DISEASES OF COOL SEASON LEGUMES (PULSE CROPS: DRY PEA, LENTIL AND CHICKPEA)

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MONTANA STATE UNIVERSITY | EXTENSION

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As pulse crops are more frequently included in crop rotations, we will see increased disease problems. In this publication we discuss the symptoms of the various diseases of pulse crops common in Montana, some diseases of concern for the future, and their management.

DISEASE PROBLEMS AT ESTABLISHMENT

Establishing a good stand is important to reduce competition from weeds and protect plant health throughout the growing season. Best management practices including pathogen-free and high-germination seed, variety selection, crop rotation and using a seed treatment can go a long way toward protecting your crop.

DAMPING OFF

Poor emergence is often the first sign of damping off. Damping off can occur before plant emergence or in the young seedling (post-emergence damping off). Symptoms include poor stand, yellow seedlings with no secondary roots or a brown/black tap root, and plant death (Figure 1).

Damping off is caused by a number of pathogens including *Pythium* spp., *Fusarium* spp., and *Rhizoctonia* spp., among others. It is soil borne and is favored by no-till management due to cooler, wetter soils at spring planting. Plant high quality seed and always use a fungicide seed treatment to manage damping off. The seed treatment should contain metalaxyl or mefanoxam for control of Pythium in addition to another fungicide for control of Fusarium, Rhizoctonia, etc. The selection of seed treatment will depend on what is available at your retailer. Decisions can be aided by the North Dakota State University Fungicide Guide, which is updated yearly, and the High Plains Integrated Pest Management (IPM) Guide (wiki.bugwood.org/HPIPM).

ROOT AND CROWN ROTS

After the seedling has emerged, continued cool wet weather often results in root rot. Symptoms will include stunted, yellow plants and may be mistaken for nitrogen deficiency (Figure 2). When the plant is dug up, the roots will be much thinner than a healthy plant or there may be no secondary roots at all. Roots will be discolored, and the color and pattern of discoloration depends on the pathogen infecting the roots. There are four main types: Pythium root rot, Rhizoctonia root rot (bare patch), Fusarium root rot, and Aphanomyces root rot. These fungal diseases affect a very broad host range, so crop rotation is of limited efficacy.

FIGURE 1. Damping off is caused by many different fungi. Above, Kabuli chickpeas to the left are more susceptible than desi chickpeas, right. Note the significant loss of stand due to damping off.

FIGURE 2. Lentil plants yellowed due to root rot, below.

FIGURE 3. Pythium root rot causes brown, reddish or black discoloration of the roots and reduces the number of secondary roots.

Pythium root rot is caused by the oomycete (water mold) *Pythium* spp. It is characterized by poor root system development, and can be difficult to diagnose. In general, roots will be brown in color and the outer cortex will peel off of the inner core of the root (Figure 3). Pythium is very common in the soil and for this reason it is recommended that all seed treatments contain metalaxyl or mefanoxam.

Fusarium root rots are caused by a number of different Fusarium species. Disease is favored by cool, wet springs followed by drought, fluctuating water conditions, and high soil nitrogen levels. Below-ground symptoms include brown to reddish-brown discoloration and lack of secondary (small) roots. Management recommendations include fungicide seed treatments and good weed control. The severity of the infection often depends on the previous crop history and species of Fusarium present in the soil. For example, *F. graminearum,* which causes root and crown rot in wheat, does not infect pea very well. *F. redolens,* which is decimating to peas, can be found on wheat at low levels causing root rot, but is not a major pathogen of wheat.

Rhizoctonia root rot is caused by the fungus *Rhizoctonia solani*. It is first diagnosed by poor or declining stands. Root development is poor and roots are generally black and soft (cover photo, top). Rhizoctonia root rot is very common where volunteer grain and weeds were sprayed with herbicide, particularly glyphosate, within days of planting. The fungus grows quickly in the dying plants and reaches a high population which then attacks the new seedlings. This is called the 'green bridge.' The green bridge can be prevented by delaying seeding two to three weeks after herbicide application to allow the plant tissue of treated plants to decompose. Other management practices include the use of a fungicide seed treatment for good plant establishment.

Aphanomyces root rot symptoms are similar to those of Pythium root rot. Oospores of *Aphanomyces euteiches* can survive in the soil up to 20 years. The pathogen can cause pre- and post-emergence damping off, and cause root rot in seedlings or older plants as long as soil conditions remain cool and moist. Genetic resistance is limited. Phosphorous acid has been shown to be effective in greenhouse and some field trials to manage this disease on peas in the Pacific Northwest when applied as a foliar application soon after emergence (Porter et al. 2009).

DISEASE PROBLEMS DURING THE GROWING SEASON

VASCULAR WILTS

Fusarium wilt is caused by *Fusarium oxysporum.* Subspecies are specific to the crop (ie. *F. oxysporum* f. sp. *pisi* on pea, *F. oxysporum* f. sp. *lentis* on lentil, and *F. oxysporum* f. sp. *ciceris* on chickpea). There can be several different races of the pathogen within each subspecies, which makes breeding for resistance challenging. However, there is resistance to race 1 and race 2 of Fusarium wilt in many pea varieties.

F. oxysporum can infect the plant during any stage of growth. The pathogen is very long lived in the soil (chlamydospores) and can increase in a field each time you replant the susceptible crop. For that reason, it is important that wilt-affected fields are entered last, and equipment is cleaned after each field operation. This is especially important for operations where there is soil contact, such as at planting. The pathogen can also be carried on plant materials such as stubble, and in wind and water. They may also be introduced on seed. The only economical control is to plant resistant varieties, which are available for lentil and chickpea. Early planting allows the crop to grow when soil temperatures are below those optimal for disease development. Seed treatments to encourage establishment and plant vigor are recommended. A minimum of four years or more between crops is advised to curtail progress of this and other soilborne root diseases.

Symptoms include downward curling of leaf edges and leaflets, thick and brittle stems at the soil line, discoloration of the vascular tissue (orange-brown or red to black) and discoloration and rotting of secondary roots. If the plant is infected when it is older, a black canker may develop on the stem close to where the pod is attached and enlarge upward and downward from that point. Affected plants die more rapidly under dry soil conditions, and death occurs in circular to oval patches. Plants may also be more scattered if the level of inoculum is low or unevenly spread. Relatively warm soil temperatures (74 to 82°F) are optimal for disease development.

Verticillium wilt is caused by *Verticillium dahliae* and *V. albo-atrum* and is reported as an economical disease only on chickpea, although *V. dahliae* can infect lentil and pea (Ligoxigakis et al. 2002). Foliage turns yellow before wilting, and the xylem is light brown in color when the stem is split. This is not considered a major cause of disease in the Northern Great Plains, but can be serious where it occurs. Crop rotation with non-hosts is the most effective method of control; resistant varieties may be available.

FOLIAR DISEASES

Foliar diseases can be some of the most devastating diseases of pulse crops, and are often noticed too late to implement management. It is very important to scout crops on a regular basis, particularly when humidity is high and following rain and hail events. Early action against foliar fungi such as Ascochyta can be very beneficial. However, growers must be very careful to discriminate between bacterial diseases, where there are no chemical options, and fungal diseases.

Bacterial blight is very commonly seen in pea after hail events or rain events associated with high wind that blows soil particles into plants, particularly at the edges of fields. It is caused by *Pseudomonas syringae* pv. *pisi* in pea and *Xanthomonas campestris* pv. *cassiae* in chickpea. It can be easily confused with Ascochyta blight, but management is very different. Bacterial blight is characterized by angular lesions (Figure 4) that are water-soaked at first (when held up to the light, you can see the tissue is translucent) and early in the disease could be confused with physical damage due to hail. Lesions of bacterial blight are stopped by leaf veins, making the lesion angular in shape. This is in contrast to Ascochyta blight (cover photo, center) where circular lesions expand beyond the leaf veins. As the tissue dries, the lesions turn from light green, water-soaked lesions to dry, brown, papery tissues which, if lesions occur at leaf edges, can cause tearing. Disease symptoms can also occur on stems, petioles, and pods (Figure 4).

If weather conditions remain humid after infection, the disease can progress very rapidly and defoliate plants. You may see cloudy droplets of bacteria along the edges of lesions, which as the leaves dry, become crystalline and flake off. If weather conditions become warm and dry after infection, the disease is halted in its progress. It is not uncommon to see symptoms only on lower leaves. Yield losses are proportional to the amount of canopy lost due to disease.

The pathogen is seedborne, and contaminated seed is considered the most important source of inoculum for field epidemics. The pathogen also survives on stubble and in the soil.

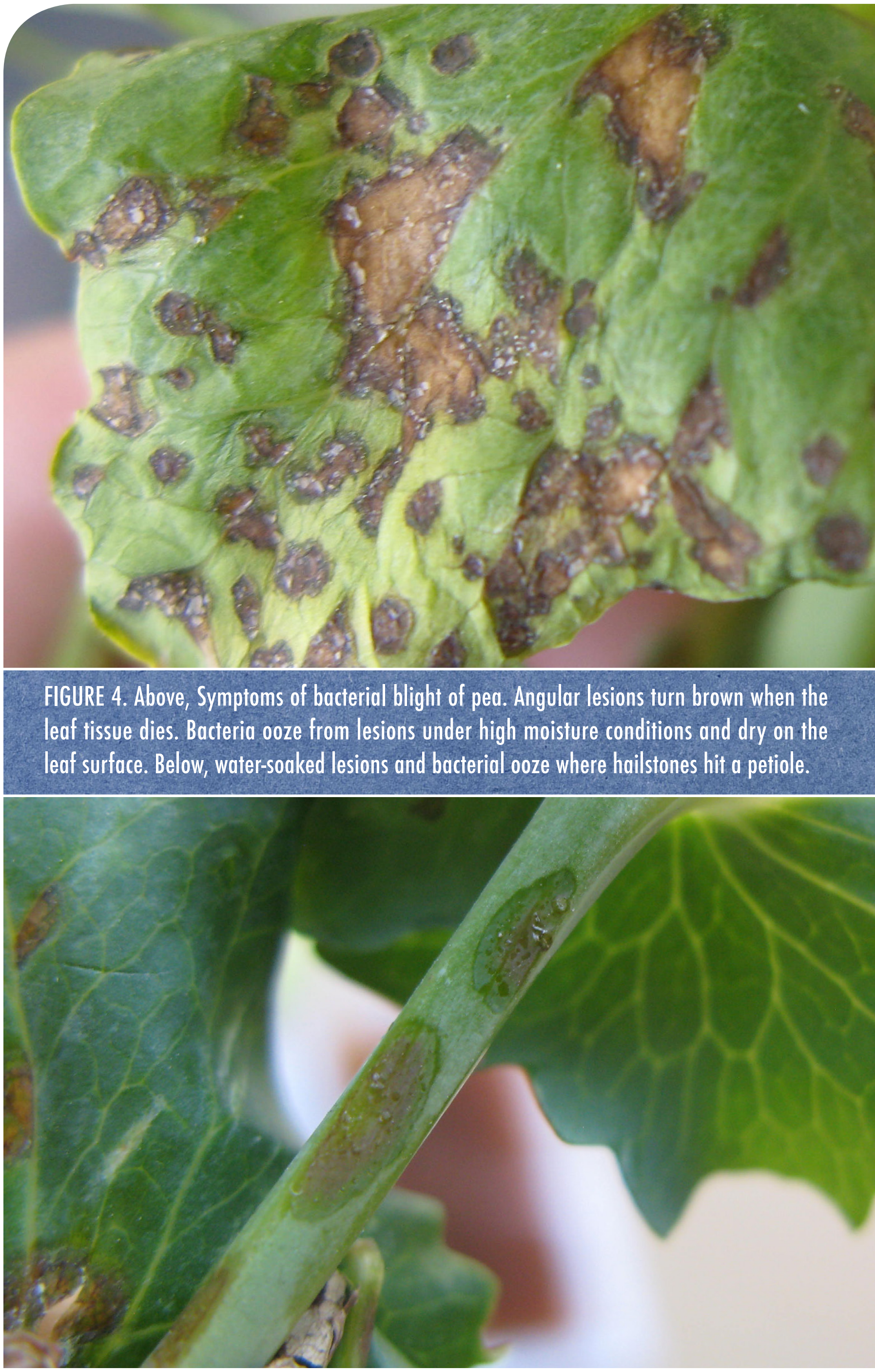

FIGURE 4. Above, Symptoms of bacterial blight of pea. Angular lesions turn brown when the leaf tissue dies. Bacteria ooze from lesions under high moisture conditions and dry on the leaf surface. Below, water-soaked lesions and bacterial ooze where hailstones hit a petiole.

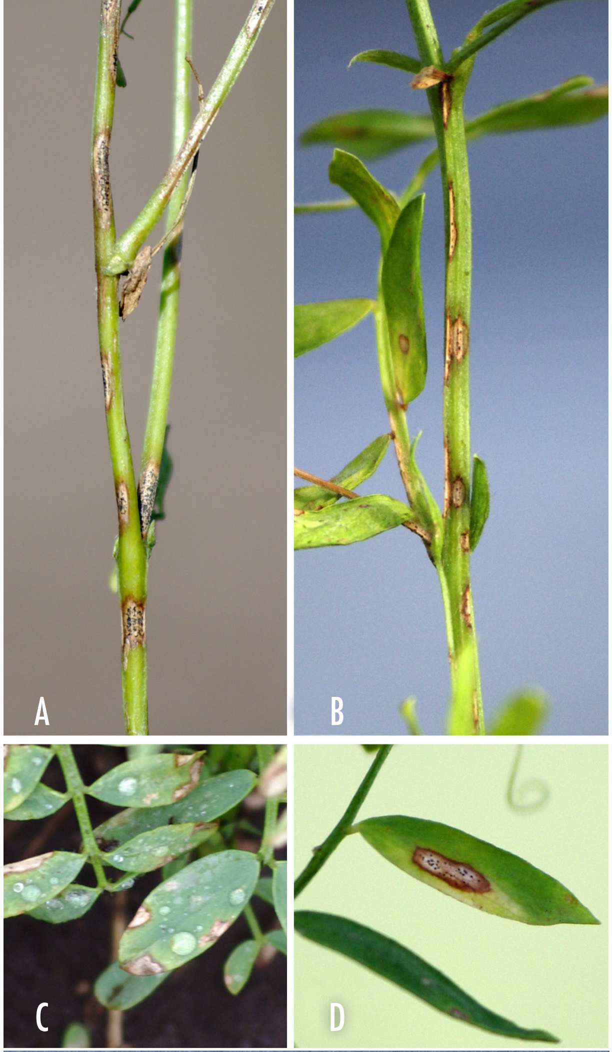

FIGURE 5. Anthracnose of lentil stem (A) and leaf (C) lesions. This disease is easily confused with Ascochyta blight (B, D) .

Alternaria blight, caused by *Alternaria alternata,* occurs sporadically and is often confused with Ascochyta blight. It infects over 400 plant species. The pathogen is seedborne and infested seed serves as the source of inoculum. The pathogen sporulates on seedlings and spreads via conidia (spores).

Symptoms include pale brown lesions on leaf margins and tips, particularly on older leaves. Affected leaflets drop off the plant. There may also be dark brown, elongated lesions on stems, petioles, flowers and pods. Temperatures of 75 to 82°F and high relative humidity (more than 85 percent) favor disease development.

Planting resistant cultivars can effectively manage this disease. Decreased plant density and reduced irrigation help reduce disease. Seed treatments can protect seedlings for up to 40 days after planting, and fungicide sprays can be applied when necessary.

Anthracnose of lentil is caused by the fungus *Colletotrichum truncatum.* It was first discovered in Canada, and has since been found in North Dakota and Montana. Where it occurs it can be a very serious disease. Symptoms include tan lesions that begin on lower leaves around 8-12 nodes or first flower (Figures 5A and C). Leaflets drop to the ground and may be the first indication of a serious disease problem. Lesions spread to stems and pods, and can defoliate plants. Deep tan lesions, often with black borders, can indent the stem, which is characteristic of anthracnose (Figure 5A). Defoliation and girdling can cause plants to wilt and lodge. Seeds from infected plants may be discolored and shriveled, resulting in significant dockage. The pathogen prefers temperatures of 68 to 75°F and 24 hours of leaf wetness.

Microsclerotia of the fungus on infested debris can live at least three years. Inoculum often comes from debris or seed, and windborne debris can carry the pathogen for many miles. This disease is best prevented by not introducing the pathogen into an area via seed transmission. There are foliar fungicides available for use. They should be applied at canopy closure or at the first symptoms of disease. Additional applications for disease control may be necessary.

Ascochyta blight is a limiting disease for chickpea production and may require multiple fungicide sprays for management. Pea and lentil are less susceptible to Ascochyta, but the disease can still require careful management depending on the timing and severity of infection and the prevailing weather conditions. The species of Ascochyta are host-specific, so for example, *Ascochyta rabiei* from chickpea will not infect pea. *Ascochyta fabae* f. sp. *lentis* infects lentil, and three different fungal species can infect pea: *Mycosphaerella pinodes, Phoma pinodella,* and *Ascochyta pisi*.

Lesions from Ascochyta on chickpea are very distinct (Figures 6 and 7). They are circular or oblong in shape, and may begin as small, light-colored specks on the leaf which expand into target-shaped lesions. Under moist conditions, each 'wave' of the lesion is surrounded by a brown to black halo, accompanied by small black fungal structures called pycnidia under moist conditions. Lesions can occur on stems, petioles, and pods (Figures 5 and 6). Lesions on pea tend to be more restricted, and the 'target' pattern tends to be less obvious (cover photo, center). Lesions on lentil are a lighter brown with a dark brown halo, but also often lack that 'target' pattern (Figures 5B and D). Lesions on plant tissue coalesce (Figure 7) and cause defoliation, stem breakage and lodging.

Management of Ascochyta blight begins at planting. This is a residue-borne disease, therefore we recommend a minimum of three to four years between the same legume crop (ie. two crops of chickpea) to allow residue decomposition. *P. pinodella* and *M. pinodes* can also survive long periods in soil as thick-walled chlamydospores. This pathogen can be seedborne at high levels (Table 1), and both North

FIGURE 6. Ascochyta blight causes stem lesions that can lead to stem breakage, left. Pod infection, right, can lead to discoloration and shrivelling of seed as well as seed transmission of the pathogen.

FIGURE 7. Ascochyta blight lesions on chickpea usually have a characteristic ring pattern. Lesions coalesce and cause defoliation. In the photo on the right, chickpeas resistant to Ascochyta blight (left) are not defoliated by the disease compared to the susceptible variety (right).

TABLE 1. Levels of seedborne Ascochyta in pulse crop seed samples submitted for tests in Montana, 2009 to 2012.

	Chickpea				Pea				Lentil			
	n	% above threshold	% with Asc	avg %	n	% above threshold	% with Asc	avg %	n	% above threshold	% with Asc	avg %
2009	2	0	0	0.0	57	12	26	0.2	25	4	12	0.1
2010	4	25	25	0.8	83	10	65	1.7	53	0	43	0.3
2011	14	43	43	0.5	107	5	85	1.8	163	12	47	4.0
2012	19	74	74	0.8	149	11	74	1.8	149	6	41	1.8

n = number of samples submitted for testing
% above threshold = percentage of samples above the threshold for Ascochyta (0% chickpea, 5% pea and 5% lentil)
% with Asc = percentage of samples with 1 seed of 500 or more with Ascochyta
avg % = the average percentage of Ascochyta in all seed samples tested

FIGURE 8. Stemphylium blight on lentil causes brown lesions that expand to a characteristic rolling of the leaves, left. Plants are defoliated, right.

FIGURE 9. Circular lesions on pods due to Septoria blight of pea, left. Note the lesions are sunken and pycnidia are not organized in concentric rings like Ascochyta blight. Irregular shaped leaf lesions on a pea leaf due to Septoria blight, right.

Dakota and Montana seed labs will test for Ascochyta. Please contact them directly for submission and fee instructions (contact information can be found on the outside back cover). We recommend zero percent seed-borne infection for Ascochyta in chickpea, and below five percent for pea and lentil. These levels are based on recommendations from other pulse-growing areas as well as the relative susceptibility of the crop. Thiabendazole (Mertect), azoxystrobin (Dynasty), and pyraclostrobin (Stamina) have shown efficacy against seedborne Ascochyta. Fluxapyroxad (Xemium) has also shown efficacy in preliminary trials, but is not currently formulated as a seed treatment for pulse crops. Due to the presence of strobilurin-resistant strains of Ascochyta in chickpea crops in Montana and North Dakota, we do not recommend the use of azoxystrobin or pyraclostrobin on chickpea. In North Dakota, resistant populations went from less than ten percent of detections to almost 100 percent in a single year (2005-2006) due to overuse of strobilurin fungicides. (Markell: personal communication)

Ascochyta also can blow in as spores from other pulse-growing areas. Environmental conditions favoring disease development include cool temperatures (59 to 77°F) and high humidity. The decision to spray a foliar fungicide will depend on the crop and variety, the timing of infection, the incidence (percent of plants infected) and severity (percent of tissue area with symptoms) of infection. Many foliar fungicides are effective against Ascochyta blight.

Examples of strobilurin fungicides include pyraclostrobin (Headline) and azoxystrobin (Quadris). Additional fungicide options include chlorothalonil (Bravo) as a protectant early in the season, prothioconazole (Proline), boscalid (Endura), and fluxapyroxad (Xemium + Headline = Priaxor) for in-season control. Fungicides should be applied at bloom initiation or canopy closure, or when the first symptoms are seen. Additional applications may be necessary. Please pay attention to label restrictions and rotate Fungicide Resistance Action Committee (FRAC) groups to prevent the development of resistance to these chemical classes.

Stemphylium blight (chickpea, lentil), caused by *Stemphylium botryosum,* is an emerging disease of importance on lentil in Canada (Garvey, 2009) and is known to occur on chickpea worldwide (Thakur et al. 2010) and is present in Montana and North Dakota. It causes leaf spots that begin as small, water-soaked lesions, become blackish-brown, and are divided by leaf veins. They often start at the edge of the leaflet, fuse with adjacent lesions and become large, causing defoliation of the plant (Figure 8). They are often oval or irregular in shape, sunken, dark brown with lighter centers and a yellow halo. Older spots on chickpea may develop concentric rings, resembling a target. In lentil, lesions tend to be more beige-colored, and dead leaves develop a characteristic rolled and twisted appearance (Figure 8). The pathogen can be transmitted by residue, soil, seed, wind and stubble. It prefers warm (about 77°F), moist (85 percent relative humidity and eight hours of leaf wetness) conditions for disease development. Infected seed has a significantly lower germination rate. There are no fungicides registered for control of this disease, and standard applications for disease control have not been effective thus far.

Septoria blight of pea does occur in Montana and is easily confused with Ascochyta blight due to the formation of small black spots (pycnidia) in the lesions. Lesions can be yellowed, sunken and circular or irregular in shape (Figure 9). Unlike Ascochyta blight lesions, pyncnidia caused by Septoria blight are not arranged in concentric circles and not all lesions are circular in shape. The disease is considered of minor importance and there are no fungicides registered for use.

Powdery mildew (*Erysiphe pisi, E. trifolii, E. baeumleri,* and *Leveillula taurica)* occurs sporadically in Montana and North Dakota, and generally occurs late enough in the season that it is not economical to control. Many varieties susceptible to powdery mildew grown in Montana can be difficult to grow elsewhere due to higher humidity and rainfall, which promote disease. This can be a dangerous practice in wet years. Early infections with powdery mildew can cause significant yield loss. The pathogen resides on infected trash, leguminous weeds or volunteer plants from previous crops. Infected plants are covered with a white powdery mass of spores that can be rubbed off the leaf (Figure 10). Disease develops at moderate to warm temperatures (70 to 85°F) and is favored by overnight dew, not rain. It can cause the crop to mature unevenly and cause problems with harvest, but desiccants will not be able to penetrate the mat of fungus and are thus not recommended. Fungicides are available for disease management early in disease development.

Gray mold (Botrytis) is considered of minor importance on pulse crops in the United States, but can be serious when flower and pod infection occur. The disease is caused by *Botrytis cinerea* in chickpea and lentil. Symptoms initially start as water-soaked lesions on stems, branches, leaves, flowers, and pods, then progress to grey/brown lesions and are often covered with a grey fuzz consisting of fungal hyphae and spores. The pathogen attacks all aerial parts of the plant, but prefers blossoms and pods.

FIGURE 10. Powdery mildew, top, forms a white mat of fungal hyphae on the leaf surface and can be rubbed off. Fungicides and dessicants cannot penetrate this thick layer of fungus.

FIGURE 11. A lentil field infected with Botrytis grey mold.

FIGURE 12. Symptoms of white mold on chickpea stems.

It is favored by temperatures of 68 to 75°F and high relative humidity (95 percent or more). Flowers commonly drop from the plant and cause significant losses (Figure 11). The pathogen can also cause a seedling soft-rot of chickpea, which is the result of seedborne inoculum.

B. cinerea has a very wide host range that includes over 100 plant species including crops and weeds. The pathogen enters a field via seed infection, infested soil and plant debris. The fungus survives on infected seed for up to five years and in chickpea stubble for nearly a year. It also survives on plant debris and in the soil as environmentally resistant sclerotia and chlamydospores.

Resistant varieties, compact and erect cultivars, wide row spacing, intercropping with non-hosts such as wheat, reducing irrigation, crop rotation, and deep plowing help manage disease. Seed treatment fungicides including thiabendazole (Mertect) can reduce seedborne inoculum.

White mold *(Sclerotinia sclerotiorum, S. trifoliorum* and *S. minor)* has a very broad host range (bean, mustard, potato, sunflower, etc.) and infects many broadleaf crops and weeds. It often enters fields in contaminated seed lots or equipment. Spores can also be windborne short distances from ditches or neighboring fields. It survives as a mass of fungal hyphae covered by an environmentally resistant black rind called a sclerotia. When conditions are favorable, such as at canopy closure when humidity levels in the canopy are high and the crop begins flowering, an inverted mushroom structure called an apothecium produces ascospores which infect the flowers. Hyphae can also grow directly into plant tissues, especially if there is plant-soil contact. The fungus will kill tissue and fill the stem with white hyphae and sclerotia, which then survive in the soil for many years (Figure 12). Sclerotia can be buried with tillage, but repeated tillage will bring them to the soil surface again. Boscalid (Endura) and prothioconazole (Proline) are registered for management of white mold and should be applied at the flowering stage of growth. Check label restrictions before application. Limited variety resistance may be available in dry pea and lentil cultivars. No resistance has been observed among chickpea cultivars. White mold is more common in winter-sown lentils than spring lentils due to their exposure to prolonged wet and cool spring weather.

VIRAL PLANT PATHOGENS

A number of viruses can infect pulse crops. The symptoms of infection can be subtle and easily confused with other disorders, including nutritional deficiency or herbicide damage, or ignored completely (Figure 13). Viral diseases are much more common in the Pacific Northwest, and are more severe in years when aphid populations are high. A common vector for many of these diseases is the pea aphid *(Acyrthosiphon pisum)*. Montana has been relatively free of viral issues thus far, which is an advantage of growing pulse crops here. However, in a year when aphids are high we may see many of these viral issues.

The pea aphid attacks pea, lentil, chickpea, alfalfa, clover, and some leguminous weeds. The aphid can cause direct damage by feeding on plants, but it also vectors several important viruses: *Bean leafroll virus* (BLRV), *Pea enation mosaic virus* (PEMV), and *Pea streak virus* (PeSV). The University of Idaho has an 'aphid tracker' website at www.cals.uidaho.edu/aphidtracker/trackerindex.asp with information on pea aphid thresholds and management. Alfalfa is a very good host of the pea aphid, so exercise caution when planting near alfalfa.

Viruses that have been found with some frequency in peas in North Dakota include PEMV and BLRV. Symptoms of BLRV (also known as pea leaf-roll virus) in pea include interveinal chlorosis, yellowing, stunting and leaf-rolling. BLRV is a luteovirus, which means the aphid must feed for an extended time to acquire and transmit the virus to new plants, so insecticides to control aphids should be effective against this disease. The pea aphid is the principal vector of BLRV. Other aphids can also transmit the virus.

PEMV is one of the most important and destructive viruses of lentils worldwide. It has been found in peas in North Dakota and Montana. Symptoms include stunting of the plant, twisted and malformed leaves, misshapen and poorly filled pods, and growths (bumps) on the pod surface. Symptoms may be confused with growth regulator herbicide damage. PEMV is also transmitted persistently by aphids, primarily the pea aphid, cowpea aphid, green peach aphid, potato aphid, and foxglove aphid. Insecticides may be effective. Generally aphid flights from other pulse-growing areas or neighboring fields carry the virus, and aphids may not be seen until too late for control to be implemented.

Other viruses which have been identified in legume crops include Alfalfa mosaic virus, Bean yellow mosaic virus, Cucumber mosaic virus, Pea seed-borne mosaic virus, and Pea streak virus.

VARIETY SELECTION

Variety selection is an important disease control strategy, especially in areas that grow significant acreages of pulse crops. Check with your retailer or county MSU Extension agent for the best-adapted variety in your area. Some variety reactions can be found in the Saskatchewan Ministry of Agriculture's 'Varieties of Grain Crops' report at www.agriculture.gov.sk.ca/Varieties_Grain_Crops.

FUNGICIDE USE

Fungicide recommendations are available from several sources. University sources include fact sheets on the High Plains IPM guide (http://wiki.bugwood.org/HPIPM), AgAlerts, presentations, and your county agent. Your fungicide salesperson also has information. Another good source for our region is the NDSU Fungicide Guide at http://www.ag.ndsu.edu/extplantpath/publications-newsletters/fungicides and the Carrington Research Extension Center website at http://www.ag.ndsu.edu/CarringtonREC/agronomy-1/copy_of_crop-index/plant-pathology. The majority of the chemicals registered in North Dakota are registered in Montana, but always check the label. Section 18 and 24c (local) registrations are available on the Montana Department of Agriculture website at http://agr.mt.gov/agr/Programs/Pesticides/Registration/SpecialRegistrations/.

FIGURE 13. Virus-like symptoms in peas

FOR FURTHER INFORMATION

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High Plains IPM Guide. http://wiki.bugwood.org/HPIPM

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HELPFUL WEBSITES AND CONTACTS

Northern Pulse Growers Association
1710 Burnt Boat Drive
Bismarck, ND 58503
Ph: (701) 222-0128 Fax: (701) 222-6340
Email: info@northernpulse.com
www.northernpulse.com/about/

North Dakota State University Diagnostic Labs
306 Plant Bioscience Building
Fargo, ND 58102
Ph: (701) 231-7854
ndsu.pdl@ndsu.edu

Pulse Info
www.ndsu.edu/pubweb/pulse-info/index.html

Schutter Diagnostic Laboratory
119 Plant BioScience Building
Bozeman, MT 59717-3150
Ph: (406) 994-5150
diagnostic@montana.edu

USA Dry Pea & Lentil Council
2780 W. Pullman Road
Moscow, ID 83843
Ph: (208) 882-3023 Fax: (208) 882-6406
Email: pulse@pea-lentil.com
www.pea-lentil.com

PULSE BREEDING PROGRAMS

Kevin McPhee, NDSU, http://www.ag.ndsu.edu/plantsciences/people/faculty/mcphee

TESTING FOR SEEDBORNE PATHOGENS OF PULSE CROPS

Contact each vendor to get details on services, prices, sampling and shipping methods.

Montana State Seed Testing Laboratory
Department of Plant Sciences/Plant Pathology
Room 40 Marsh Lab
P.O. Box 173145
Bozeman, MT 59717-3145
(406) 994-2141
http://plantsciences.montana.edu/seedlab/index.html

North Dakota State Seed Department
P.O. Box 5257
Fargo, ND 58105-5257
(701) 231-5400
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SGS Seed Services, Inc
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