Disease Identification and Management

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Principles of Disease Management

Fungi, bacteria, nematodes and viruses cause problematic diseases of dry edible bean. Diseases can reduce yield and quality and add to production costs. Disease management tools and strategies are available and can reduce the potential impact of diseases. This section describes the general principles of disease management, followed by discussion of the most problematic diseases in the North Dakota and Minnesota production regions. Figures 34 to 51 at the end of this publication provide photographs to identify anthracnose, rust and white mold (sclerotinia).

1. **Assess your greatest threats**

   Many pathogens can cause disease on dry bean. However, each disease is not a threat in every year and every location. Try to determine which pathogens are more likely to cause you problems.

Field history: If you consistently have problems with a specific disease on a specific field (for example, root rots) or have had a recent outbreak of a disease on your farm (for example, anthracnose or white mold), put greater emphasis on managing that disease when preparing for the season (for example, planting a resistant cultivar or budgeting for a fungicide).

Environment: Although climatic trends exist, nobody can predict the weather accurately and consistently in an upcoming growing season. However, assessing your local environmental conditions and responding appropriately to them is very important. For example, if rain and cool temperatures are forecasted as your beans begin to bloom, a foliar fungicide for white mold control may be very important. If heavy dews and fog occur frequently, you should look for rust and prepare to respond with a fungicide if it is found.

Adapt: Every year is different. If you have been dealing with white mold for three years and assess it to be your greatest threat, but you have record heat and a drought in your current growing season, re-assess your threats and react appropriately.

2. Keep pathogens and beans separated

Certified disease-free seed: Certified seed must meet certain quality standards with regard to seed-borne diseases. No seed is disease free; however, planting certified seed is the best way to minimize the introduction of bean pathogens on the seed.

Crop rotation and geographic separation: A crop rotation of three or four years is recommended, and longer rotations may be required if disease is severe in a field. Avoid planting next to last year's bean field if diseases were severe.

Avoid cultivating plants when wet: This helps prevent the spread of pathogens, especially those that cause bacterial blights and anthracnose.

3. Identify the disease or pathogen

This is the most important component of disease management.

Scout: You have no substitute for proper scouting (walking the fields).

Identify: Diseases and pathogens can be difficult to identify; however, accurate identification is critical for management. Take advantage of many knowledgeable Extension agents, the NDSU diagnostic lab, crop consultants or seed company agronomists. As an example of the importance of proper identification, if you misidentify halo blight (a bacterial disease) as rust (a fungal pathogen) and apply a fungicide to manage it, you will not manage the disease and will add significant production costs needlessly.

4. Strengthen the bean plant

Plant disease-resistant cultivars: Genetic resistance is a cost-effective way to manage diseases.

Manage fertility: Provide adequate soil fertility (based on soil test results) and adequate trace

minerals such as zinc. Avoid excess nitrogen levels that stimulate lush plant growth, which can enlarge the canopy and provide a microclimate conducive to disease development.

Control weeds: Weeds can be hosts to pathogens that cause disease on dry bean.

Control volunteers: Volunteer bean plants may harbor pathogens, which limits the effectiveness of your rotation to reduce inoculum and may facilitate race changes (for example, rust).

5. Attack the pathogen

Scout fields for disease: For many diseases, early detection is critical for effective management.

Foliar fungicide selection: Fungicides may aid in disease management by limiting new infections; however, fungicides are not all equally effective on all pathogens. Some fungicides are effective on rust but largely ineffective on white mold, and vice versa. Match the more effective fungicide with your target disease.

Foliar fungicides timing: The timing of an application is critical and different for every disease. For example, an application to manage white mold should occur at R1, while an application to manage rust should occur shortly after pustules are first identified.

Seed treatments: Fungicidal seed treatments may limit damping off and root rots and aid the establishment of a robust stand.

6. **Stay engaged and adapt**

   Important diseases, pathogen races, management tools and information strategies change constantly. Staying engaged will help you manage the most critical diseases with the most current and effective tools.

White Mold

White mold is a very troublesome disease affecting dry bean production in the Northarvest growing region. It can be especially devastating when wet weather occurs at flowering. Infected plant tissues will turn tan to dry-bone colored. The tissue may be covered with "white mold" and will shred toward the end of the season.

The fungus produces hard, black survival structures about the size of rat droppings, called sclerotia, after killing the plant tissues. These sclerotia allow the fungus to survive in the soil. Some sclerotia will germinate during the following season, but a number of them will remain dormant and can germinate years later.

When the soil surface is wet, sclerotia will form tiny mushroomlike bodies (apothecia) (Fig. 44 and 45) that liberate millions of wind-borne spores. These spores colonize dead bean blossoms and use them as an energy source to invade green tissues. In wet weather, infected tissues are tan and soft with tufts of fluffy white fungal growth. These tufts of "white mold"

develop into sclerotia. Leaves of infected plants turn yellow and wilt.

In dry weather, affected stems have a bleached or whitish appearance. The epidermis of such tissues peels easily and appears shredded. Infected seeds are discolored, chalky and lightweight.

White Mold Management

Crop rotation: Avoid short rotations or rotation with other susceptible crops, especially sunflower, canola, lentil and soybean. Although crop rotation is important, it has only modest value because the sclerotia can survive for several years in the soil.

Foliar fungicides: Many foliar fungicides are labeled and can provide some management of the disease. However, management of white mold is simply that; no fungicide will "control" white mold. Because the pathogen uses flower petals as a food source, early bloom is the best time to apply fungicides. A second application may be recommended seven to 10 days later if conditions favoring the disease (cool and wet) persist. Although additional applications may limit additional infections, the most devastating lesions occur in the early bloom stages, and preventing them is critical. Good canopy penetration of the fungicide is required to ensure blossoms and lower stems are protected. The most effective method is band application using drop nozzles, high pressure and high water volumes. High-pressure broadcast

application is not quite as effective as banding but also can be used when band application is impractical.

Biological control: Commercial production of a fungus that attacks sclerotia, *Coniothyrium minitans*, also is available. *Coniothyrium minitans* needs to be incorporated in the soil, preferably late in the fall.

Cultural control: Increasing row spacing may help enhance drying and subsequently help the crop escape severe infection in years when conditions are marginal for white mold development.

Weed control: Many broadleaf weeds are hosts to the pathogen. Effective weed control every year in each field is important for limiting the buildup of the pathogen for future bean crops.

Rust

Rust is a common dry bean disease and can lead to partial or complete crop failure. The rust fungus forms discrete pustules, which are filled with cinnamon-brown spores (urediniospores). On the upper side of the leaves, pustules will appear small (1/16 inch) and may be surrounded by a yellow halo. On the underside of the leaves, the pustules will appear slightly larger and be more raised, and the dusty spores are rubbed off easily with a finger (Fig. 39).

These spores may be wind-blown for many miles. Infection is favored when free moisture, dew, fog or light rain occurs frequently. The infection cycle can

repeat every 10 to 14 days, and a significant epidemic can result very quickly if the disease goes unmanaged. Pustules break through the leaf surface, opening the interior of the plant to desiccation. Large numbers of pustules result in plants drying out and dying even when the soil moisture is good.

Late in the season, the cinnamon-brown spores will be replaced with black spores (teliospores). Both spore types overwinter on bean debris and can lead to infections the next spring. The rust life cycle also includes an inconspicuous sexual stage that can result in new races.

Rust Management

Resistance: Resistance is an effective and inexpensive way to manage rust. However, in 2008, a new race of rust (20-3) capable of causing disease on the most effective resistance gene was identified in the state. In 2013, most dry bean cultivars are believed to be susceptible to this race. However, resistant cultivars will be available in the future.

Destroy volunteer beans: Destruction of volunteer bean plants will reduce early season rust pressure and slow the development of new rust races.

Scout: Foliar fungicides can be used to manage rust effectively, but they are most effective shortly after rust is found. Scouting should be done regularly, with an emphasis on looking for "hot spots" (localized areas

of infections). When a rust outbreak begins, symptoms are most readily observed in the lower-middle canopy and on the underside of the leaves. Monitor fields carefully, paying particular attention to areas prone to heavy dews or fog (for example, near tree lines).

Foliar fungicides: Many foliar fungicides are labeled for rust. Protectant compounds such as chlorothalonil (Brave, Echo) can delay onset of rust if applied before infection, but FRAC 3 (Folicur, Proline) and FRAC 11 (Headline, Quadris) fungicides are more effective, particularly once rust infection occurs.

Foliar fungicide timing: If rust is detected, a FRAC 3 or FRAC 11 fungicide should be applied unless the crop is striping (R7).

Crop rotation: Use crop rotation and avoid planting next to a field that was severely diseased last year.

Additional information on rust can be found in the NDSU Extension Service publication "Dry Edible Bean Rust" (PP1601).

Root Rots

Several pathogens, including *Fusarium, Rhizoctonia* and *Pythium*, cause root rots. Root rots can occur individually or in combination, and cause many symptoms, including damping off, cankers and browning, depending on the pathogen and environment.

Fusarium is common in dry bean, particularly in drought years. *Fusarium* produces a dry rot with indistinct brown lesions and occasionally a more general browning of the roots.

Rhizoctonia is most common in warm, moist soils when dry bean is grown in rotation with sugarbeet or soybean. *Rhizoctonia* causes more distinct lesions that are chocolate-colored to dark red.

Pythium develops in wet soils, causing a soft brown rot resulting in a hollow tap root. Plants with root rot may be stunted with yellow leaves. Infected plants form fewer pods and smaller seeds.

Root Rot Management

Crop rotation: Longer rotations may help reduce inoculum. If *Rhizoctonia* is present, avoid sugarbeet and soybean in close rotation. Root rot is less severe following wheat.

Seed: Plant high-quality seed.

Seed treatments: Most dry bean seed comes with a fungicidal seed treatment, which will aid in disease management.

Resistance: Some cultivars may be more resistant to root rotting pathogens than others.

Anthracnose

Anthracnose (Fig. 34-37) periodically has been observed in North Dakota. The fungus that causes this disease survives in seeds and plant residues. Anthracnose can develop at any time during the growing season if cool, wet weather occurs. Infections occurring early in the growing season usually result in greater yield and quality losses.

Anthracnose symptoms initially are observed as linear, dark lesions on the veins on the underside of leaves. These lesions eventually can be seen in the upper side of the leaves and on petioles and stems. Severely infected leaves fall off, and the pathogen also can kill the growing point.

Infection on pods produces reddish-brown circular cankers ⅛ inch or greater in diameter. Larger areas of pods can be destroyed when these cankers merge. Under moist conditions, the center of these cankers is filled with beige to pink masses of spores.

Symptoms on infected seeds can range from light discoloration to the presence of cankers similar to those produced on the pods.

Symptomless infections also can occur. The spores of the pathogen can be moved easily in the field by splashing water and machinery. Long-range spread occurs through infected seeds, infected plant material blowing in the wind, equipment carrying the sticky spore masses, and wind driven rain.

Anthracnose Management

Clean seed: The most effective way to manage the disease is to prevent its introduction in your fields by planting certified disease-free seed. The use of bin-run seed greatly increases the anthracnose risk.

Seed treatments: Fungicide seed treatments **will not** eradicate the anthracnose pathogen in seed.

Cultural methods: If you have an infected field, work infected fields the last, and wash your implements thoroughly before entering other fields. Avoid cultivating when the canopy is still wet.

Crop rotation: A minimum of a three-year crop rotation is recommended.

Resistance: Cultivars with resistance to anthracnose have been identified. Consult your Extension agent for specific information on your market class.

Scout: Monitor fields for the presence of anthracnose and do not plant saved seed from anthracnose-infected fields.

Foliar fungicides: Limited fungicide data exists at this time; however, foliar fungicides may limit disease spread and epidemic potential if applied preventatively.

Additional information on anthracnose can be found in the NDSU Extension Service publication "Anthracnose of Dry Beans" (PP1233).

Bacterial Blights

Bacterial blights cause leaf and pod lesions, defoliation and shrunken, discolored seed. All pathogens are seed-borne and can survive on bean residue. Bacterial pathogens are favored by wet weather and are spread by splashing rain. Bacterial diseases are intensified by events that cause small wounds in the leaves (for example, from hail), allowing entry of bacteria into the leaf. The brown spot pathogen also survives on weeds. Common blight is the most prevalent of the bacterial blights, but others can be severe periodically.

Common blight lesions on leaves begin as small, greasy green spots, which later develop into large brown areas surrounded by a narrow lemon-yellow border. Veins near the lesions are darkened. Infected pods develop greasy green lesions with brick red margins. Pod lesions exude yellow ooze in wet weather. Seeds may be shriveled and discolored.

Halo blight first appears as small water-soaked or greasy green spots, which develop into small dead spots. Nearby veins may be darkened. During cool weather, the lesions are surrounded by light green halos up to ½ inch in diameter. Pod lesions are similar to those of common blight except that they exude a creamy white ooze in wet weather. Occasionally, halo blight infections may become systemic, causing stunted, yellow and malformed leaves. Whole plants also may be stunted.

Brown spot first appears as small water-soaked spots. These spots remain small, turn a reddish brown and are surrounded by a narrow, light green halo. Nearby veins may be darkened. Pod lesions are similar to those produced by halo blight.

Bacterial Blights Management

Clean seed: Plant high-quality certified seed.

Crop rotation: Use a three- to four-year crop rotation.

Fungicides: Fungicides do not work on bacteria. Cupric hydroxide (copper) compounds have been used in a program approach (multiple applications) in the central Great Plains under irrigated conditions and have shown good results in that environment. Their effectiveness generally has been limited in our northern environment.

Table 18. Seed treatments[1].

Chemical	Application	Dosage[2]	Control[3] of Seedling Blights[4]	Remarks
Captan				
Captan 400, 37.4% Captan 4000, 38.4% Captan 30-DD, 28.7%	See individual labels for rates of application, formulations and registered use.	See individual labels for amounts of formulated product to apply	X	
Captan + PCNB + Thiabendazole				
Rival Flowable, 19.8%:8.4%:1.0%	Slurry	4 fl oz/cwt	X	Registered for control of Rhizoctonia.
Carboxin				
Vitavax-34, 34%	Slurry	3 to 4 fl oz/cwt	X	Vitavax-34 may be used on seed previously treated with Captan or Thiram. Germate Plus contains 15% diazinon and 25% lindane insecticide.
Germate Plus, 14%	Drill box	1.5 oz/42 lb (2 oz/bu)		
Carboxin + Thiram				
RTU-Vitavax-Thiram, 10%:10%	Liquid, slurry or drill box	6.4 fl oz/bu (6.8 fl oz/cwt)	X	
Vitaflo 280 14.9%;13.2%	Slurry	4 fl oz/cwt	X	

Chemical	Application	Dosage[2]	Control[3] of Seedling Blights[4]	Remarks
Chloroneb				
Chloroneb 65W, 65%	Slurry	4 oz/cwt	X	May be used as a supplemental seed treatment for improved suppression of Rhizoctonia and Pythium.
Fludioxonil				
Maxim 4FS, 40.3%	Slurry	0.08 to 0.16 fl oz/cwt	X	For seed-borne and soil-borne fungi. Registered for control of Rhizoctonia and Fusarium.
Mefenoxam				
Apron XL LS, 32.3%	Slurry or mist	0.32 - 0.64 fl oz/cwt	X	For Pythium control. For commercial and on-farm use.
Metalaxyl				
Allegiance FL, 28.35%	Mist or slurry	0.75 fl oz/cwt	X	Metalaxyl is only for Pythium damping control. For use only with commercial seed treatment equipment.
Apron Dry Seed Protectant, 12.5%	Drill box	4 oz/cwt	X	Apron Dry Seed Protectant is for drill box application to seed not previously treated with Apron. Thorough mixing of fungicide and seed is essential for good control.

Chemical	Application	Dosage[2]	Control[3] of Seedling Blights[4]	Remarks
Metalaxyl + PCNB + Carboxin				
Prevail, 3.12%:15%:15%	Drill box	6 to 8 oz/cwt	X	Controls early season Pythium and Rhizoctonia.
PCNB				
RTU-PCNB, 24%	Liquid or slurry	3 fl oz/cwt	X	Controls early season Rhizoctonia and Fusarium.
Streptomycin 62.6%				
Agri-Strep 500, AS-50, or Agricultural Streptomycin	Slurry (%)	.83 oz/cwt		Controls bacterial surface contamination on dry beans.
	8⅓ lb in 10 gal. water treats 16,000 lb. of seed. Do not use with Rhizobium inoculant. Triple-treat process uses Fungicide + Insecticide + Streptomycin.			
Thiram				
Protector-D, 35%	Drill box	4.5 oz/cwt	X	Contains molybdenum.
42-S Thiram, 42%	Liquid or slurry	2 fl oz/cwt	X	
Thiram 50WP Dyed, 50%	Drill box or slurry	2 oz/cwt	X	

[1] Seed treatments available as of 2013.

[2] Dosage = Amount of formulated product to apply.

[3] X = Product labeled for crop and disease; Blank = product not labeled for specific disease.

[4] Seedling blights due to various fungal infections of seed.

Note: Some seed treatments may affect Rhizobia inoculants; read inoculant label for specific information.

Table 19. Foliar sprays[1].

Chemical	Application[2]	Dosage[3]	Disease Control[4]			Remarks
			Rust	Halo Blight	White Mold	
Azoxystrobin						
Amistar, 80%	Spray or fungigation	2 to 5 oz/A	X			Maximum of four applications per season.
Quadris, 22.9%	Spray or fungigation	6.2 to 15.4 fl oz/A	X			Maximum of four applications per season.
Boscalid						
Endura, 70%	Spray or fungigation	8 to 11 oz/A	X		X	Maximum of two applications per season.
Chlorothalonil						
Bravo 500 or Echo 500, 40.4%	Spray or fungigation	2 to 3 pt/A	X			Do not apply Chlorothalonil within 14 days of harvest. See publication "Dry Edible Bean Diseases" (PP576).
Bravo Weatherstik, Echo, Equus 720, 54%	Spray or fungigation	1.38 to 2 pt/A	X			Carefully monitor fields for disease.
Bravo Ultrex DG, or Equus DF, 82.5%	Spray or fungigation	1.25 to 1.8 lb/A	X			Bravo Zn, Echo Zn and Terranil Zn also contain zinc.
Bravo Weatherstik Zn, 51%	Spray or fungigation	1.38 to 2 pt/A	X			
Echo Zn or Terranil Zn, 38.5%	Spray or fungigation	2 to 3 pt/A	X			

Chemical	Application[2]	Dosage[3]	Disease Control[4] Rust	Halo Blight	White Mold	Remarks
Chlorothalonil						
Echo 90 DF, 90%	Spray or fungigation	1.13 to 1.63 lb/A	X			
Copper						
Basicop WP, 53%	Spray	2 to 4 lb/A		X		
Champ DP, 57.6%	Spray or fungigation	0.66 to 2 lb/A		X		
Champ Formula 2 Flowable, 37.5%	Spray or fungigation	0.66 to 2 pt/A		X		
Cuprofix Disperss, 36.9%	Spray or fungigation	1.5 to 3.5 lbs/A		X		
Kocide 2000, 53.8%	Spray or fungigation	0.75 to 2.25 lb/A		X		
Kocide 4.5 LF, 37.5%	Spray or fungigation	0.66 to 2 pt/A		X		
Maneb						
Maneb 80, 80%	Spray or fungigation	1.5 to 2 lb/A	X			Do not apply within 30 days of harvest. Do not exceed 9.6 lb ai/A per season of total Maneb products (12 lb/A of Maneb 80 or 12.8 lb/A of Maneb 75; 9.6 qt/A of Manex).
Maneb 75 DF, 75%	Spray or fungigation	1.5 to 2 lb/A	X			

Chemical	Application[2]	Dosage[3]	Disease Control[4]			Remarks
			Rust	Halo Blight	White Mold	
Maneb						
Manex, 37%	Spray or fungigation	1.2 to 1.6 qt/A	X			See note on Maneb on Page 70.
Pyraclostrobin						
Headline, 23.6%	Spray or fungigation	5.5 to 8 fl oz/A	X			Maximum of two applications per season. 30-day PHI.
Sulfur						
Thiolux, 80%	Spray	3 to 10 lb/A	X			
Microthiol Disperss, 80%	Spray	7 lb/A	X			
Thiophanate-methyl						
Topsin M WSB, or T-methyl 70W WSB 70%	Spray or fungigation	1.5 to 2 lb/A in one application or 1 to 1.5 lb/A with two applications			X	Apply 1.5 to 2 lb once when 70 to 100 percent of the plants have at least one open blossom. Or apply 1 to 1.5 lb twice with the first application when 10 to 30 percent of the plants have at least one open blossom and the second application four to seven days later. Complete coverage of all parts of plant is essential for control of white mold. Do not apply more than 4 lb product/acre/season. Do not apply Thiophanate methyl within 28 days of harvest.

[1] Fungicides available as of 2013.
[2] Spray = ground or aerial, Fungigation = application through sprinkler irrigation system.
[3] Dosage = Amount of formulate product to apply.
[4] X = Product labeled for crop and disease; Blank = product not labeled for specific disease.