Dry Edible Bean Diseases

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Dry edible beans (DEB) grown in North Dakota are primarily pinto and navy (pea) beans, but other types such as black, great northern, and kidney yield well. In good years, yields of 20 to 30 hundredweight per acre (2,200-3,400 kg/ha) have been obtained.

Diseases of DEB reduce yield and quality of the harvested beans. Dry edible beans are susceptible to many diseases, but white mold, rust, bacterial blight (four types), and root rots appear to be the most serious diseases in North Dakota. Serious losses can occur when weather conditions are favorable for disease development and the disease organisms are present.

Growers can reduce losses from diseases by following these practices:

- Use a three- to four-year crop rotation. Avoid sunflowers in short rotation. Increase rotation length if Sclerotinia (white mold) is present.
- Plant high quality seed tested for low levels of disease organisms.
- Treat seed with streptomycin, fungicide, and insecticide (triple treated).
- Handle bean seed and harvested beans carefully.
- Use wide row spacings if Sclerotinia (white mold) has been known in the area. Wide row spacings of 30 inches (75 cm) or more increase aeration, which dries foliage and soil more rapidly. Varieties with open canopies tend to dry more rapidly than those producing dense canopies.
- Control weeds to remove plants which can be hosts of disease organisms and to improve aeration. Caution: Overapplication of herbicides must be avoided.
- Avoid cultivating when plants are wet.
- Hill beans to stimulate lateral root development if root rot is present. Close cultivation can prune roots and deep cultivation can bring weed seeds above the herbicide layer.
- Inspect fields frequently to detect disease early and use recommended fungicides when appropriate (see Extension Circular PP-622, Field Crop Fungicide Guide).
- Bury bean straw as soon after harvest as possible. Deep incorporation (6 to 8 inches, 15 to 20 cm) to hasten decomposition is preferred.
- Avoid planting next to a field that had a severe bean disease problem last year; do not rotate beans between adjacent halves of center pivot irrigation circles.
- Use disease resistant or tolerant varieties when available (see Extension Circular A-654, North Dakota Dry Bean Performance Testing).

Bacterial Blights

Four types of bacterial blight occur In North Dakota:

Common blight *(Xanthomonas campestris* pv. *phaseoli)*
Fuscous blight (a variant of *Xanthomonas campestris* pv. *phaseoli)*
Halo blight *(Pseudomonas syringae* pv. *phaseolicola)*
Brown spot *(Pseudomonas syringae* pv. *syringae*)

Blight bacteria cause plant defoliation with discoloration and shriveling of seed. Because blight bacteria are highly contagious, they can easily cause epidemics with losses exceeding 75 percent of the potential yield.

Halo blight is most evident during cool, rainy weather, especially early in the season. Common and fuscous blights occur during warm, wet weather. Brown spot is more serious in protected areas where plants dry slowly. Blight bacteria are seed-borne and enter the seed through natural openings or wounds. The bacteria survive in seed many years. Certified seed should contain few blight bacteria.

Disease generally begins from infected seed or from bacteria surviving in debris of previous crops. The bacteria cause small spots on cotyledons or young foliage. From these spots, bacteria exude onto the leaf surface during periods of rain or dew. The bacteria are then spread from plant to plant by rainsplash or overhead irrigation.

Blight bacteria can enter plants through natural openings but enter most easily through wounds. Hailstorms or blowing sand accompanied by rainstorms are ideal for spreading bacteria.

Blight bacteria also spread by contaminated equipment, by insects, or by animals, including man. Reducing movement through fields and cultivating after plants are dry helps reduce spread of blight.

Symptoms

Blight can be observed as small, greasy green (water-soaked) spots on leaves, stems, or pods. On leaves, the water-soaked spots enlarge and are rapidly replaced with dead tissue. If halo blight is the pathogen, the dead tissue is surrounded by a diffused light green zone or halo. Halos are not produced at temperatures above 70 degrees Fahrenheit (21 degrees Celsius). Sometimes the halo-causing toxin is transported to the upper young leaves, which become yellowed. When halos are not formed, the necrotic spots resemble the symptoms of brown spot, so named because the lesion remains a small chocolate-brown spot with little halo formation.

Leaves infected with common or fuscous blight show large dead areas and sometimes appear as if they have been burned with a torch. Common blight on younger green foliage can be recognized by the distinctive yellow band separating apparently healthy and dead tissue (Figure 1).

Figure 1. Blight spots with yellow band. (29KB b&w photo)

All of the blight organisms form water-soaked, greasy-looking lesions on pods. With age, the water-soaked spots become sunken and develop a reddish margin. Masses of bacteria often exude from the centers of the spots. When fresh, the masses are yellowish in the case of common and fuscous blights and cream colored in the case of halo blight and brown spot. They dry to form a flaky surface which glistens in sunlight (Figure 2).

Figure 2. Damage to pods caused by blight. (25KB b&w photo)

Stem infections occur. Generally the affected areas are dark red. If the area encircles the stem near joints (nodes), the plants can break.

White bean seed heavily infected with common blight turn a butter-yellow color. Pinto or other colored beans generally do not show this color. Infected seed often is shriveled. Heavily infected seeds do not germinate. Lightly infected seeds produce stunted and internally infected plants. Even a few infected plants can cause an epidemic in favorable weather.

Control

- Plant high quality seed which has been tested for blight. Certified seed from North Dakota has been tested for blight

bacteria.
- Treat seed with streptomycin to eliminate surface bacterial contaminants. Treatment does not eliminate internal bacteria, however. Streptomycin should be a component of triple seed treatment. Streptomycin affects Rhizobium nodulation bacteria. A granular, in-furrow inoculant rather than a seed-applied inoculant may be more effective with treated seed.
- Practice crop rotation of three to four years to allow decomposition of debris. Deep plowing of bean straw soon after harvest speeds decomposition and restricts windblown debris dispersal. DEB blight bacteria generally do not cause disease on other crops such as soybeans, sunflowers, mustard, potatoes, flax or grains.
- Most commercial bean varieties do not have resistance to bacteria. Pinto and navy beans have some field resistance to halo blight, and great northern varieties have tolerance to common blight. Resistant or tolerant pinto bean varieties are being developed. Use resistant varieties when they become available (see Circular A-654).
- While some copper fungicides are registered for blight control, they have not been effective in North Dakota.
- Clean equipment is essential, especially if beans are being grown for certification. Steam cleaning is most effective. If steam is not available, equipment should be washed with detergent and water to remove infected debris (in which bacteria can survive many years), rinsed thoroughly, and, if possible, sprayed with a noncorrosive disinfectant. Equipment should be cleaned between seed lots, between fields, between seasons, etc.

Rust

Periodically, rust infection reaches severe epidemic proportions in North Dakota. Under normal weather conditions, the disease develops too late in the growing season (about early pod striping) to cause serious damage. Rust attacks when growing conditions are cool (60-75 F, 15-24 C) and moist with frequent, prolonged dew or rains. Rust is most serious on late planted beans, on heavily fertilized beans, on beans delayed in maturity by weather damage such as hail, or on beans planted on or adjacent to old bean ground.

Rust, caused by a fungus *(Uromyces appendiculatus),* is found mainly on bean leaves. Severely infected plants are defoliated. The most obvious symptom of the rust disease is the presence of pustules containing rusty-colored masses of spores. The rusty-colored spores (ureodospores) are the summer spores and spread the disease from plant to plant. Hundreds to thousands of spores are produced in each pustule, and new pustules arise about 10 days after infection.

Late in the season the rusty-colored spores are replaced with dark, thick-walled winter spores (teliospores). Teliospores usually overwinter in association with bean debris. In the spring, teliospores germinate and produce basidiospores, which are wind blown to bean leaves. The basidiospores germinate and a fungal strand infects the bean leaves. Fungal strands from different basidospores fuse to complete sexual crossing, which results in another, rarely observed, spore stage (aeciospore). Aeciospores are wind blown to bean leaves where they infect and give rise to uredospores (Figure 3). Aeciospores are produced more commonly on volunteer beans.

Figure 3. Rust disease cycle. (14KB b&w diagram)

Besides arising from overwintered teliospores, the repeating summer stage may be initiated by overwintered uredospores or possibly by airborne spores transported long distances. Long range movement of spores coupled with great variability (North Dakota races attack a wide range of bean varieties) make control via resistance difficult. Ten races of rust have been identified in North Dakota. Newer resistant varieties have multiple genes for resistance.

Weather is an important factor in rust epidemics. Rust uredospores germinate best at about 63 F (17 C). Poor germination of spores at 81 F (27 C) may account for reduced spread of disease at high temperatures. Free moisture (rain, dew) or high relative humidity (96 percent plus) are essential for infection. When moisture and temperature are favorable for more than eight hours and spores are present, infection occurs.

Control

Deep plowing of residue soon after harvest helps confine debris to the field and promotes rapid decomposition of the debris and fungus. This reduces the amount of overwintering fungus and delays onset of the disease the next year. Leaving the plowed soil rough helps minimize soil erosion by wind and water. Destruction of volunteer beans helps reduce early-season development of rust; it also helps to restrict development of the sexual stage, reducing the production of new rust races.

Rotation from beans for three to four years reduces the amount of surviving fungus. The fungus does not attack weeds or crops other than beans. Fungicides can control the disease when early infections threaten production. Early detection is essential.

Early infections often appear in small areas in the field. Discovery of these infection "hot spots" during or before the flat pod stage of bean development should signal immediate initiation of a spray control program. When infections are generally spread through the field, the need for fungicide application can be based on the spray guide shown in Table 1. Table 1 shows how to rate severity of the disease from 0 to 9 based on the approximate number of pustules per leaf. In the table the rating is matched with plant maturity to indicate profitable fungicide application. Examples of disease severity are shown in Figures 4 and 5.

Table 1. Fungicide use based on plant maturity and rust severity.

Weeks to Harvest	Plant Stage	Rust Severity Rating: 0	1	2	3	4	5	6	7	8	9
		Pustules per Leaf: 0	Trace	2-3	6	12	25	50	100	200	400-Dead
8	Early bloom	e	F	F	F	F		n	n	n	n
7	Full bloom	e	F	F	F	F		n	n	n	n
6	Small pods	e	F	F	F	F	F		n	n	n
5	Flat pods	e	F	F	F	F	F		n	n	n
4	Early pod fill	e	e		F	F			n	n	n
3	Early purple stripe on early pods	e	e	e	e	n	n	n	n	n	n
2	Purple stripe on most pods	e	e	e	e	n	n	n	n	n	n
1	Pods and beans drying	e	e	e	e	n	n	n	n	n	n
0	Harvest										

e = escape from serious disease
n = costs of fungicide would not be compensated by increased yield. Special concern for next year's crop is needed.
F = apply fungicide

Figure 4. Leaf with 10 spots and a severity of 4. (31KB b&w photo)

Figure 5. Leaf with 200 rusty spots and a severity of 8. (33KB b&w photo)

Apply fungicides when pustules average about two per leaf and the crop has not yet reached the pod fill stage. After the lower pods are striping (three weeks to harvest), fungicide applications are usually not profitable. Fungicide applications also are usually not profitable if the severity already exceeds the level shown for spraying. For example, if the disease is widespread, if there are 40 spots per leaf, and if the plants are in the bloom to small pod stage, the disease has already progressed too far for economical control with fungicides.

Most fungicides protect foliage from rust infections. Newer fungicides can stop the fungus once it is in the plant but only for a period of four days. Since the fungus grows for about 10 days before spores are formed, pustules can form after fungicides are applied, as long as the infection occurred before the fungicide was applied.

Current recommendations are available at your county extension office and in Circular PP-622, Field Crop Fungicide Guide. Check for Section 18 or other special use allowances for systemic and therapeutic materials such as propiconazole (Tilt�).

White Mold

White mold (sometimes called watery soft rot) is a fungal disease *(Sclerotinia sclerotiorum)* which threatens bean production in North Dakota. White mold can cause substantial yield losses.

White mold is difficult to eliminate because the fungus forms tough black to grayish bodies called sclerotia which can survive more than 10 years in the soil. These rarely germinate to produce a white fungal mat which infects lower bean stems directly. More commonly they germinate to produce small fruiting structures 1/8 to 3/8 inch in diameter and shaped like funnels. As many as 40 fruiting structures can arise from a single sclerotium. The fruiting bodies release airborne spores that are dispersed throughout the growing season. The spores cannot infect healthy plant tissue directly, but germinate on dead plant tissue (such as dried blossoms, broken leaves lodged in the foliage, etc.); the fungus then proceeds into healthy tissue.

Spread may appear to be rapid. Following a spore shower, an entire field can be lost only days after initial symptoms are detected. Debris from infected plants or plant contact can spread the pathogen.

Sclerotia and watery soft rot are the main diagnostic characteristics of the disease. Infected plants first develop small, water-soaked spots on the pods, stems or foliage. The spots enlarge to form large masses of soft-rotted tissue covered with masses of white moldy fungus growth (hence the name). In dry weather, infected plants appear yellowish brown, bleached, dried, and shriveled as if they had been cut from the roots. Late season infections make the bean seeds chalky-colored and lightweight.

New sclerotia are formed within the white moldy growth (Figure 6). They also are formed within the stems of beans and sunflowers (Figure 7). New sclerotia do not germinate and spread the disease during the current season. Rather, they germinate in later years and provide the source of new outbreaks. The disease cycle is illustrated in Figure 8.

> **Figure 6. White mold. Masses of mold develop into sclerotia that perpetuate the disease.** (27KB b&w photo)
>
> **Figure 7. White mold sclerotia produced inside of stems.** (10KB b&w photo)
>
> **Figure 8. White mold disease cycle.** (14KB b&w diagram)

The fungus may be brought into a field through infected bean seed, through flood and irrigation water, through sclerotia in seed lots (sunflower and bean), through windblown soil or by man.

White mold disease develops best at moderate temperatures (about 75 F, 24 C), but fungus fruiting bodies develop best at cool temperatures (about 60 F, 15 C). Dew, rain, and irrigation can provide moisture required for disease progress.

Vining beans, shelterbelts, windrowing and other field conditions reduce airflow around beans. Plants dry slowly and disease develops rapidly.

Control

A high level of resistance to white mold has not been incorporated into commercially acceptable pinto and navy beans. Some cultivars have more resistance (tolerance) than others (see Circular A-654). Fungicides can help suppress the disease. Benomyl (Benlate) and thiophanate methyl (Topsin M) are registered for this use (see Circular PP-622 for current fungicides). These materials are locally systemic and do not move downward into older plant tissue. Since the disease usually begins on the dead blossoms and lower parts of the plant, control depends on thorough lower plant coverage. Use drop nozzles (between the rows) and at least 40 psi to obtain satisfactory coverage. It is doubtful that thorough coverage can be obtained after bean rows have closed. Low volume fungicide application (less than 5 gallons, 19 liters) by aircraft generally gives poor coverage of the lower plant parts. High volume (7-10 gallons/A) by aircraft has provided good control in recent trials.

The most economic use of fungicide is a banded or directed spray applied at early bloom. Higher rates provide better control. Fungicide decision guidelines, in use since 1987, have proved helpful. A fungicide is required if: 1) wet weather maintains soil surface wetness for 10-14 days before flowering, and maintains plant wetness for 2+ days during flowering; 2) the yield potential is over 2000 pounds per acre; and 3) white mold has affected crops in the area in previous years. Recent field trials in Minnesota showed that fungicides would more likely provide economic return whenever the rain and/or irrigation from June 1 until 10 days after initiation of bloom totaled more than 5 inches.

Keeping rows open longer can help provide aeration which dries plants more rapidly. Planting more upright (navy, black, kidney) beans rather than vining (pinto) and planting at wide row spacings (at least 30 inches, 75 centimeters) helps keep rows open.

Deep plowing (6-8 inches, 15-20 centimeters) aids in microbial decomposition of debris and some sclerotia. Shallow incorporation (1-2 inches, 2.5-5 centimeters) may increase the danger from this disease.

Sanitation is important to keep the fungus from spreading between fields. Proper cleaning of thrashers and proper disposal of seed screenings, bin cleanout, etc. can reduce dispersal of the pathogen.

The fungus attacks many crops (sunflowers, rapeseed, mustard, dry peas, buckwheat, lentils, garbanzos, safflower, and sometimes potatoes or flax) and many weeds (Canada thistle, pigweed, lambsquarter, marsh elder, etc.). Long rotations between susceptible crops and good weed control can assist in the control of white mold. Planting to non-susceptible crops (grains, corn, sorghum) and fallow also reduces the amount of fungus in a field.

Alternaria Blight

Alternaria blight is a fungal disease that has caused high losses in the field. The disease appears as spreading irregular brown lesions, often with light tan to whitish centers. The outer margin of the lesion generally is dark purplish to black. The lesion may or may not have a chlorotic zone surrounding the lesion. After moist periods, the undersides of lesions are covered with black spores that give the area a gray appearance.

The pathogen enters bean leaves and stems through wounds. The disease is most severe after hailstorms or other trauma that cause wounding. Little is known of the life cycle of the fungus, nor of chemical control.

Root Rot

Root rot has become increasingly serious in North Dakota and has reduced yields in some fields.

Several fungi cause root rot, but *Fusarium* spp. has been most troublesome. Rhizoctonia is common when dry beans are rotated with sugarbeets or soybeans. Both fungi are soil borne and more common where beans have been grown for many years. The fungus attacks the roots and causes reddish-colored lesions which later turn dark brown (Figure 9). If roots are heavily infected, upper plant parts are yellowed and stunted and often wilted.

Figure 9. Root rot. (69KB b&w photo)

Upper plant symptoms are more obvious when drought, salt, or other field conditions prevent lateral (secondary) root development. The disease is most commonly observed during mid to late season.

Control

Long rotations can help keep the amount of fungus in the soil at low levels. Hilling soil around the base of the plant during cultivation can stimulate lateral root development and provide some drainage of surface water from the plant row. Close cultivation can trim shallow roots, and deep cultivation can bring weed seeds above the herbicide layer. Avoid soil compaction and short rotations with sugarbeets or soybeans.

Tolerant varieties are available (see Circular A-654). Plant tolerant varieties in fields where root rot has been a problem.

Herbicide Damage

Herbicide damage due to drift, improper herbicides, carryover, improper application, etc. is a common problem which has caused total loss of hundreds of acres of beans. Puckering of leaves, swollen basal stems, stunting, death of the growing buds, "cauliflowering" of plants, and leaf burning are among symptoms of herbicide damage. Besides directly affecting plants, the herbicides may open plants to disease such as root rots. Careful application, attention to the label instructions and good field records are important in this preventable "disease" (see Circular W-253, Agricultural Weed Control Guide).

Bean Common Mosaic Virus (BCMV)

BCMV is a seedborne virus transmitted by aphids and mechanically by plant sap. Systemically infected plants, especially those from infected seeds, have leaves with green mosaic patterns and distortions (curling, strapping, or puckering of tissues along leaf veins). Plants may be stunted and have only a few pods which mature later than uninfected pods. Vascular tissue can become necrotic, producing dark streaks on petioles and stems. Nonsystemic infections can appear as ring-like lesions on foliage. Appearance and severity of symptoms depends on strain of the virus, variety, time of infection, and environmental conditions.

At high temperatures (above 78 F), cultivars with the hypersensitive resistance gene (I gene) respond to necrosis-inducing strains of BCMV with a systemic necrosis called black root. Plants with black root die.

More than 15 strains of BCMV are known, and breeders have incorporated resistance to the more important strains in many commercial varieties. Certified seed programs are restrictive for BCMV contamination. Many types of beans, alfalfa, and common clover are hosts. Controlling large populations of aphids can reduce spread. The primary control is selection of high quality, virus-tested seed of genetically resistant varieties.

Bean Yellow Mosaic Virus (BYMV)

BYMV is occasionally seen but is not serious in North Dakota. This virus is readily transmitted by aphids and mechanically by plant sap, but it is not seedborne. It causes plant stunting and leaves with contrasting areas of dark green and yellowed tissue. Bright yellow spots can be obvious on older plants. The virus also attacks wild hosts such as clover and sweet clover. Genes for resistance have been identified.

Fusarium Yellows

Fusarium yellows has been identified by field symptoms, and the pathogen *(Fusarium oxysporum* f. sp. *phaseoli)* has been isolated from plants in a systematic field survey. The pathogen is soilborne and can penetrate roots directly or through wounds. The pathogen plugs the vascular tissue in bean roots and stems. Initial symptoms are yellowing and wilting of lower foliage. Yellowing and wilting progress upward into the youngest foliage. Plants become stunted and leaf margins become necrotic. Severely infected plants wilt permanently, defoliate, and die. Symptoms are sometimes confused with nutrient deficiencies, but discoloration of the vascular tissues is diagnostic. Crop rotation, seed protection (high vigor plus fungicides) and cultivation practices that promote good root growth help control the disease. Resistance genes have been identified.

Anthracnose

Anthracnose *(Colletotrichum lindemuthianum)* is a potentially devastating disease that has been found only once in North Dakota commercial production. In experimental irrigated field trials, anthracnose developed from contaminated seed. The most characteristic symptoms appear on the undersides of leaves where small, angular, reddish to purplish-brown lesions develop predominately along veins. Older lesions become darker, extend to the upper surface, and proceed along the veins. Pod lesions are sunken, circular, tan to rust-colored with a raised dark margin surrounded by a thin zone of reddish tissue. On the lesion surface, tan spores dry into dark, granular masses. Genetically resistant varieties and tested "pathogen free" seed are primary controls. Several races of the pathogen are known.

Rhizomania

Rhizomania is not a bean disease. It is a sugarbeet viral disease carried by a common soil fungus. The pathogen has been identified in fields used for production of bean seeds in other states and may be introduced into North Dakota in soil-contaminated seed. North Dakota bean growers who obtain seed from private sources should check with the producing state's Department of Agriculture to ensure the seed is from an area without the pathogen.

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