

Burley and flue-cured tobacco- blue mold

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Introduction

Blue mold of commercial tobacco is caused by *Peronospora tabacina*, a fungus-like organism that is highly destructive to tobacco seed beds, transplants and production fields in the humid farming zones of the southeastern and eastern U.S., Canada, and countries bordering the Caribbean basin. The disease was first reported in the U.S. in 1921 in Florida and Georgia, and reappeared in the same region in 1931, spreading north into North Carolina, Virginia and Maryland; in subsequent years, it spread farther into the burley tobacco producing areas of Kentucky and Tennessee. In North Carolina, blue mold is introduced each year by windblown spores or from the importation of infected transplants from outside the region because the pathogen does not typically overwinter in this state.

Symptoms

In general, burley tobacco is much more susceptible to blue mold than flue-cured varieties. Once established, blue mold is fairly easy to identify, although symptoms vary with plant age. On beds of seedlings with leaves up to 4 cm in diameter, blue mold is first seen as circular, yellow areas of diseased seedlings. Plants in the center of the affected area may have distinctly cupped leaves. Some of these leaves should exhibit a gray or bluish downy mold on the lower surface; hence the name *blue mold*. The upper surfaces of infected leaves will remain almost normal in appearance for 1-2 days before the plants begin to die and turn light brown. Diseased leaves often become twisted so that the lower surfaces turn upward.

Blue mold can affect plants in the field throughout the growing season. Single or groups of yellow spots (lesions) appear on the older, shaded leaves (Figures 1 & 2). Often the spots grow together to form light brown, necrotic (dead) areas. Leaves become puckered and distorted, large portions disintegrate, and the entire leaf may fall apart (Figure 3). Under continuous favorable weather conditions, blue mold can destroy all leaves at any growth stage. Lesions may occur on buds, flowers, and capsules. In its early stages, blue mold can easily be confused with cold injury, malnutrition, or damping-off. However, the presence of the characteristic downy gray-blue spores on the bottom of leaves (Figure 4) quickly identifies the disease as blue mold and distinguishes it from other problems.

In severe situations, blue mold may also cause systemic stem infections, resulting in partial or overall stunting of the plant, with narrow, mottled leaves (Figure 5). Discoloration (brown streaks) can be found inside these stems. The plants often lodge or snap off if systemic infections occur near the base of weakened stems.

Causal Organism

Tobacco blue mold is a devastating downy mildew disease caused by the fungus-like organism *Peronospora tabacina*. *Nicotiana* species are the only known hosts. *P. tabacina* is an 'obligate parasite', which means that it requires a living host to grow. Although *P. tabacina* is an oomycete,

its sporangiospores (Figures 6 & 7) do not produce zoospores; infection occurs via direct germination of these sporangiospores.

Disease Cycle

The pathogen is not known to overwinter in the more temperate zones; it is assumed that inoculum is introduced each year into the U.S. Sporangiospores can be dispersed thousands of kilometers by weather events and are the primary source of inoculum for epidemics. Likely sources of yearly blue mold epidemics are windblown spores from tobacco crops in Mexico and the Caribbean that move northward, or from wild tobacco in the southwestern U.S. It is unclear whether the pathogen is capable of overwintering in infected debris and the role of oospores in disease is not clearly understood. Another common way blue mold spreads is by the distribution of infected transplants. In some cases, transplants that appear healthy may actually be infected. Farmers periodically buy transplants from distant growers and run the risk of buying diseased plants and introducing blue mold into their region.

Once blue mold is present, its development depends on weather conditions. Spores require wet leaves for germination and infection. Cloudy weather increases susceptibility, but sunlight is fatal to spores and stops the production of new spores. Therefore, blue mold is most severe and can develop rapidly during periods of cloudy, wet weather, but stops developing during sunny, dry weather. A 5- to 7-day, symptom-free incubation period takes place before the appearance of the first visible symptoms (yellow lesions). Incubation becomes longer with less than ideal conditions and with the age of the tobacco plants. The latent period for sporulation is generally 5-7 days. Sporulation can occur the day symptoms first appear, but it usually occurs the following night. Under favorable conditions, a second set of spores is usually produced 7-10 days after initial infection; without chemical control, this cycle may be repeated several times during the growing season, creating a much larger epidemic.

Diagnostic Methods

Blue mold is fairly easy to diagnose; detection is typically based on symptomology and presence of sporangiospores (Figures 6 & 7) on the underside of infected leaves. Although some molecular approaches have been developed that utilize *P. tabacina*-specific PCR primers, diagnostic laboratories do not currently employ these techniques.

Disease Management

Blue mold forecasts. The North American Plant Disease Forecast Center, located at NC State University, issues blue mold forecasts each Monday, Wednesday, and Friday, and more often if necessary, from March through August. The forecasts, plus additional information, are available on the World Wide Web at:

<http://www.ces.ncsu.edu/depts/pp/bluemold/>

or by calling toll-free at 1-800-662-7301 (press '2' for burley or '3' for flue-cured).

All blue mold collections in recent years have been resistant to Ridomil (mefenoxam). With the development of Ridomil-resistant strains, the disease has become more difficult to control. Some general strategies for blue mold control are:

- Manage your own crop as much as possible.
- Make the environment less favorable for the pathogen to survive and infect your tobacco.

- Keep the pathogen out of tobacco and the area for as long as possible.
- Protect tobacco plants with fungicides when they are most vulnerable. Ridomil will not control blue mold anymore; it is however of value for controlling *Pythium* diseases and black shank.
- Manage the crop to harvest quickly, but not prematurely.
- Don't forget about other diseases; Target spot is often misdiagnosed as blue mold.

Transplant production

To avoid introducing blue mold on infected transplants from out of state, growers should produce their own transplants or obtain them locally. If blue mold shows up in the beds or greenhouse, it is advisable to destroy the transplants rather than plant them. You can prevent blue mold by properly using protectant-type fungicides as outlined below.

The rate for Dithane DF Rainshield is less in greenhouse and float-bed systems because of possible injury of more tender plants produced in these systems. *Important:* Mix only 1 level teaspoon of Dithane DF Rainshield per gallon of spray, and apply every five to seven days. Apply 3 gallons of spray per 1,000 square feet on small (dime-size) plants, and increase to 6 to 12 gallons per 1,000 square feet as plants grow. *Note:* Forum, a new BASF product, is replacing Acrobat 50WP. Forum, Acrobat 50WP, and Actigard 50WG are strictly prohibited in all greenhouse and float-bed transplant systems for blue mold control.

Remember that many cultural and sanitation practices can prevent the establishment of blue mold or slow its spread during transplant production:

- Grow your own plants, or buy them from a reputable, local source.
- Don't seed any earlier than 7-9 weeks before transplanting.
- Manage temperature and ventilation systems to minimize leaf-surface moisture by reducing relative humidity and condensation.
- When blue mold advisories have been issued and weather permits, remove plant bed covers to aid drying of the foliage.
- Irrigate beds early in the day to allow drying before nightfall.
- Follow a recommended clipping schedule for greenhouse plants (remove clippings from trays and dispose of them far from transplants).
- Use a regular, preventative-fungicide spray program in greenhouses and plant beds.
- Promptly destroy ALL plants within the system, should blue mold occur in beds or greenhouses.
- Do not set ANY plants from blue mold infested sources.
- Destroy plant beds as soon after transplanting as possible. Conditions in an old plant bed are usually ideal for the disease and for spreading spores to the crop in the field.

Field production

When blue mold threatens, tank mixes of Acrobat 50WP and Dithane DF Rainshield should be applied weekly anytime between transplanting and topping. Acrobat 50WP is still on shelves but has been replaced with a liquid formulation of dimethomorph with the trade name of *Forum*. The labels require application of Acrobat 50WP or Forum only in tank mixtures. The current recommendation for tank mixing is Dithane DF Rainshield (mancozeb), which has a 24(c) registration in North Carolina. Actigard 50WP, metalaxyl, and mfenoxam are not suitable mixing partners with Acrobat 50WP due to different methods of application and label restrictions.

Actigard 50WG also is effective against blue mold and should be used preventively, but it may be applied with a low-pressure sprayer directed over top of the row. It has a narrow window of use, starting when flue-cured and burley varieties are 12 and 18 inches high (respectively), and up to

topping. Actigard 50WG may be phytotoxic on young tobacco, causing yellowing, stunting, and yield loss if applied when plants are younger than stated above. Actigard 50WG is a systemic product that induces the plant to resist blue mold *beginning four to five days following application*. The induced resistance will persist for approximately 10 days, and Actigard 50WG must then be reapplied to continue protection. Due to this delay in plant response, this chemical is not recommended as the first chemical application when blue mold is forecasted immediately in your area. Use the following guidelines for applying Acrobat 50WP and Actigard 50WG.

*When blue mold warnings are issued for your area, begin weekly sprays with tank mixes of Acrobat 50WP (or Forum) and Dithane DF Rainshield using rates in the table below. Apply 20 gallons of spray solution per acre within three weeks of transplanting, increasing the number of gallons per acre as plants grow, up to a maximum of 100 gallons of spray solution per acre (e.g. 40 gal of water/A near layby, 60 gal of water/A when plants are waist high, 80 gal of water/A when plants are chest high, and 100 gal of water/A when plants are shoulder high or near topping). Do not exceed 32 ounces per acre total for the season. Spray to obtain complete coverage, and before blue mold shows up in the field. Because thorough coverage is critical for control, application is allowed only with tractor-driven air-blast equipment, mist blowers, and some aerial equipment. Spray for maximum coverage by using a high-pressure sprayer (100-250 psi), with sprayer drops between rows, and hollow-cone nozzles. For small plantings of up to 1 acre, a backpack mist blower can be used effectively, provided care is taken to cover all plant surfaces with the spray. **Both top and bottom leaf surfaces MUST be well covered.***

Weeks of growth after transplant	Tank mix rate (ounces of product)		Spray volume for tractor-driven sprayer (gallons/acre)	Spray volume for backpack mist blowers (gallons/acre)
	Acrobat 50WP or Forum	Dithane DF Rainshield		
Recently transplanted to 3 weeks after transplanting	2	6	20	10
3-4 weeks (knee high)	3	12	40	20
4-5 weeks (waist high)	4	18	60	30
6-7 weeks (chest high)	6	24	80	40
7 weeks & beyond until topping (shoulder high)	7	30	100	50

As an alternative, Actigard 50WG may be used once flue-cured and burley varieties are 12 and 18 inches high (respectively). Make two over-the-row applications, 10 days apart, at 0.5 ounce of product per 20 gallons per acre. While other products are labeled for blue mold control, some are phytotoxic to burley, and some are not as effective as Acrobat or Actigard. **Note: Use only properly registered products. It is the user's responsibility to follow all usage directions on the pesticide label.**

Variety resistance. In general, burley tobacco is much more susceptible to blue mold than flue-cured varieties. Although there is no current source of blue mold resistance in flue-cured tobacco, the burley varieties NC 2000 and NC 2002 have shown good resistance to blue mold, however they have no resistance to black shank. Growers not equipped to spray with fungicides might consider growing these varieties, provided black shank is not present. All other commercial burley varieties are susceptible to blue mold, but some appear more tolerant than others.

Other precautions. Cultural and sanitation practices can prevent the establishment of blue mold or slow its spread:

- Avoid planting areas in the field that receive early morning or late afternoon shade. Blue mold will become established in shaded areas first. Once established in the shade, it will move into the rest of the field when weather conditions become more favorable. In addition, avoid shady, moist locations with poor drainage, for example: sites near streams.
- Avoid close plant spacing, both in the row and between rows. Close plant spacing contributes to shading, reduces air movement, and prolongs wetting of foliage, factors that favor disease development.
- Fertilization: avoid excess nitrogen fertilization.
- Topping and sucker control: early topping and improved sucker control slow disease progress.
- Do not harvest early if blue mold begins to develop late in the season. Top plants at the button stage and allow leaves to mature and gain weight normally. Topping slows development and further spread of the blue mold organism.
- **DO NOT WAIT UNTIL YOU SEE BLUE MOLD ON YOUR FARM BEFORE STARTING SPRAYS !!**

The information given herein is supplied with the understanding that no discrimination is intended and no endorsement by North Carolina Cooperative Extension Service is implied.

Figure 1.



Circular yellow spots develop on the topside of leaves infected with the blue mold pathogen.

Figure 2.



Groups of blue mold lesions appearing on an old burley leaf; often these spots eventually grow together.

Figure 3.



Heavily infected leaves become distorted and large portions will disintegrate.

Figure 4.



Characteristic downy gray-blue sporulation on bottom of infected leaf.

Figure 5.



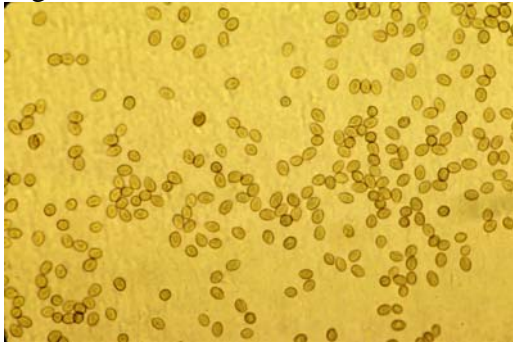
Burley plant with systemic blue mold infection.

Figure 6.



Sporangiophores bearing sporangiospores of *P. tabacina*.

Figure 7.



Sporangiospores of *P. tabacina*. Unlike other oomycetes, these spores do not contain zoospores.