar to that of *S. nodorum* (Berk.) Berk., which is very common on wheat in Virginia.

Secale cereale L. - rye.

Most fungi we have encountered on rye are plurivorous and have been listed previously. Only four additional fungi need be annotated.

Basidiomycotina - Ustilaginales:

Urocystis occulta (Wallr.) Rabenh. ex. Fuckel, the cause of flag smut, is reported by Farr et al. (1989) as occurring in Virginia. We are unable to find the source of this report. We presume that it is from records kept by F. D. Fromme, James Godkin or S. A. Wingard in the 1915-1940 era. It has not been seen in Virginia for several decades.

Basidiomycotina - Uredinales:

Puccinia recondita Roberge ex Desmaz. occurs on rye throughout Virginia. It is less damaging on rye than on wheat; see under wheat.

Deuteromycetes - Coelomycetes:

Dinemasporium strigosum (Pers. ex Fr.) Sacc. is reported by Farr et al. (1989) to occur on rye throughout its range. Although we have found it on other grasses in Virginia we have not encountered it on rye.

Septoria secalis Prill. & Delacr., the cause of rye leaf blotch, is reported by Farr et al. (1989) to have occurred in Virginia. That report traces to Sprague (1950). We have not found the fungus.

Sorghum bicolor (L.) Moench. - grain sorghum.

In Virginia, the acreage of sorghum is relatively small. Like corn, barley, and oats, it is a feed grain in this state. Very few observations have been made on sorghum diseases; most of our records pertain to fungi on sudangrass (*S. vulgare* var. *sudanense* (Piper) Hitchc. and Johnsongrass (*S. halepense* (L.) Pers.). These will be covered in a later paper.

Ascomycotina:

Gibberella fujikuroi (Sawada) Ito & K. Kimura, although a plurivorous grass fungus, is a common cause of sorghum head blight in eastern Virginia. The anamorph, *Fusarium moniliforme* Sheldon, is very conspicuous and is the stage usually seen. We have collected classroom material at the Experiment Station in Holland.

Basidiomycotina - Ustilaginales:

Sporisorium sorghi Link in Willd. causes covered kernel smut. The fungus is seed-borne and hence would be introduced in Virginia on seed stocks. Since the fungus can be eliminated from seeds by fungicides, it has not appeared in recent years. We have only one record of its occurrence, circa 1959, in Montgomery Co. It probably was of common occurrence before 1940.

Basidiomycotina - Uredinales:

Puccinia purpurea Cke. occurs commonly in the southeastern states, and occasionally spores blow northward into eastern Virginia causing isolated outbreaks. Although we observed and identified the fungus from urediniospores on sorghum in test plots at Holland, Va. (Nansemond Co. = City of Suffolk), no herbarium specimens are on file.

Deuteromycotina - Hyphomycetes:

Cercospora sorghi Ellis & Everh. causes gray leaf spot of *Sorghum* spp. Farr et al. (1989) list it from Virginia but we have no collections of it.

Cladosporium herbarum (Pers.:Fr.) Link, leaf mold, and the head blight fungi *Fusarium acuminatum* Ellis & Everh., *F. culmorum* (Wm. G. Sm.) Sacc., *F. equiseti* (Corda) Sacc., and *F. oxysporum* Schlecht.:Fr. are listed by Farr et al. (1989) to occur in the "range of the host", thus, including Virginia. We have no records of their occurrence.

Deuteromycotinia - Coelomycetes:

Macrophomina phaseolina Tassi, the cause of charcoal rot, according to the Agricultural Handbook 165 (Anonymous, 1960), occurs from Maryland to Georgia; however, we have no records of its presence.

Triticum aestivum L. - common wheat

Formerly an important crop in western Virginia, especially the Shenandoah Valley, wheat is now concentrated in the Coastal Plain and Piedmont.

Zygomycotina:

Rhizopus stolonifer (Ehrenb.:Fr.) Vuill., frequently emerges from wheat seeds plated on agar. Farr et al. (1989) call it a "range of host" fungus. It is a plurivorous fungus we have only found associated with wheat and corn seed.

Basidiomycotina - Ustilaginales:

Tilletia caries (DC.) Tul. & C. Tul. and *T. laevis* Kühn in Rabenh., the smooth and spiny-spored bunt fungi, have both occurred throughout Virginia. They were common in wheat until the 1930's when effective seed-treatment fungicides and seed certification programs virtually eliminated them. No recent collections have been made.

Basidiomycotina - Uredinales:

Puccinia recondita Roberge ex Desmaz. is the leaf rust fungus and is common on wheat in Virginia; however, its prevalence may be diminished by production of resistant cultivars. These cultivars usually succumb to rust after a few years of production as virulent races evolve or spread into a region. The spermagonial and

aecial stages occur on several *Thalictrum* spp. which occur in Virginia but apparently, these meadowrue species do not function as aecial hosts in this region.

Deuteromycotina - Hyphomycetes:

Tetraploa ellisii Cooke in Cooke & Ellis, has been observed on wheat leaves from Dinwiddie Co. Spores of *T. ellisii* appeared while leaves were being incubated to induce sporulation of *Pyrenophora tritici-repentis*.

Deuteromycotina - Coelomycetes:

Ascochyta graminea (Sacc.) Sprague & Johnson has been collected from Caroline Co. and two locations in Westmoreland Co. Spores were 14-20 *X* 4.5-6.0 μm in all collections. Specimens were collected in February, March and early April from overwintered leaves and early spring growth suggesting that the fungus is active in winter. These are new records.

Dilophospora alopecuri (Fr.) Fr. causes twist of grasses. The disease occurred frequently in wheat when the gall nematode *Anguina tritici* (Steinbuch) Filip. was rampant in Virginia, although no biologic relation between the twist fungus and nematodes has been established. Since the 1930's when the nematode was brought under control, it has disappeared from wheat, probably due to improvement of wheat culture. We last collected it in 1959 from Pittsylvania Co., where 70% of the plants had twist.

Septoria tritici Roberge in Desmaz., causes speckled leaf blotch of wheat. It is more common in the Midwest than in Virginia. We have collections from Montgomery and Northumberland Cos.

Stagonospora nodorum (Berk.) Castellani & Germano (known previously as *Septoria nodorum* (Berk.) Berk.) is the most common leaf spotting fungus of wheat in Virginia. It also infects the glumes and nodes; the disease whether on leaves or glumes is called glume blotch. It occurs throughout the state.

Zea mays L. - corn or maize, including dent, pop and sweet corn.

Myxomycota:

Polymyxa graminis Ledingham was listed on corn under plurivorous fungi. However, since there is only an abstract (Roane & Roane, 1983) reporting its presence in corn roots, we reiterate that we identified it in roots from Hanover, Richmond and Sussex Cos. No doubt, it can be found wherever "soil-borne" wheat and oat viruses are present as *P. graminis* is the transmitting agent for them. This includes most of the Coastal Plain and much of the Piedmont.

Mastigomycotina:

Physoderma maydis (Miyabe) Miyabe, the cause of brown spot, occurs from Virginia southward. In Virginia, it occurs primarily in southeastern counties; we have collections from that area in class material.

Pythium aphanidermatum (Edson) Fitzp. has been identified from stalks with a watery soft rot collected in Chesterfield, Mathews, Nelson, and Northampton Cos. between 1941 and 1955.

Zygomycotina:

Absidia sp., *Mucor* sp., *Rhizopus stolonifer* (Ehrenb.:Fr.) Vuill. and *Rhizopus* sp. are listed by Farr et al. (1989) as having been isolated from Virginia corn samples. We have isolated these and *Cunninghamella* sp. (Roane, 1950) at various times during experimental studies of corn seed microflora. *Mucor* and *Rhizopus* are usually found associated with untreated corn seeds and may sometimes interfere with germination.

Ascomycotina:

Chaetomium spp. have been observed on corn seed in agar plating experiments. These fungi are commonly associated with corn (Farr et al., 1989).

Cochliobolus carbonum R. R. Nelson is found on corn leaves, ears and sometimes roots in its anamorphic stage, *Bipolaris zeicola* (G. L. Stout) Shoemaker (= *Helminthosporium carbonum* Ullstrup). It is unusual in that race 1 produces a toxin that severely damages inbred maize lines of the *hm hm* genotype. All above ground parts are affected. The specific epithet was suggested by the charcoal-black kernels produced by ear infections. Although races 2 and 3 also cause kernel blackening, the symptoms are usually restricted to ear-tip kernels. Spots caused by race 1 are circular, whereas those caused by 2 & 3 are elongate and narrow. Races 2 & 3 are widespread in Virginia but more commonly found in the western parts.

Cochliobolus heterostrophus (Drechs.) Drechs. is the teleomorph of *Bipolaris maydis* (Nisik. & Miyake) Shoemaker, a common leaf spotting fungus of corn in southeastern Virginia. In some years it occurs on corn throughout the State. When the fungus was known as *Helminthosporium maydis* Misik. & Miyake, in 1970 it spread from corn in Florida northward into the corn belt states with devastating fury and caused a 15% loss of the national corn crop (Anonymous, 1972, p. 7). This outbreak was predicted by the discovery in 1962 that corn having a cytoplasmic gene that induced male sterility and which facilitated making hybrid corn seed without the arduous task of detasseling was very susceptible to *H. maydis* in the Philippines (Anonymous, 1972, p. 12). Since the sterility gene had been discovered in Texas, it was designated *Tms* (Anonymous, 1972, p. 10). A race of *H. maydis* evolved in the United States that could make a toxin, especially in corn of *Tms* origin. The latter fungus was called *H. maydis* T, to distinguish it from an older race known as *H. maydis* O. Breeders quickly abandoned *Tms* and reverted to detasseling; *H. maydis* T caused little damage in 1971 and virtually none since. Although *H. maydis* T may be isolated today, *H. maydis* O predominates the population. The teleomorph occurs only rarely in nature; it was collected from several plants at the Tidewater Research Station, Holland, in 1949 (Roane, 1950).

Gibberella fujikuroi (Sawada) Ito in Ito & Kimura occurs commonly on fallen, weathered corn stalks throughout Virginia. Farr et al. (1989) list only its anamorph, *Fusarium moniliforme* Sheldon, in their host-fungus list of maize pathogens (p. 431), but in the fungus list (p. 714) acknowledge *G. fujikuroi* as a maize pathogen. It should be the other way around. When hybrid corn varieties were first introduced into Virginia, farmers in the southeastern quarter endured severe stalk breakage epidemics when G. *fujikuroi* rotted out the nodal tissue, then covered the nodes with pink mycelium and spores of the *F. moniliforme* stage (Roane, 1950). The susceptible hybrids were soon discarded in favor of stalk-rot-resistant ones.

Presently, in Virginia, *G. fujikuroi* is a common kernel infecting fungus but it does not cause much stalk rot in commercial corn production.

Massarina arundinacea (Sow.) Leuchtmann, synonym *Leptosphaeria arundinacea* (Sow.:Fr.) Sacc. occurs on one-year-old corn stalks in Montgomery Co. Collections were first made in 1950 from year-old fallen stalks of open-pollinated corn. Fallen hybrid stalks are not as durable as were fallen open-pollination stalks; thus, the fungus has not been found recently. Our original collection was identified by W. W. Diehl, U.S.D.A., Beltsville, Md.

Mycosphaerella zeae (Sacc.) Woronow, = *M. zeicola* Stout, was found on corn leaves in Richmond (1951) and Tazewell (1955) Cos. The fungus developed on leaves having severe phosphorus deficiency symptoms possibly resulting from low soil pH. The fungus was common but not of economic importance.

Odontotrema sp. is listed by Farr et al. (1989) as occurring on corn in Virginia but we could not find the origin of this report. Clements and Shear (1931) illustrate *O. hemisphaericum* (Fr.) Rehm but give no clue as to its habitat.

Setosphaeria turcica (Luttrell) Leonard & Suggs, anamorph *Exserohilum turcicum* (Pass.) Leonard & Suggs (synonym, *Helminthosporium turcicum* Pass.), occurs in the field only in the anamorphic stages. It causes northern leaf blight of corn (a strange common name since it occurs in Central America and other areas of the Tropics) and is common throughout Virginia. Its prevalence and severity are conditioned by the relative susceptibility of hybrid varieties currently in production.

Basidiomycotina - Uredinales:

Puccinia polysora Underw., the southern corn rust fungus, occurs sporadically in Virginia when spores from the South are blown northward. A statewide incidence was observed in 1980; a collection was obtained from Northumberland Co.

Puccinia sorghi Schwein. occurs annually on all types of corn throughout Virginia. It is rarely of economic importance except on late-planted sweet corn which it can defoliate, thereby reducing the quantity and quality of ears. We have collections only from Montgomery Co. The aecial hosts are *Oxalis* spp. which occur in Virginia but we have no records of aecia in the State. The fungus does not parasitize *Sorghum* spp. as the binomial would suggest.

Basidiomycotina - Ustilaginales

Ustilago zeae (Beckm.) Unger, common or boil smut, occurs on all types of corn throughout Virginia. Young galls are edible and American Indians consumed them; they also used black mature galls to make face paints worn during various ceremonies. We have various collections preserved for classroom use.

Deuteromycotina - Hyphomycetes:

Acremonium strictum W. Gams, formerly *Cephalosporium acremonium* Auct. non Corda, causes black bundle disease and Cephalosporium kernel rot of corn. On kernels, very fine parallel stripes may indicate its presence. It is readily isolated from corn samples taken throughout the State. Its presence was first noted in 1950 (Roane, 1950).

Alternaria spp. commonly colonize dead tissues of corn plants. Most probably *A. alternata* (Fr.:Fr.) Keissl. (= *A. tenuis*) is among those present.

Aspergillus spp. are widely distributed and are common contaminants of grain products. Farr et al. (1989) list the following as occurring in Virginia: *Aspergillus candidus* Link, *A. flavus* Link:Fr., *A. glaucus* Link:Fr., *A. niger* Tiegh., *A. ochraceus* K. Wilh., *A. parasiticus* Speare, *A. restrictus* G. Sm. and *A. tamarii* Kita. See plurivorous species for comments.

Aureobasidium zeae (Narita & Hiratsuka) Dingley (synonym, *Kabatiella zeae* Narita & Hiratsuka), causes eye-spot disease of corn. We collected it in Montgomery and Orange Cos. in fall of 1984.

Botrytis cinerea Pers.:Fr. causes ear and seed rot of corn. It has been isolated from kernels of various origin in Virginia (Roane, 1950).

Cercospora sorghi Ellis & Everh. is listed by Farr et al. (1989) as occurring on corn in Virginia. We have found it only on *Sorghum* spp.

C. zeae-maydis Tehon & Daniels, the cause of gray leaf spot, was first observed in Virginia in Montgomery Co. in 1949 (Roane, 1950). With the production of so-called "no-till" corn, in which the crop residue is left on the soil surface, gray leaf spot has become a major disease of corn production in the United States. At present, it is widespread in Virginia.

Chalara sp. is listed by Farr et al. (1989) as occurring on corn in Virginia. That report is attributed to C. L. Porter (1927) who isolated the fungus from nodal tissue.

Nigrospora sphaerica (Sacc.) Mason, causes ear rot of corn and is widely distributed but of sporadic occurrence. It is often isolated from grain samples. Gray cob rot is caused by this fungus.

Penicillium spp. cause blue mold, blue-eye, and green molds of corn ears. *Penicillium chrysogenum* Thom, *P. expansum* Link, and *P. oxalicum* Currie & Thom. are verified as occurring in Virginia. Farr et al. (1989) list 30 species (probably isolated from kernels or meal) associated with corn. Hence our list is very minimal. *Penicillium* spp. are among the earliest colonizers of fallen ears.

Periconia spp. are associated with roots and kernels of corn. We have encountered *Periconia* only twice but did not determine the species. Both materials were from Hanover Co. in 1983. Farr et al. (1989) list only *P. circinata* (Mangin) acc. as associated with corn root rot.

Spegazzinia tessarthra (Berk. & Curtis) Sacc. produces small black colonies with tiny spores. It is reported by Farr et al. (1989) to occur in Virginia; we could not find the origin of the report.

Stachylidium bicolor Link:Fr., has been found on prop roots of corn from Hanover Co. in 1981. This is a new report for this fungus in Virginia.

Trichoderma viride Pers.:Fr. causes a green ear rot and is widespread but common on ears from upright plants; it is a frequent colonizer of fallen ears. We have isolated it from many sources. Numerous ears of hybrid Va. 556 from Botetourt Co. were colonized by *T. viride* in 1960.

Trichothecium roseum (Pers.:Fr.) Link is listed by Farr et al. (1989) as occurring in Virginia. The report is attributed to Porter (1927) who isolated it from nodal tissue of stalks; however, he did not specifically identify the state from which the fungus was collected.

Deuteromycotina - Coelomycetes:

Dinemasporium strigosum (Pers.:Fr.) Sacc. [synonym, *D. graminum* (Lib.) Lév.]

was collected on one-year-old stalks in Montgomery Co., July, 1957. Undoubtedly, it is a saprophyte. Neither *D. strigosum* nor its teleomorph, *Phomatospora dinemasporium* Webster, are listed by Farr et al. (1989) as occurring on maize.

Diplodia maydis (Berk.) Sacc. causes ear and stalk rot and is widespread in Virginia. The taxonomy of this fungus is confusing. Its older name was *D. zeae* (Schwein.) Lév.; Sutton (1980) places *D. zeae* in the taxon *Stenocarpella maydis* (Berk.) Sutton but does not mention *D. maydis* as a separate taxon or synonym. The treatment of *Diplodia* and *Stenocarpella* requires additional consideration by mycotaxonomists. Spores of *D. maydis* are 25-30 *X* 6 μm.

Diplodia macrospora Earle [*Stenocarpella macrospora* (Earle) Sutton] has been found by us on a single ear collected at Holland circa 1952 (when Suffolk was Nansemond Co.). The ear is in our classroom collection. Spores from this specimen measure 65-82 *X* 6-8 μm, much longer than those of *D. maydis*.

Phyllosticta sorghina Sacc. was collected on leaves from corn growing at Warsaw, Richmond Co., Aug., 1951. Spore dimensions were 2.5 *X* 5.0 μm, different from other species known on corn.

Deuteromycotina - other:

Sclerotium rolfsii Sacc., the cause of southern blight of many plants, is listed by Farr et al. (1989) on corn in Virginia. The origin of the report is not known. We have not collected this fungus on corn.

SUMMARY

The fungi annotated in the text are listed alphabetically below. Their hosts are signified by the first letters of the common names of the hosts, i.e., B = barley, C = corn, O = oats, R = rye, S = sorghum, and W = wheat.

Absidia sp. - C
Acremonium strictum = *Cephalosporium acremonium* - C
Alternaria alternata - B C O R S W
Ascochyta brachypodii - B O
A. graminea - W
A. hordei - B R W
A. sorghi - B R W
Aspergillus candidus - C W
A. flavus - C W
A. glaucus - C W
A. niger - C W
A. ochraceus - C
A. parasiticus - C
A. restrictus - C
A. tamarii - C
Aureobasidium zeae = *Kabatiella zeae* - C
Botrytis cinerea - C
Cercospora sorghi - C S
C. zeae-maydis - C
Chaetomium spp. - C
Chalara sp. - C

Cladosporium herbarum - B C O R S W
Claviceps purpurea - B R W
Cochliobolus carbonum = *Bipolaris zeicola* - C
C. heterostrophus = *B. maydis* - C
C. sativus = *B. sorokinianum* - B W
C. victoriae = *B. victoriae* - O
Colletotrichum graminicola - B C O R W
Cunninghamella sp. - C
Dilophospora alopecuri - W
Dinemasporium strigosum - C R
Diplodia macrospora = *Stenocarpella macrospora* - C
D. maydis = *Stenocarpella maydis* - C
Dreschslera graminea - B
Epicoccum nigrum - B C O R S W
Erysiphe graminis - B O R W
Exserohilum turcicum - C
Fusarium acuminatum - S
F. avenaceum - O
F. culmorum - S
F. equiseti - S
F. oxysporum - S
Gaeumannomyces graminis - B W
Gibberella fujikuroi = *F. moniliforme* - C S
G. zeae = *F. graminearum* - B C R W
Heterosporium avenae - B C O R S W
Hymenula cerealis - R W
Macrophomina phaseolina - S
Massarina arundinacea - C
Mucor sp. - C
Mycosphaerella zeae - C
Nigrospora sphaerica - C
Odontotrema sp. - C
Penicillium chrysogenum - C
P. expansum - C
P. oxalicum - C
Periconia sp. - C
Phaeosphaeria avenaria - O(?)
Phyllosticta sorghina - C
Physoderma maydis - C
Polymyxa graminis - B C O R W
Puccinia coronata - O
P. graminis - B O R W
P. hordei - B
P. polysora - C
P. purpurea - S
P. recondita - W
P. sorghi - C

Pyrenophora avenae = *Drechslera avenae* - O
Pyrenophora teres = *D. teres* - B
Pyrenophora tritici-repentis = *D. tritici-repentis* - R W
Pythium aphanidermataum - C
Rhizoctonia solani = *Thanatephorus cucumeris* - B O W
Rhizopus stolonifer - C W
Rhynchosporium secalis - B R
Sclerophthora macrospora - B C O W
Sclerotium rolfsii - C
Septoria passerinii - B
S. secalis - R
S. tritici - W
Spegazzinia tessarthra - C
Sporosorium sorghi - S
Stachylidium bicolor - C
Stagonospora nodorum = *Septoria nodorum* - W
Tetraploa ellisii - W
Tilletia caries - W
T. laevis - W
Trichoderma viride - C
Trichothecium roseum - C
Urocystis occulta - R
Ustilago avenae - B O
U. hordei = *U. segetum* - B O
U. nuda - B R W
U. zeae - C

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