

A Survey of Peony Diseases in the Central and Eastern United States

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Research Results

Background

For the last 5 years, we have been researching botrytis gray mold on peonies. In addition to being a major production problem for peonies, *Botrytis* species are some of the most challenging pathogens to manage for greenhouse and field cut flower farmers all over the world. While conducting our field surveys for Botrytis gray mold throughout the Pacific Northwest (Alaska, Oregon, and Washington) of the United States, it became clear to us that peony growers were encountering diseases in their fields caused by a wide variety of pathogens other than *Botrytis*. Some of these pathogens had never before been reported formerly in the literature; therefore, information on how to identify these diseases on peony in the field was not available. Due to the lack of resources for growers, diseases were often misdiagnosed, which can have negative financial and crop health consequences if subsequent disease management decisions are not appropriate. With the help of funding through the ASCFG Research Foundation, we solicited samples from states in the Central and Eastern parts of the United States to determine which pathogens were most prevalent in peony fields in areas we had not yet explored in our research.

What We Did

Through combined efforts from growers and university extension specialists, we collected samples from 8 states during the 2016 growing season: Connecticut, Indiana, Massachusetts, Maryland, North Carolina, New York, Pennsylvania, and Virginia. The samples were sent to our lab at Washington State University and analyzed visually for the range of symptoms present on diseased tissues. Using standard laboratory fungal isolation techniques, we recov-

ered the pathogen from the tissue and grew it in culture. A combination of morphological and molecular identification was used to determine the identity of the putative causal organism of the symptoms we observed. If the pathogen had not before been reported in the state from which it was collected, we performed a procedure to re-infect a healthy peony plant with the pathogen to confirm its ability to cause disease. We also received one photo from a grower in South Carolina, but the sample did not require shipping for adequate identification of the diseases with which the peony was afflicted.

What We Found

Botrytis gray mold Not surprisingly, we received peonies that were infected with *Botrytis* species, the cause of Botrytis gray mold. Although we identified multiple other pathogens throughout the United States, the presence of *Botrytis* seems to be widespread throughout the country and the most common pathogen of peony. Samples of *Botrytis* were obtained from Maryland, Indiana, North Carolina, and New York. *Botrytis* causes brown, necrotic lesions on stems, foliage, and flowers, and is sometimes characterized by alternating light and dark brown “zonation,” or concentric circles. In humid or moist conditions, the lesions will often appear fuzzy and gray (hence the disease name “gray mold”); the fuzzy gray growth is comprised of the spores from the fungus which become airborne to initiate new infections on healthy tissue. Historically, two species of *Botrytis*, *B. cinerae* and *B. paeoniae*, have been associated with gray mold on peonies. However, our research has indicated that there is a much greater diversity of *Botrytis* species in the Pacific Northwest than previously reported. Additional sampling in the central and eastern portions of the United States would be necessary to determine the range of species diversity present in

these areas. We provided the ASCFG with additional photos of *Botrytis* gray mold on peonies that can be seen in the fall 2015 issue of *The Cut Flower Quarterly*.

Measles Another common fungal disease we identified was measles, caused by a fungus called *Graphiopsis chlorocephala*. Measles, also known as leaf blotch or *Cladosporium* leaf blotch (a name that reflects the old name of the fungus, *Cladosporium paeoniae*), causes reddish-purple to dark purple lesions on the stems, foliage, and flower buds that can range from small flecks to large expanding lesions. The underside of the large lesions is typically light brown. In some conditions, olive green spores within the lesions can be observed using a hand lens. Measles infections were identified from Indiana, Maryland, Pennsylvania, and Virginia.

Alternaria *Alternaria* fungi were frequently associated with diseased peony samples; however, the epidemiology is not well understood. Pathogenicity trials were not conducted due to current taxonomic uncertainties of these fungi. *Alternaria* species were often found in association with irregularly-shaped, uniformly tan brown spots on foliage with well-defined margins. Other reports of *Alternaria* have described the fungus causing reddish-purple, purple-brown, or brown to black. In 2016, *Alternaria* fungi were isolated from samples from Connecticut, North Carolina, and New York.

Anthracnose In our survey, Anthracnose diseases were found in peonies from Connecticut and Maryland. The cause of Anthracnose in these samples was found to be two species of a fungus called *Colletotrichum*. Anthracnose can cause lesions on foliage or cankers on stems. Lesions and cankers are dark purple, sometimes with an ashy gray center. Pink to salmon-colored spore masses, called acervuli, can also be observed in lesions or cankers under humid conditions.

Powdery mildew Powdery mildew is a fungal disease caused by multiple different species. Powdery mildew is often more prevalent in areas that experience drier conditions, as the spores of this fungus does not require moisture to germinate and infect healthy tissue. Powdery mildew was identified on samples from Indiana, Virginia, and New York. The name powdery mildew comes from the white fungal growth that appears on the surface of leaves when infected. In addition to the powdery growth, the tissue underneath can turn purple as a response to the wounding inflicted by the fungus. Later in the season, small, round orange (immature) or black (mature) structures called chasmothecia can be observed among the white fungal growth, often on the underside of the leaves. To the naked eye, the chasmothecia can look like sand grains, but can be observed a little more clearly with a hand lens. This fungus is considered an “obligate” parasite, which means that it requires living host tissue to survive; therefore, powdery mildews do not typically cause death of the host plant.

White stem rot Like powdery mildew, white stem rot gets its names from its obvious white growth that typically

can be observed on the base of the stems. The white stem rot fungus, *Sclerotinia sclerotiorum*, can also cause brown leaf spots on foliage that closely resemble *Botrytis* infections, but without the fuzzy gray growth. Infected stems often appear soggy light brown underneath the fungal growth and hard, black structures a few millimeters in length can develop along infected tissue in later stages of infection. White stem rot was found on samples collected from North Carolina and Maryland during our 2016 surveys.

Pilidium concavum *Pilidium concavum* was identified as the causal organism of foliar spots from a sample collected in Virginia during the 2016 season. We have collected this organism from several other states, including Washington, Oregon, and North Carolina during other surveys not associated with this project, all of which represent first reports of this pathogen on peonies in the United States. This fungus causes tan-brown lesions on foliage, often dotted with concentric rings of orange-brown (young) to black (old) spore masses. Infections not showing these spore masses are difficult to distinguish in the field from other fungal pathogens that cause tan foliar spots.

Botryosphaeria *Botryosphaeria* has been reported in China and Korea on tree peonies as the cause of cankers of woody stems. *Botryosphaeria* was isolated from foliage of an herbaceous peony from New York during our survey, which is a first report of this pathogen on peonies in the United States. The fungus was confirmed as a foliar pathogen of herbaceous peonies through trials conducted in our lab. The fungus produces a brown lesion, often with alternating light and dark concentric circles, similar in appearance to a lesion caused by *Botrytis*, but without prolific gray sporulation in humid conditions. The distribution and severity of this pathogen on herbaceous peonies is not known at this time.

Phoma Some species of the fungus *Phoma* have been reported from Asia on both tree and herbaceous peonies. In tree peonies, it can be the cause of cankers on woody stems. *Phoma* was isolated from stem cankers from an herbaceous peony from Massachusetts, the first report of this pathogen on peonies in the United States. Pathogenicity trials confirmed this fungus was able to cause brown, elongate stem lesions during tests in the lab. Like *Botryosphaeria*, the distribution and the severity of this pathogen on peonies is unknown at this time.

Tobacco rattle virus Tobacco rattle virus was visually identified from samples from South Carolina and New York and, according to additional surveys, appears to be a relatively widespread virus infection of peonies. Tobacco rattle virus has variable expression of symptoms, but typically appears as ringspots of alternating yellow and green or yellow banding or mottling on the leaf. In certain conditions, red to purple mottling or banding has been observed in association with viral infection. We reported more in-depth information about tobacco rattle virus in the fall 2016 issue of *The Cut Flower Quarterly*.

Overall, we found a wide variety of diseases during our 2016 surveys, some of which have been reported before in the state in which they were found, while others were new reports in the state or country. All first reports have been confirmed for pathogenicity and will be officially published in an academic journal. With the exception of *Botryosphaeria*, we have identified all of these diseases in our surveys across the Pacific Northwest as well, therefore, growers in these states can utilize the information contained in this report. The survey results reported here represent a small sampling and it's likely that additional surveys would yield further insight into the distribution and variety of pathogens on peony.

While there is still more to learn about the distribution of these pathogens, it is clear that some of the pathogens found in this survey have the ability to cause significant economic damage. Out of the diseases identified as a result of this project, *Botrytis* gray mold, measles, anthracnose, and red spot have all been observed to cause severe yield losses in fields that we have surveyed or have been identified by growers as major disease issues. More comprehensive surveys could help elucidate an understanding of the impact of these diseases on a nation-wide scale.

Photographs of all the diseases found in 2016 and discussed in this article are included to aid growers and diagnosticians with identification. Accurate diagnosis is the most important step in an effective disease management program, as each disease may require unique control strategies. Although these results, descriptions, and images should help growers with a baseline of what to look for in their fields, this is not an exhaustive list of all diseases of peony, merely the results of our one-year survey. Furthermore, depending on infection time, cultivar, and environmental conditions, disease expressions may appear different than the photos shown here. It is always recommended to consult an expert, such as a plant disease diagnostician, in your area to help with initial diagnosis if you are unsure. We did not provide management recommendations in this article, however, are in the process of using the information collected during this and other studies to develop a more comprehensive growers' guide that describes both management and additional information on the epidemiology of peony diseases.

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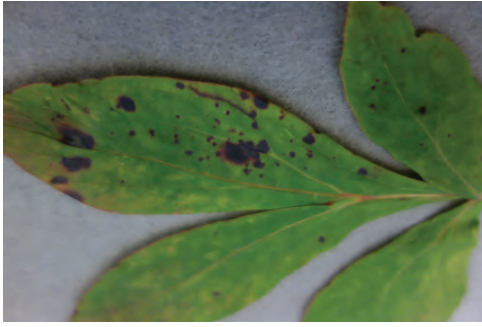
Anthracnose cankers from Maryland



Botryosphaeria lesion on a peony leaf tip from New York



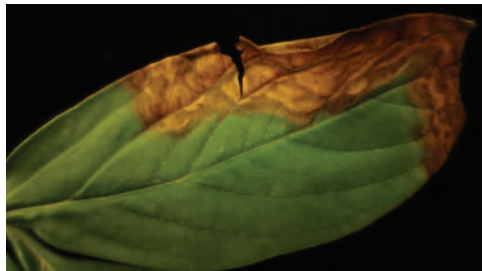
Botrytis blighted flowers from Maryland



Anthraxnose on leaf from Connecticut



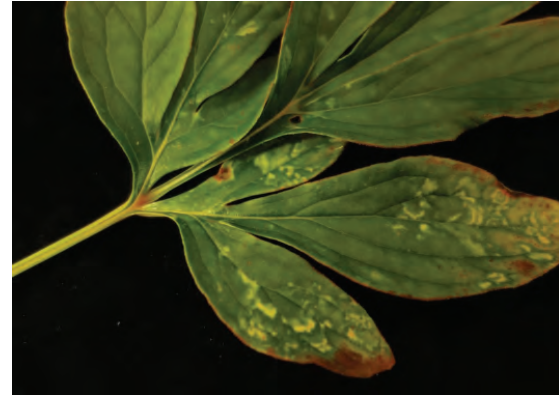
Pilidium concavum lesion with conidiomata from Virginia



Botrytis lesion on foliage from New York



Measles on stem and foliage from Maryland



Tobacco rattle virus from New York



Measles and powdery mildew on a leaf from Indiana



Phoma stem canker from Massachusetts



Measles and powdery mildew on a leaf from Virginia



White rot from North Carolina