

Contents

Alfalfa (AL)

Diagnostic Section	3
Scouting Calendar	3
Generalized Calendar for Alfalfa Insect Pests of Wisconsin	3
Alfalfa Pest Management Form	4
Insect Section	5
Quick Reference	5
Insect Profiles	7
Alfalfa Blotch Leafminer	7
Alfalfa Weevil	7
Clover Root Curculio	9
Occasional Pests of Alfalfa	10
Pea Aphids	11
Plant Bugs	12
The Potato Leafhopper	13
Disease Section	15
Quick Reference	15
Alfalfa Disease Management	17
Disease Profiles	18
Winter Injury	18
Heat and Drought Injury	19
Tractor Damage	19
Genetic Rough Rot	19
Leaf and Stem Diseases	20
Leptosphaerulina Leaf Spot	20
Common Leaf Spot	20
Spring Black Stem and Leaf Spot	21
Summer (Cercospora) Black Stem	21
Yellow Leaf Blotch	22
Downy Mildew	23
Stemphylium or Zonate Leaf Spot	23
Rust	24
Alfalfa Mosaic	24
Anthracnose	25
Reducing Losses from Leaf and Stem Diseases	25
Vascular Wilts	26
Bacterial Wilt	26
Fusarium Wilt	27
Verticillium Wilt	27
Phytophthora Root Rot	28
Phytophthora - Aphanomyces Root Rot Complex	29
Violet Root Rot	30
Fusarium Root and Crown Rots	30
Management to Reduce Root and Crown Rot Losses	31

Scouting Calendar

Generalized Calendar for Alfalfa Insect Pests of Wisconsin

May	June	July	August	September
Alfalfa Weevil				
Pea Aphid				
Spittle Bug (nymphs)				
	Potato Leaf Hopper			
Plant Bugs				
May	June	July	August	September

Alfalfa Pest Management Form

Grower:	County:	Date:
Field No./Location:	Weevil degree days (base 48° F):	

Alfalfa Weevil Larvae: Sample of 40 stems picked at random.

Number of stems with tip feeding _____ + 0.40 = _____ % tip feeding.

Number of stems with flower buds _____, with blossoms _____.

Plant height (inches) use 10 plants from original 40:

__+__+__+__+__+__ +__+__+__+__+__ = __/10 = Av. Ht.

Diseased larvae present? _____.

Potato Leafhoppers: Use 20 net sweeps per set.

	<u>Set 1</u>	<u>Set 2</u>	<u>Set 3</u>	<u>Set 4</u>	<u>Set 5</u>	<u>Total</u>	<u>Av./sweep</u>
Number adults							
Number nymphs							

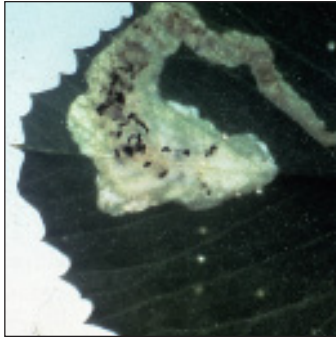
Pea Aphid: use 20 net sweeps per set.

	<u>Set 1</u>	<u>Set 2</u>	<u>Set 3</u>	<u>Set 4</u>	<u>Set 5</u>	<u>Total</u>	<u>Av./sweep</u>
Number of aphids							
Diseased or parasitized aphids present?							

Plant Bugs (Tarnished, Rapid, and Alfalfa): Use 20 net sweeps per set.

	<u>Set 1</u>	<u>Set 2</u>	<u>Set 3</u>	<u>Set 4</u>	<u>Set 5</u>	<u>Total</u>	<u>Av./sweep</u>
No. of Plant bugs							
<p>Here include alfalfa diseases noted and abnormal growth patterns, observations on spittlebugs, armyworms and cutworm and results of stubble scouting for continuing feeding by alfalfa weevil, and nutrient deficiencies and weeds.</p>							

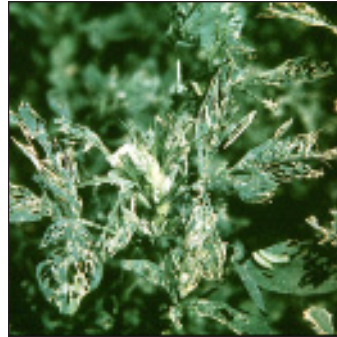
Alfalfa Insects



Alfalfa Blotch Leafminer



Alfalfa Weevil
Adult/Larvae/Pupae



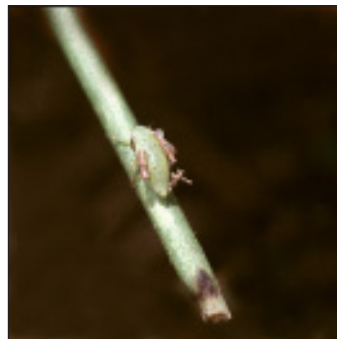
Alfalfa Weevil
Damage



Clover Root Curculio
Damage



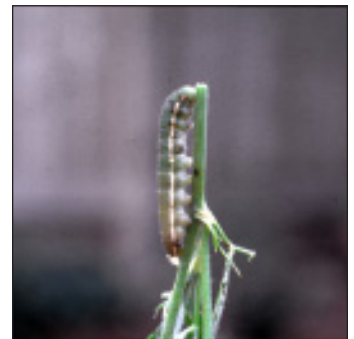
Meadow Spittlebug *Eggmass*



Meadow Spittlebug
Nymph



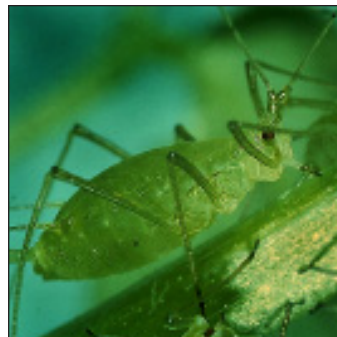
Meadow Spittlebug



Alfalfa Caterpillar



Pea Aphid



Pea Aphid



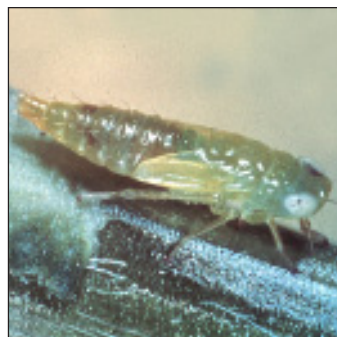
Alfalfa Plant Bug
Nymph/Adult



Tarnished Plant Bug
Nymph



Tarnished Plant Bug



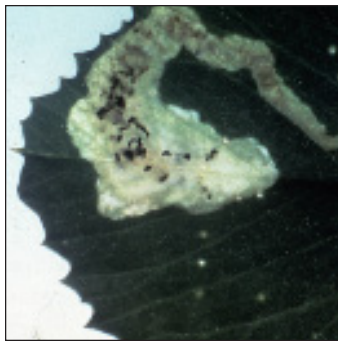
Potato Leafhopper
Nymph



Potato Leafhopper

Insect Profiles

Alfalfa Blotch Leafminer



Identification and Life

Cycle:

The alfalfa blotch leafminer, *Agromyza frontella* (Rondani), may go through 3-4 generations/year in the upper Midwest. The adult is a black, approximately 1/8-inch long hump-backed fly.

The maggots are small and

pale yellow. Females will lay 1-3 eggs/leaf. When the maggots hatch, they feed between the leaf surfaces in a mining fashion. When development is complete, larvae will leave the leaf and drop to the ground to pupate.

Damage:

Larval mines can usually be diagnosed through their comma-like appearance. Twenty five to fifty percent of the leaflets may be mined during heavy infestations and this could result in loss of quality. Yield loss is not expected unless significant leaf drop occurs. Adults feed by puncturing tiny “pinholes” in the leaf. This type of damage is usually not considered a plant health problem.

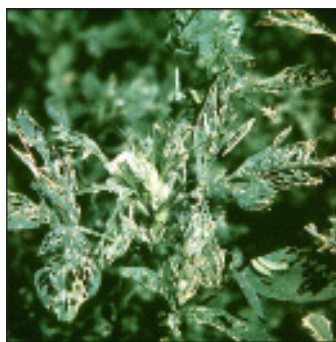
Scouting and Damage Threshold:

Decisions to treat must be made during the adult pinhole feeding stage. Scout fields on a weekly basis to determine the percentage of leaves with pinhole feeding. Control may be necessary when 30-40% of the leaflets show the adult pinhole feeding.

Control:

The need for chemical control is difficult to determine. Economic benefits will only be obtained if leaf drop occurs or if a high percentage of the leaflets show excessive feeding. Early cutting can be used to reduce damage and would be most beneficial during first crop. Subsequent cuttings may not coincide with peak larval damage. Biological control has been firmly established and has been very effective in the northeastern United States after the release the introduced parasite *Dacnusa dryas* (Nixon). An indigenous parasitoid has been found attacking Alfalfa Blotch Leafminer pupae in Wisconsin. Parasitism rates of greater than 50% have been found. However, it is uncertain what degree of control this parasitoid may provide on an annual basis.

Alfalfa Weevil



Identification

Alfalfa weevil adults are small (1/4 inch), light brown in color with a darker brown v-shaped “shield” on their back. Larvae have a black head, a white stripe down their back and will grow to a length of 3/8 inches. Small larvae are slate-colored when small but will eventually become green in color.

Life Cycle

Alfalfa weevils overwinter as adults in plant debris along fence rows, ditch banks, woodlots, etc. Starting with the first warm

spring days they migrate to alfalfa fields and lay eggs in new or dead plant stems. Peak egg lay and larval feeding is usually around early and late May, respectively. Larvae spin a white silken cocoon when development is complete and adults emerge within two weeks. Newly emerged adults will feed on alfalfa foliage for a short time before migrating out of the field to their summer “hibernation” sites. Adult weevils are not active during the summer months but occasionally will be collected in sweep nets. By using degree days, crop advisors and field scouts can monitor alfalfa weevil activity. Begin scouting activity at egg hatch (approximately 300 degree days, base 49°F). An additional 295 (base 48° F) degree days are required to complete larval development (see table below).

Damage

Some larvae cause damage by chewing tiny holes in the upper leaves. As larvae grow, the amount of foliage consumed increases dramatically. When larval numbers are high, complete defoliation of the upper leaves can occur. Peak

damage often occurs when the first cutting is ready for harvest. Significant yield loss can also occur when larvae and/or adults feed on second crop regrowth. Feeding is usually completed by the time second crop regrowth is 8-10 inches tall.

<u>Stage of Development</u>	<u>Degree Days Required to Complete Indicated Life Stage</u>	<u>Accumulated Degree Days</u>
egg	300 (base 44° F)	300
1st instar	71 (base 48° F)	371
2nd instar	67 (base 48° F)	438
3rd instar	66 (base 48° F)	504
4th instar	91 (base 48° F)	595
pupa		219 (base 49° F) 814

Scouting and Economic Threshold

Start monitoring alfalfa at 300 degree days. Spot-check sandy knolls or fields with south facing slopes and look for tiny pinholes in the upper leaves. Spot-checking will help determine when to start detailed scouting of all fields.

To make a detailed evaluation of first crop weevil damage, walk an M-shaped pattern and collect 50 stems at random. When finished, carefully look over each stem for signs of weevil feeding. Count all stems that show signs of feeding and divide that number by 50 (total number of stems initially collected) to determine percentage tip feeding. Control is suggested when 40% or more of the stems show signs of weevil feeding.

Check alfalfa regrowth 4-5 days after cutting for signs of weevil injury. Remember that dry weather, as well as weevil feeding, can delay regrowth. Look for larvae (or adults) on the soil surface around alfalfa crowns. They often can be found under leaf litter or at the juncture between soil and the alfalfa crown. During cool, cloudy weather you may find weevils feeding on new alfalfa buds during daylight hours. It is difficult to make control decisions based on the number of larvae found. A better method is to take another stem sample, as you did with first crop, and treat the field when 50% of the stems have feeding injury. Before deciding to spray, use an insect sweet net to make sure weevils are still present. Natural control factors can significantly reduce weevil numbers or the weevils may have formed a cocoon and will no longer be causing damage.

Control Methods

If 40% tip feeding is found more than 7-10 days prior to the suggested harvest date, the field should be sprayed as soon as possible. Although "early" harvest is an excellent way of killing alfalfa weevil larvae, harvesting too early could be

detrimental to alfalfa stands. Also, growers may not be able to harvest fast enough to stay ahead of weevil damage. In these cases, growers may have to spray the most heavily infested fields and harvest those with lighter infestations. There are a number of insecticides registered for alfalfa weevil larval control. However, if you have adult weevils, select an insecticide that is labeled for adult control. For more information regarding insecticides labeled for alfalfa weevil control, consult University of Wisconsin-Extension bulletin number A3646 "Field Crop Pest Management in Wisconsin" which is available from your local county extension office. Pay close attention to pre-harvest restrictions. These restrictions vary according to the insecticide used and the rate at which it is applied. When selecting insecticides, consider price, potential hazards to honey bees and whether or not it is a restricted use pesticide. Read the label carefully before applying any pesticide.

There are several natural enemies that do an excellent job of controlling the alfalfa weevil. Which is why insecticides are recommended only as a last resort and then only when significant yield losses are unavoidable. Several small, non-stinging species of wasps have been introduced by the Wisconsin Department of Agriculture, Trade and Consumer Protection and can be responsible for keeping weevil populations below treatment levels. There is also a fungal pathogen that attacks weevil larvae and can decimate weevil populations in a few days. Although these natural control factors are effective, conditions may not always be favorable for acceptable results. Always use timely field scouting before making control recommendations.

Clover Root Curculio



The clover root curculio, *Sitona hispidula* (F.) is of foreign origin and was first discovered within the United States in New Jersey during 1876. Since that time it has spread to many of the alfalfa and clover producing areas. In Wisconsin, this pest can be found in most clover and alfalfa fields but high popula-

tions and serious damage have been localized and sporadic. However, it is possible that low level populations have contributed to stand declines.

At this time there is no reliable method of damage prediction or control.

Identification

The adult is a black to dark brown, blunt-snouted weevil approximately 1/8 inch long and 1/16 inch wide. Red, brown or gray scales are present on the upper surface. The surface is also deeply "punctured".

Eggs are small and white to yellow when first laid, but turn black within 1-2 days. They are either deposited on stems, the undersides of lower leaves, or on the soil surface.

Larvae are small, white, fleshy, legless, slightly tapered grubs with a light-brown head. They are approximately 1/4 inch long when fully grown.

Life Cycle

There is only one generation per year, and although there may be a few overwintering eggs, the adult (beetle) is the primary overwintering stage in Wisconsin. They locate under plant debris in alfalfa and clover fields, pastures, and uncultivated waste areas.

Adult activity and egg laying begin with the first warm days of spring. Although mating has been observed at 40°F, the beetles are most active at temperatures from 50-75°F.

Research indicates that peak egg laying will be over by early-to mid-June. Spring-laid eggs will hatch within 1-2 weeks but those laid in the fall will not hatch until the following spring.

After hatching, the young larvae will move through soil cracks and begin to feed on roots. With the exception of fall-laid eggs, adults will begin to appear within 40-45 days after the eggs are laid. Although there is an overlap of overwintered and new spring adults, the old adults die off rapidly in May.

The larval stage lasts 3-4 weeks. Newly emerged larvae first feed on small rootlets and nodules then move to the main root as they mature. Mature larvae leave the roots in June and July and form a pupal cell. Within these cells, the larvae will change into beetles in approximately 10-20 days. These new adults move to the surface and begin to actively feed on leaves. During hot

summer weather they will remain relatively inactive on lower plant parts and the soil surface. Mating commences in early autumn and continues until the arrival of winter.

Damage

Although adults are capable of flying, most appear to migrate primarily by crawling from field to field. Adults injure plants either by chewing crescent-shaped notches in the margins of leaves, or chewing the stems and leaf buds of young seedlings. This can weaken seedlings. Feeding injury to mature plants is not important unless adults are numerous. The larvae do the greatest damage, and such damage can be cumulative over the years that a field exists. They destroy small rootlets and nodules and chew out portions of the main root; this latter damage may appear as long brown furrows, and result in partial girdling of the plant. Their damage is believed to reduce the potential longevity of a stand, as well as contributing to winter heaving and providing places of entrance for disease organisms.

Although larval damage has been found as deep as 28 inches below the soil surface, most damage occurs in the upper 6 inches.

Host Plants

The clover root curculio has been associated with damage to several species of clover, alfalfa, and soybeans. Larvae have even been found on the roots of bluegrass. Although there are no recorded instances of injury to commercial peas in Wisconsin, the adults will probably feed on them as readily as any other leguminous crop.

Although injury to soybeans is uncommon, it can be severe. Adults either feed on leaves or gouge holes in the stem near the soil surface. They can completely defoliate soybeans in rows adjacent to recently plowed clover or alfalfa. Damage can occur throughout soybean fields previously containing alfalfa or clover.

Alfalfa is attractive to, and can be severely damaged by adults and larvae. There have been instances when adults have migrated from clover and destroyed adjacent alfalfa seedlings. However, clovers are the preferred host. In a host preference study (Thompson, 1971), the larvae preferred (in order of decreasing preference) roots of red, white, and alsike clover over those of alfalfa and birdsfoot trefoil. Little damage was noted on the trefoil. Adult preference was similar except that white clover was distinctly preferred over the rest; trefoil was again low in preference. The preferred clover plants may also be more susceptible to attack than alfalfa.

References

Thompson, L.S. and C.B. Willis. 1971. Forage legumes preferred by the clover root curculio and root lesion nematodes for species of *Trifolium* and *Medicago*. *J. Econ. Entomol.* 64(6) : 151-20.

Occasional Pests of Alfalfa

Meadow Spittlebug

Philaenus spumaris (Linn.)

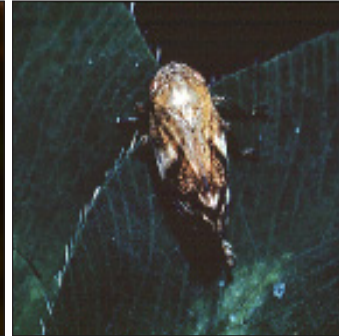
Identification and Life

Cycle:

Adults are 3/8 inch long, wedge-shaped and range in color from pale brown, dark brown, gray or mottled.

Nymphs resemble the adults in shape. Early instar nymphs are pale orange to yellow in color and by the fifth instar are green. There is one generation/year. Meadow spittlebugs

overwinter as eggs. When nymphs hatch they form a spittle mass which may be used to prevent desiccation and for protection from predators. Nymphs stay in this spittle mass until late first crop or early second crop, at which time they will become light green in color and can be confused with potato leafhopper nymphs. However, it is uncommon for leafhopper nymphs and spittlebug nymphs to be present simultaneously.



Damage:

Spittlebug damage to alfalfa is uncommon. However, stunting may result when nymphs are present in high numbers.

Scouting & Damage Threshold:

Meadow spittlebugs are common but rarely cause economic damage. An average of 1 nymph/stem is necessary before control is needed. Adults do not damage alfalfa.

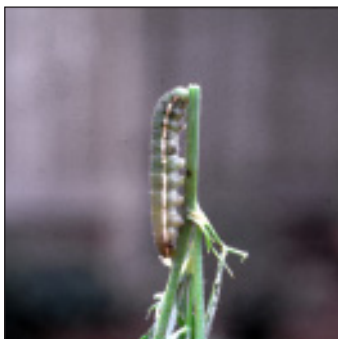
Alfalfa Caterpillar

Colias eurytheme

Identification and Life Cycle:

Alfalfa caterpillars overwinter in the pupal stage and complete 2 generations/year in the

upper Midwest. Larvae are dark green and have a small white stripe on each side. Full-grown larvae are approximately 1 1/2 inch long. The adult butterfly is yellow with black wing margins and has a wingspan of approximately 2 inches.



Damage:

Alfalfa caterpillars damage alfalfa by feeding on the leaves of second and subsequent cuttings of alfalfa. First signs of damage will be holes in the leaves and/or feeding from the leaf margin in. Under high populations, alfalfa leaves will be partially to completely consumed.

Scouting:

To get an accurate and unbiased estimate of alfalfa caterpillar populations you must use a standard 15-inch sweep net. Walk an M-shaped pattern in the field and take twenty consecutive sweeps in each of five randomly selected areas. The economic threshold is based on the average number of larvae/sweep. Keep a running total of the numbers caught and divide by 100 (total number of sweeps taken/field). Treatment is only suggested when you average 10 or more alfalfa caterpillars /sweep. Although alfalfa caterpillars are easily found, economic damage is unusual. An insect virus can spread rapidly and cause high mortality. Early symptoms of viral infection include pale coloration. Infected larvae soon become blackened and can be found hanging from the plant when dead.

Pea Aphids

Acyrtosiphon pisum

Identification



Pea aphids, often called plant lice, are green, soft bodied insects which range in size up to 1/8 inch. Adults may or may not have wings. Nymphs resemble adults but are smaller and do not have wings. Pea aphids are easily confused with plant bug nymphs. Plant bugs, as compared to pea aphids, are very mobile and have thicker and easily recognizable antennae. Pea aphids have a pair of cornicles (sometimes called tailpipes) protruding from the end of their abdomen. This is a characteristic that only aphids have. However, these “tailpipes” are hard to see without magnification.

Life Cycle

Pea aphids overwinter as eggs in alfalfa fields and hatch in early spring. All of these aphids are female. Males do not appear until late summer or early fall. Early season females do not need to mate to reproduce and do not have an egg stage. Instead, they give birth to living young at an extremely high rate when conditions are favorable. Therefore, population explosions are possible. Male aphids appear when days become shorter and mate with female aphids, which will lay eggs capable of surviving our winters.

Damage

Pea aphids have piercing sucking mouthparts and damage alfalfa by removing plant sap. Symptoms of aphid feeding are 1) stunted plants and 2) possible wilting during hot/dry weather. Damage from aphids can potentially be found in all cuttings. Aphids secrete a sugary substance call honeydew. Although honeydew does not directly affect alfalfa, it is a sign that aphids are present.

Scouting and Economic Threshold

Because aphid populations fluctuate, the only way to accurately monitor their populations is through the use of an insect sweep net. Walk the field in an M-shaped pattern and take twenty consecutive sweeps in each of five randomly selected areas. Do not take sweeps within 75 feet of the edge of a field.

If you are scouting contour strips, we suggest taking sweeps along the middle of each strip. Keep a running total of the number of pea aphids found and divide by 100, which is the total number of sweeps taken for each field. The economic threshold (point at which the amount of damage will exceed the cost of control) is based on the average number of aphids/sweep. When aphid populations exceed 100/sweep, control strategies may be necessary, especially if plants show signs of wilting. Pay close attention to new seedings of alfalfa. Aphid populations frequently build to damaging levels because of the lack of, or longer time period between harvest when compared to established stands.

Control Methods

Although pea aphids are capable of building to high numbers in a very short period of time, they are considered an occasional pest of alfalfa. Why? Because there are many natural insect predators and parasites which effectively control aphids. Lady beetles, green lacewing larvae, damsel bugs, and parasitic wasps are just some of the important natural enemies of aphids and they can be responsible for keeping aphid populations below economic levels. However, excessive use of insecticides for other alfalfa pests will kill beneficial insects as well as the target pest. Therefore, use insecticides only when economically justified. In addition to the insect predators and parasites, a naturally occurring fungal disease is also capable of controlling aphid populations when cool/humid weather conditions are present.

When aphid populations reach the economic threshold and you are within 7 days of cutting, an early harvest is an excellent method of control. Our frequent cutting schedule is one of the reasons aphid populations do not frequently reach high numbers. Aphids exceeding the economic threshold can easily be controlled with insecticides that are registered for use on alfalfa. Consult UW-Extension bulletin A3646, Pest Management in Wisconsin Field Crops (available from your local county extension office) for an approved list of insecticides, rates and precautions. Pay close attention to pre-harvest restrictions. This restriction varies depending on the insecticide used and the rate in which it is applied. Typically these restrictions vary from 7-14 days, although some are longer and some shorter. When selecting an insecticide you should also consider price, potential hazards to honey bees, and whether or not it is a restricted use pesticide. Read the label carefully before applying any pesticide.

Plant Bugs

The alfalfa plant bug and tarnished plant bug are occasional insect pests on alfalfa. Damage estimates for Wisconsin are difficult to obtain because the Wisconsin Department of Agriculture Trade and Consumer Protection combines plant bug and potato leafhopper damage. However, it is usually agreed upon that plant bug damage potential is quite small, especially when compared to the potato leafhopper. Although individual fields can suffer yield loss when infested with plant bugs.

Alfalfa Plant Bug

The body of the adult alfalfa plant bug is oblong, 3/8 inch long, and green to yellowish-green in color. Nymphs are usually lime green but are occasionally a reddish-orange color and range from 1/16 to 3/8 inch in length. The nymphs closely resemble the adults in appearance except they do not have wings and are smaller. Adults and nymphs feed on a variety of plants. They overwinter as eggs laid in alfalfa stems. The nymphs go through five instars before they turn into adults. In the midwest, there are usually two distinct generations. Peak first generation adults appear between the end of June and mid-July. Peak numbers of second-generation adults occur from early August to early-September.



Tarnished Plant Bug

The tarnished plant bug adult is oval and approximately 1/4 inch long and brown in color. Newly hatched nymphs are approximately 1/16 inch in length and are pale green. Tarnished plant bug nymphs, like alfalfa plant bugs, must go through five instars before they become adults. By the third instar you can see five black spots on their backs. The tarnished plant bug overwinters as an adult and will begin to lay its eggs in alfalfa stems in the spring. There are two generations/year. The first nymphs will appear as early as mid-May with the first generation adult peaking by the end of June to mid-July. The second-generation peak occurs from the end of August to early-September.



Damage to Alfalfa

Adults and nymphs of both species damage alfalfa by sucking plant sap and by leaving some toxic saliva in the plant. It is not fully understood if one species causes more damage to alfalfa than the other. Currently we suggest combining totals of each species when scouting.

Plant bug injury symptoms appear as stunting, malformed, crinkled and/or mis-shaped leaves. They do not cause alfalfa to discolor. The toxic saliva of plant bugs inhibits cell expansion near the feeding site and this is the cause of malformed leaves. However, this symptom can also be found in the absence of plant bug feeding. We have noticed this symptom associated with very cool and hot conditions. If you are not sure if symptoms are a result of plant bug feeding or environmental influence, use an insect sweep net to confirm your suspicions.

Scouting

Because plant bug densities vary from year to year and especially from field to field and because they are highly mobile, the only way to accurately monitor their populations is through the use of a fifteen inch diameter insect sweep net. Walk the field in an M-shaped pattern and take twenty consecutive sweeps in each of five randomly selected areas. Do not take sweeps within 75 feet of the edge of a field. If you are scouting contour strips, we suggest taking sweeps along the middle of each strip. Keep a running total of plant bug numbers (both tarnished and alfalfa) and divide by 100 (the total number of sweeps taken for each field). The economic threshold for plant bugs is to spray when plant bug populations exceed 3/sweep on 3 inch or shorter alfalfa. When the alfalfa is greater than 3 inches tall, the economic threshold is increased to 5 plant bugs/sweep. Do not spray if you are with 7 days of harvest.

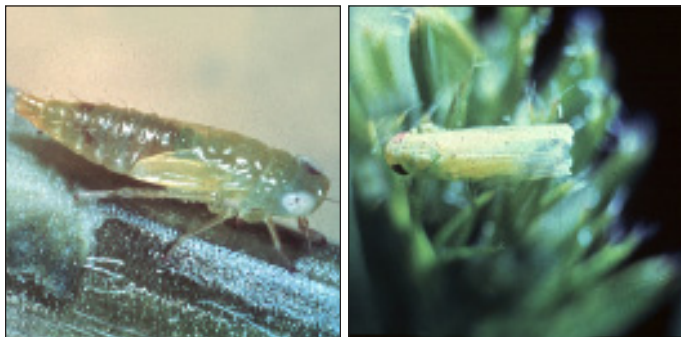
Control Methods

There are few natural predators of plant bugs and there is no known varietal resistance. As mentioned in the previous paragraph, an early cut is an effective cultural control measure when the economic threshold is exceeded and you are within 7 days of your normal cutting schedule.

When plant bug populations exceed the economic threshold they can be easily controlled with insecticides that are registered for plant bugs on alfalfa. Consult UW-Extension bulletin A3646, Pest Management in Wisconsin Field Crops (available from your local county extension office) for an approved list of insecticides, rates and precautions. Pay close attention to pre-harvest restrictions. This restriction varies depending on the insecticide used and the rate in which it is applied. Typically these restrictions vary from 7-14 days, although some restrictions are longer and some shorter. When selecting an insecticide you should also consider price, potential hazards to honey bees, and whether or not it is a restricted use pesticide. Read the label carefully before applying any pesticide.

The Potato Leafhopper

The potato leafhopper is the worst insect pest on alfalfa in the Midwest. Damage estimates (yield loss + control costs) prepared by the Wisconsin Department of Agriculture, Trade and Consumer Protection in recent years have ranged from



as little as \$2 million (1989) to as much as \$23 million (1986).

Identification

Adult potato leafhoppers are 1/8 inch long, wedge shaped, are fluorescent green in color and have wings. Nymphs have the same general appearance as adults except they: 1) can be much smaller, 2) range in color from yellowish-green to fluorescent green and 3) do not have wings. Leafhopper nymphs can also be distinguished from other small green insects because they can walk sideways when disturbed.

Life Cycle

Potato leafhoppers do not overwinter in Wisconsin, but instead, migrate to the Midwest from the Gulf States on southerly spring winds. The migration pattern is the reason why it can be difficult to predict their damage potential from year to year. When winds are light, few southern storm fronts develop and/or the winds patterns are shifted to the east or west of our state, we receive relatively few leafhoppers. Although, we may not have widespread problems with leafhoppers in these situations, localized fields may still have significant problems. When migrating conditions are favorable we can have significant problems statewide. Migrating leafhoppers typically arrive in mid to late-May. Therefore, first crop alfalfa usually escapes economic damage. Each generation takes approximately 4-5 weeks to mature and we may experience 3-4 generations/year in the Midwest. Potato leafhoppers can survive and cause economic damage through late summer or early fall.

Damage

Both adult and nymphs damage alfalfa by sucking plant sap and injecting a toxin back into the plant. This toxin inhibits water and nutrient transport. Damage symptoms appear as stunting as well as yellowing of the leaves in a v-shaped pattern starting at the tip of a leaf. Eventually, these leaves may turn completely yellow or reddish in color.

As a result of this injury, there are several ways leafhopper cause economic damage. They are:

- 1) Yield loss
- 2) Quality loss, because the plant produces sugars instead of protein
- 3) Reduction in overall plant vigor, causing slower recovery of regrowth after harvest, increased stand loss due to winter kill and a potential yield loss the following season when leafhopper populations are high.

Scouting

Because leafhopper population densities vary from year to year and from field to field, the only way to accurately determine damage potential is by monitoring fields on a weekly schedule. To get an accurate and unbiased estimate of leafhopper populations you must use a standard 15-inch diameter insect sweep net. Walk an M-shaped pattern in the field and take twenty consecutive sweeps in each of five randomly selected areas. The economic threshold (point at which you need to implement a control program) is based on the average number of leafhoppers/sweep. Keep a running total of the number of leafhoppers caught and divide by 100 (which is the total number of sweeps taken in each field). Be very careful when looking for leafhopper nymphs. Usually you will not find them at the bottom of the sweep net (as you would the adults). Instead, they are frequently found around the collar of the net.

The threshold for potato leafhopper is based on plant height, the shorter the alfalfa, the fewer leafhoppers it takes to cause economic damage. If the alfalfa is 3 inches tall, spray when the average number of leafhoppers reaches 0.2/sweep. When alfalfa reaches an average height of 6 inches, the threshold is increased to 0.5 leafhoppers/sweep. When plant height is 8-11 inches or greater than 12 inches the leafhopper threshold is then 1.0/sweep and 2.0/sweep, respectively. Do not spray if you are within 7 days of your normal cutting schedule. Instead, cut the alfalfa and reassess the situation by sweeping the regrowth for leafhoppers.

Control Methods

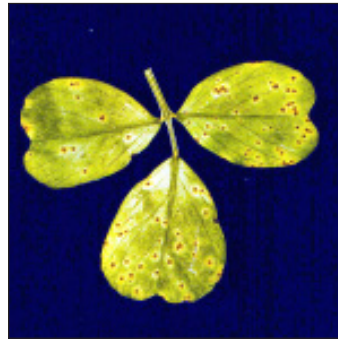
There are few natural predators and parasites of the potato leafhopper and those present do not provide adequate and consistent control. However, cutting alfalfa usually kills a high percentage of the nymphs and forces the adults out of the field in search of food. Commercial alfalfa varieties are also available which claim resistance to potato leafhoppers. Potato leafhoppers are not difficult to control with insecticides. There are a number of registered insecticides that provide adequate control. Consult UW-Extension bulletin A3646, Pest Management in Wisconsin Field Crops (available from your local

county extension office) for an approved list of insecticides, rates and precautions. Pay close attention to the pre-harvest restrictions. This restriction varies depending on the insecticide used and the rate at which it was applied. Typically, these harvest restrictions vary from 7-14 days. Although some restrictions are longer and some are shorter. Also, you should consider price, honeybee hazards and whether or not it is a restricted use insecticide. Read the label carefully before applying any pesticide.

Alfalfa Diseases



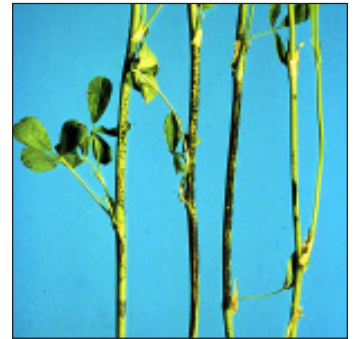
Winter Injury



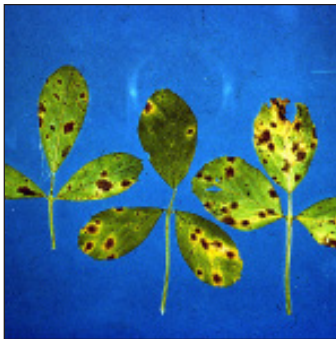
Leptosphaerulina Leaf Spot



Common Leaf Spot



Spring Black Stem and Leaf Spot



Summer (Cercospora) Black Stem



Yellow Leaf Blotch



Downy Mildew



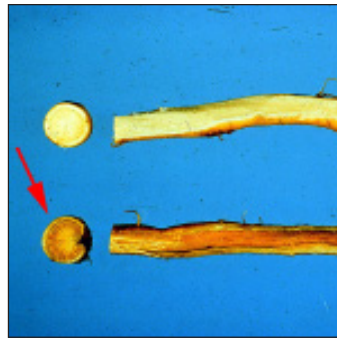
Stemphylium or Zonate Leaf Spot



Rust



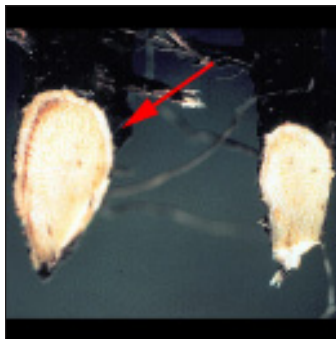
Alfalfa Mosaic



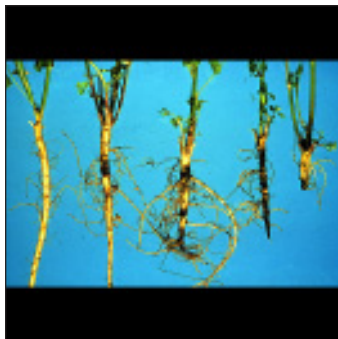
Bacterial Wilt



Fusarium Wilt



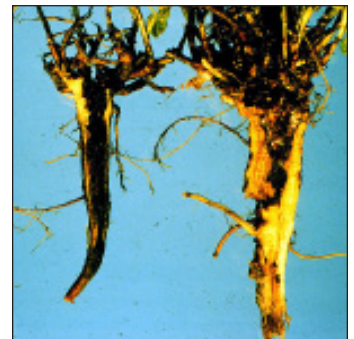
Verticillium Wilt



Phytophthora Root Rot



Violet Root Rot



Fusarium Root and Crown Rot

Alfalfa Disease Management

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Alfalfa diseases may reduce yield and quality of individual plants, but may also deplete alfalfa stands and render them non-profitable. Losses from alfalfa diseases may be sudden and obvious, but, more often, diseases take their toll gradually each year and often without detection. From a distance, foliar symptoms caused by diseases may appear similar and accurate diagnosis is difficult. However, the complete inspection of individual plants, this meaning stems, crowns and roots, enables the investigator to look for key diagnostic characteristics for each disease. In addition to plant symptoms, the time of year, growth stage of the crop, distribution of diseased plants in the field and soil characteristics, are also

bits of evidence to use in diagnosis.

Resistant varieties are economical and effective control measures for many alfalfa diseases. Many varieties have resistance to several diseases, thus they can be grown over a wide-range of disease potentials. Although many varieties have good disease resistance, this resistance can be made even more effective if used in conjunction with sound management practices. Disease prevention, not cure, is the situation for alfalfa diseases.

Probable occurrence and/or severity of alfalfa diseases by harvest and age of stand.

Disease	Harvest				Seeding	Year			
	1st	2nd	3rd	4th		1st	2nd	3rd	4th
Pythium Rot	3	1	1	1	3	0	0	0	0
Phytophthora Root Rot	2	3	3	3	3	2	2	2	2
Anthracnose	0	1	3	3	2	3	3	3	3
Verticillium Wilt	3	1	2	3	0	1	2	3	3
Bacterial Wilt	1	1	3	3	0	1	2	3	3
Fusarium Wilt	1	2	3	3	0	1	2	3	3
Spring Black Stem	3	2	0	1	1	3	3	3	3
Summer Black Stem	0	2	3	2	1	3	3	3	3
Common Leaf Spot	2	3	3	3	3	3	3	3	3
Downy Mildew	3	1	1	3	3	2	2	2	2
Fusarium Crown Rot	3	2	2	3	0	1	2	2	3

Probability of occurrence and/or severity.

0 = none

1 = low

2 = moderate

3 = high

Disease Profiles

Winter Injury



Maintaining stands over winter is one of the really important problems related to the culture of alfalfa in northern areas. Plant losses are the result of temperature in association with free water in or on the soil or in the plant itself. Winterkilling or injury may be the result of one particular condition

occurring at one period during the winter or it may be the result of the interrelationship to several conditions occurring at one period or during several successive periods during the winter. All winter injury is not necessarily due to freezing, since some of it results from suboxidation and/or toxic gasses when ice sheets occur. Although abiotic factors are dominant causes of winter injury, biotic agents may interact with abiotic factors and contribute to winter injury.

Factors affecting winter injury

1. Climatic conditions
2. Low temperature (5° kill, 17° injury, 26° no injury of plants hardened)
3. Alternate freezing and thawing (high soil moisture with little surface insulation)
4. Ice sheets for prolonged periods
5. Lack of snow cover
6. Unfavorable conditions for hardening
7. Warm periods during the winter (reduce hardness, use up reserves)
8. Late spring freezes
9. Warm drying winds

II. Soil conditions

1. High soil moisture in fall
2. Topography
3. Marginal soil fertility; especially potassium

II. Cultural practices

1. Late summer and fall seeding
2. Late fall cutting or grazing
3. Frequent cutting or grazing

II. Plant traits

1. Nonhardy to less hardy varieties
1. Winter injury increases as plants age

Symptoms

Symptoms vary with age of the host, the severity of the

freezing, and the time after injury that samples are examined. If roots are examined only a few weeks after the freezing, the upper parts of the taproots may appear more or less water-soaked but will not be conspicuously softened. It is difficult at this time to assess the damage by mere macroscopic examination of the plants. Sections, however, will show tissue almost completely disorganized; rifts, may extending the entire length of the rays; the larger groups of parenchymatous cells separated into loose aggregations; and, the cells of the cambium region collapsed through coherent. In some plants nearly all of the tissue except the cambium will be disorganized while in others rifts may occur only along the rays. No unusual straining reaction of injured cells may be apparent.

A little later when the frost is out of the ground many of the dead roots will become soft and can be recognized. Damaged living roots may remain fairly firm but will have a much water soaked appearance and when sectioned will show characteristic cell and tissue injury. A faint staining reaction characteristic of winter injury may also be obtained. The dead and injured tissues of live plants do not yet show visible discoloration by which they can be recognized in the field.

As time goes on, the damaged tissues become more and more discolored and the staining reaction more pronounced. Damage in 1-year old plants is located usually in the phloem fibers. Injury in the exterior of the phloem results in a sheath of damaged tissues surrounding the root, which kill the phellogen or cork cambium exterior to it. Injury in the phloem usually is accompanied by necrosis (browning) of the large cells in the xylem rays in the center of the root. In more severe winter damage, portions of the root near the crown are killed completely or disorganized sufficiently for fungi to enter and rot the tissues. Under such conditions, the plants fail to recover the following spring.

Damage in plants the season or later is largely in the parenchymatous cells of the phloem and phloem rays. The location of the injured cells is different than in the first year, however, as they are located inside rather than outside, the last group of fibers of the phloem. This injury usually extends inward through the cambium and xylem rays of the previous season's growth and results in breaks in the cambium cylinder, but usually the injury does not extend inward to the center of the root. Damage in the sheath of cells immediately beneath the phellogen occurs independently or in conjunction with phloem injury.

Injury of the crown stems is similar to that in the roots. The large cells beneath the phellogen show damage first.

Phloem parenchyma is injured as in the root. Crown buds are damaged or killed.

The nature of the injury appears to be due in part to the separation of the cells along the middle lamellae. When extensive, this results in the physiological isolation and death of the tissue. The cells are killed and sometimes ruptured by the freezing. These injured cells and those adjacent respond by biochemical changes and the deposition of brown amorphous substances in and between the injured cells. The injured cells are isolated ultimately by the meristematic activity of the surrounding cells.

Many investigations have been made to correlate or associated some component of the alfalfa plant with the development of winter hardiness. Although no direct

correlations have been established it has been suggested that protein and other nitrogenous components may be responsible in part for winter hardiness. It has been reported that the hardening process is accompanied by a marked increase in water-retaining power of the cell colloids and that a higher soluble nitrogen content is present in hardy alfalfa roots than in nonhardy roots. It seems to be true that extreme resistance to cold is associated with the ability of cells to endure desiccation.

References

1. Jones, F. R. 1928. Winter injury of Alfalfa. *J. Agr. Res.* 37:189-221.
2. Sprague, V. G., and L. F. Graber. 1940. Physiological factors operative in ice-sheet injury of alfalfa. *Plant Physiol.* 15:661-673.
- Weimer, J. L. 1930. Alfalfa root injuries resulting from freezing. *J. Agr. Research* 40:121-143

Heat and Drought Injury

Two pathological condition of alfalfa may occur during hot dry periods. One is a yellowing and drying of the tops of individual plants or groups of plants; the other is an extensive dying of buds found associated with restricted terminal growth during the hottest part of the summer.

References

1. Jones, F. R. 1937. A foliage yellowing and floral injury of alfalfa associated with heat and drought. *Phytopathology* 27:729-730.

Tractor Damage

Significant damage is inflicted on young legume plants when subjected to tractor traffic. Leaves, stems, and crowns are broken and crushed; some parts are completely severed. Damaged plants continue to grow but may be greatly retarded and give poor yields. The greater the area of contact, the more severe the damage; thus smooth tires cause more damage than new tires. Increasing the drawbar pull also

increases plant damage. Slippage of the drive wheel is not as important as weight, but the two factors combined inflict more damage than weight alone.

References

1. Byers, G. L., and R. F. Lucey. 1962. Legume damage by tractors. *New Hampshire Agr. Expt. Sta. Bull.* 473. 14 p.

Genetic Rough Rot

Occasional alfalfa plants suffer from a genetic weakness known as "rough root". This condition is due to the phellogen originating deeper in the cortex than in normal plants, and it remains continuously active like the vascular cambium. The thick phellem thus produced does not appear to protect the underlying cells, and new deeper cambial activity is developed which fails in the same manner.

Symptoms

The defect does not appear in seedlings until secondary root growth is well developed. Roots become yellow gradually, sometimes in irregular areas, and they may be a quarter of an inch or more in diameter before discoloration is conspicuous and cracks develop. When the roots are cut, the discoloration

is found limited to the outer part of the phloem or "bark". The entire root system develops a roughened condition. The roughening is usually least severe at the crown and most severe on the branch roots out to the feeding roots. The latter are normal. Affected plants differ greatly in degree of discoloration and amount of root cracking. Sometimes the plants are small and appear to have been retarded in development, but many appear as vigorous as normal ones at the end of their first summer. Later they lack vigor.

References

1. Jones, F.R. 1949. Rough root: a heritable character in alfalfa. *Agron. J.* 41:559-561.

Leaf and Stem Diseases

Although leaf and stem disease occur in almost every alfalfa field, their severity is dependent on periods of wet weather and/or heavy dews. Most leaf diseases of alfalfa are favored by moderate to cool temperatures, and are generally suppressed by high temperatures and low rainfall. Yields may

be reduced by leaf and stem diseases, but their main effect is often reducing the nutritional value of the forage because severe leaf disease can cause excessive leaf drop. The leaves of alfalfa plants contain much more protein and are more digestible than are the stems.

Leptosphaerulina Leaf Spot



Caused by the fungus *Leptosphaerulina briosiana*, can be found in alfalfa fields most any time in the growing season. Symptoms: The leaf spots (round to oval) are variable from small pin-point, gray-black spots under low light intensity, to larger 1/8" diameter spots with a light

tan center, dark margin surrounded by a yellow halo under high light. Affected leaves usually do not die or drop prematurely unless spots are very numerous. Dead leaflets and petioles often remain attached to stems for a time.

Epidemiology

It is more prevalent during cool, wet weather. It is usually the first leaf spot to develop on regrowth after cutting. The fungus overwinters in leaves on the soil surface. Optimum temperatures for disease are between 60°F and 80°F. Maximum disease follows periods of at least 36 hours of high humidity or leaf wetness.

Common Leaf Spot



Caused by the fungus *Pseudopeziza medicaginis*. Common leafspot occurs wherever the crop is grown. It has been reported from the U.S., Canada, Europe, USSR, and Africa. Some consider the disease of minor importance, but many believe it causes significant

yield and forage quality losses.

Symptoms

(4)Circular, small (rarely exceed 2-3 mm in diam.), brown spots with smooth or dendritic margins occur on the leaflets. These usually do not coalesce or cause discoloration of surrounding tissue. When spots are numerous, the leaflets soon turn yellow and drop off. A dark-brown to black raised disk (apothecium) occurs in the center of the mature spot and is an important diagnostic character. These disks usually occur on the upper side of the leaf, sometimes on the lower side, and rarely on both sides from the same spot. Under moist conditions the disk may appear as a jelly-like drop of exudate. Lower leaves show symptoms first. The disease often occurs on succulent stems as small (1.5-3.0mm),

elliptical spots with smooth margins. These are not abundant and rarely from apothecia.

Host Range

Medicago sativa, *M. falcata*, *M. arabica*, *M. globosa*, *M. hispida*, *M. ciliaris*, *M. orbicularis*, *M. scutellata*, *M. truneatula*, *M. tuberculata*, *M. varia*, and *M. lupulina* are some of the hosts (4, 7, 8, 9). *Onobrychis sativa*, several species of *Trigonella*, and *Vicia villosa* have been reported as hosts (4).

Epidemiology

The disease occurs whenever alfalfa is grown and appears to be most serious on soils that are acid or low in fertility. Seedling stands, especially under thick cover crops (e.g., oats), often become diseased with common leaf spot. Although plants may be severely weakened and stunted the first year, apparently little permanent damage occurs. Disease starts on the lowermost foliage and progresses up the plant. Later cuttings are usually most severely attacked. Common leaf spot is favored by long periods of moist, cool weather (60°-75°F) and so is most often severe on the second cutting, causing leaflets to fall off before cutting. Plants are rarely killed outright by common leaf spot, but defoliation can reduce plant vigor and predispose plants to winter injury. Premature defoliation reduces the quality and quantity of the hay. The causal fungus survives on fallen,

undecayed leaves. It is not known to be seed-borne.

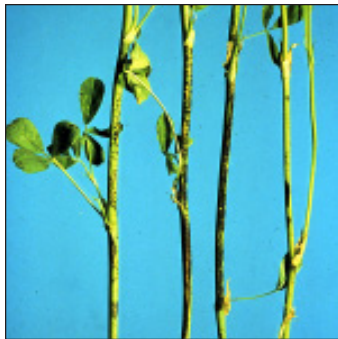
Control

Use of resistant varieties is the best hope for control. Most commercial varieties are susceptible but Caliverde, Dupuits, and a few others have moderate resistance. Individual plants and clones differ greatly in resistance; some have a high degree of resistance (5, 6). Much work is currently being done to develop resistant varieties. Hay crop should be cut and removed early if disease becomes severe to arrest development of the disease, save the leaves, and remove inoculum from the field.

References

1. Carnahan, H. L., J. H. Graham, and R. C. Newton. 1962. Quantitative analyses of inheritance of resistance to common leaf spot in alfalfa. *Crop Science* 2:237-240.
2. Davis, R. L. 1951. A study of the inheritance of resistance in alfalfa to common leaf spot. *Agron. J.* 43:331-337.
3. Frosheiser, F. I. 1960. A method for screening alfalfa plants for resistance to *Pseudopeziza medicaginis*. (Note) *Phytopathology* 50:568.
4. Jones, F. R. 1919. The leaf-spot disease of alfalfa and red clover caused by the fungi *Pseudopeziza medicaginis* and *Pseudopeziza trifolii*, respectively. U.S. Dept. Agr. Bull. 759. 38 P.
5. Jones, F. R. 1953. Measurement of resistance to common leaf spot. *Phytopathology* 43: 651-654.
6. Jones, F. R., J. L. Allison, and W. K. Smith. 1941. Evidence of resistance in alfalfa, red clover and sweetclover to certain fungus parasites. *Phytopathology* 31:765-766.
7. Schmiedeknecht, M. 1958. Untersuchungen sur Spezialisierung von *Pseudopeziza medicaginis* (Lib.) Sacc. *Phytopathol. Z.* 32:433-450.
8. Schmiedeknecht, M. 1959. Beitrag zur Eigenschaftsanalyse der Resistenz verschiedener Medicago-Arten gegen *Pseudopeziza medicaginis* (Lib.) Sacc. *Der Zöchter* 29:65-72.
9. Schöepp, H. 1959. Untersuchungen über *Pseudopezizoideae* sensu Nannfeldt. *Phytopathol. Z.* 36:213-269.

Spring Black Stem and Leaf Spot



Cause: The fungus *Phoma medicaginis* var. *medicaginis*.

Symptoms

Numerous spots develop on the lower leaves, petioles, and stems. These spots are small, dark brown to black, and irregular. Young shoots are often girdled and killed. Leaf lesions may enlarge and

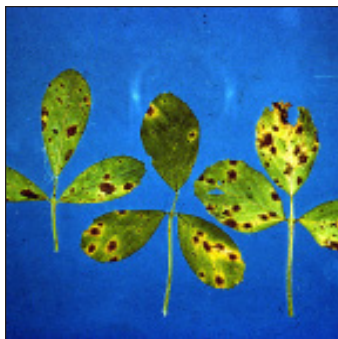
merge, killing large areas of the leaflets. The leaves turn yellow and often wither before dropping off. Stem and petiole lesions may enlarge, girdle, and blacken large areas near the

base of the plant. Affected stems are brittle and easily broken. When severe, entire stems are blackened and killed.

Epidemiology

The *Phoma* fungus mostly overwinters as mycelium in old stubble and crop debris where minute, brown to black, pimple-like fruiting bodies (pyrenidia) are produced. Cool, wet weather favors the disease. Infection of new shoots occurs as they grow through the residue or stubble of a previous alfalfa crop. The fungus is also seed borne. In a cool, wet spring, whole shoots are blackened, stems become brittle and break over or are killed. This disease may also cause some losses during cool, wet weather in the fall. Losses are most severe when cutting is delayed.

Summer (Cercospora) Black Stem



Cause: Fungus named *Cercospora medicaginis* (C. zebra).

Symptoms

Loss of leaves and blackened stems are the most obvious symptoms. Small, brown spots form on both leaf surfaces. Spots enlarge to form leaf spots that

are gray-brown with an irregular margin and often are as large as 1/8 to 1/4" in diameter. Tissue around these spots soon turns yellow. These spots are typically located on or near the midrib, often near the tip of leaflets. One spot on a

leaflet causes it to yellow and drop within a few days; when severe, leaflets are killed and defoliation is heavy. Plants are not killed in the field by this disease. Elongate, dark brown to black lesions enlarge, merge, and may cover most of the stems and petioles. Infected stems are not as brittle as those attacked by spring black stem, so damage is not as serious.

Epidemiology

Cercospora develops most rapidly at temperatures of 80° to 90°F and near 100% humidity after regrowth is tall enough to shade lower leaves. These requirements make it most serious on the second, third, and fourth cuttings. During cool or dry summers, it causes little loss, but under warm, humid conditions, it is the most serious leaf and stem disease-causing yield losses of 20% or more and reducing quality of the forage as well.

Yellow Leaf Blotch



Yellow leaf blotch is widely distributed in the United States (1) and occurs also in Canada, south America (Argentina), and Europe (Austria, Germany, France, Italy). In Wisconsin, it is most prevalent in the sandy areas of the central part of the state. In most regions and years it is considered of secondary

importance, but causes severe defoliation under some conditions. Melchers (3) reported that in many places in Kansas the disease caused losses of 40% of the foliage of the first and second crops. Losses of more than 50% of the leaves have been in occasional fields in Wisconsin.

Symptoms

Young lesions appear as yellow blotches elongated parallel to the leaf veins. The lesions enlarge, and the color becomes a deeper yellow, often approaching a brilliant orange on the upper surface, and a little paler beneath. Small orange-colored, later dark-brown to almost black, pycnidia are formed in the lesions on the upper surface of the leaf; subsequently, a smaller number of pycnidia may develop in the lesions on the underside of the leaf. Apothecia occur, but except under very favorable weather conditions, do not develop until after the death of the entire leaf. The first apothecia appear as small black dots, rarely as much as a millimeter in diameter on the lower surface of the leaf; later, a few may appear on the upper surface. Stem lesions occur, but appear later than the leaf symptoms and are of less importance. These are elongated yellow blotches which soon turn a dark chocolate-brown. Pycnidia and apothecia have been observed on stems but are not as abundant as on leaves.

Epidemiology

Yellow leaf blotch occasionally is serious in Wisconsin. The yellow leaf blotch fungus overwinters as mycelium and

apothecia in infected leaflets and stems. It is spread mostly by planting infected seed and by air-borne ascospores. Yellow leaf blotch attacks are favored by prolonged, cool, wet spring weather, a thick nurse crop, and succulent, tall, lush growth. Severe epidemics of yellow leaf blotch can occur in the fall, but are less common. Ascospores are produced in the late spring form overwintered apothecia and constitute the primary inoculum. They are produced in decreasing numbers as the growing season advances but become abundant again late in the fall. The cold weather of early spring appears to be unfavorable for their abundant production; and the hot, dry weather of midsummer also has an inhibiting effect. Disease development is favored by prolonged cool periods. Optimum temperature for ascospore germination is 12-26°C; on culture media most mycelial growth occurs at 16-25°C. Conidia have not been shown to incite infection. Little is known about the dissemination of the disease. Jones (1) thought it likely that ascospores are blown at least short distances by the wind. There is no evidence that the pathogen is carried on the seed as such, but it is likely that if seed contains bits of infected hay the pathogen might be introduced into new areas with seed. Alfalfa is the only species damaged by this fungus. Penetration appears to be direct.

Control

1. Burning leaves and stubble in early spring helps reduce inoculum. Lodged plants on the field and around its edges form sources of inoculum.
2. Cut hay early when disease is severe to save leaves and reduce inoculum to infect next crop.
3. Commercial varieties are not characterized extensively for reaction to the pathogen, but sources of resistance have been reported (2).

References

1. Jones, F. R. 1918. Yellow-leaf blotch of alfalfa caused by the fungus *Pyrenopeziza medicaginis*. J. Agr. Research 13:307-329.
2. Jones, F. R. 1949. Resistance in alfalfa to yellow leaf blotch. (Note) *Phytopathology* 39:1064-1065.
3. Melchers, L. E. 1916. Plant diseases affecting alfalfa. P. 339-353. In Report Kansas State board Agr. Vol 35, No. 138. 484 p.

Downy Mildew



Cause: Caused by the fungus *Peronospora trifoliorum*.

Symptoms

The most notable symptoms are light yellow to grayish-green blotchy areas on the leaves giving the field a light green appearance. The

other fungus leaf diseases of alfalfa generally start on lower leaves and progress up the plant, but downy mildew appears first on the younger leaves near the top of the plant. Downy mildew symptoms can be confused with symptoms of nutrient deficiencies. Infected leaves may be somewhat curled and distorted. Under severe infection, entire stems may be stunted and thickened due to systemic infection. In high humidity, the lower surface of the infected leaves shows patches of gray to violet-gray “downy” growth which are the

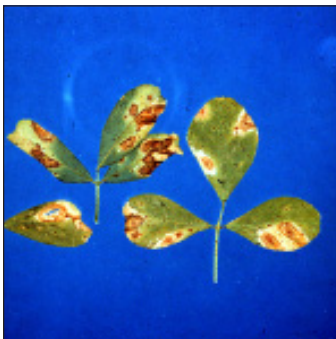
spore-producing structures of the fungus.

Epidemiology

Optimum conditions for spore production and infection are near 100% relative humidity and 50° to 65°F. Therefore, this disease is most serious in the cooler, wetter parts of the Midwest, but occurs in warmer, dryer areas during spring and fall. Newly seeded alfalfa is most severely affected. The fungus survives dry summers and cold winters in the crowns of infected plants. Mildew disappears during warm, dry weather, but may reappear during cool, wet periods in the autumn. The mildew fungus persists in systemically infected crown buds and shoots of certain susceptible plants, enabling it to survive from season to season. Weather-resistant spores (oospores) also form in old dead leaves, where they remain dormant over the winter and germinate the following spring. The fungus is also seed-borne.

Control: More than one race of the fungus exists. Downy mildew-resistant varieties are available but are not well documented. Seed treatment with Apron 25W fungicide provides control of downy mildew in the seeding year.

Stemphylium or Zonate Leaf Spot



Cause: Caused by *Stemphylium botryosum* (*Pleospora herbarium*).

Symptoms

Small, oval, dark-brown spots appear on the leaves, petioles, stems, peduncles, and pods. The slightly sunken spots later enlarge and often become zoned.

They are light and dark brown, often surrounded by a pale yellow “halo”. Infected leaves commonly turn yellow and fall prematurely. Black areas appear on the stems and petioles. Stems and petioles may be girdled in wet weather, causing the foliage beyond to wilt and die.

Epidemiology

Stemphylium leaf spot is a common disease that develops during prolonged periods of warm, wet weather in the summer and fall, especially in dense stands. The Stemphylium fungus overwinters on seed and as mycelium in plant refuse. The fungus is spread by air- and water-borne spores (conidia and ascospores) and by sowing infected seed.

Stemphylium leafspot is usually a minor disease of alfalfa cut for hay, but it can cause considerable defoliation (1,2). It is

most important in fields left for seed.

Symptoms (2)

All of the above-ground parts of the plant (leaves, stems, petioles, peduncles, flowers, pods, and seeds) may show symptoms. Leaf spots are irregular in shape and vary in size (a single infection can involve as much as one-half a leaflet). In early summer, conidia are produced in the lesions incited by ascospores. These are olive-brown to dark-brown. Older lesions from conidial infections are dark-brown and accompanied by increasing necrosis and chlorosis. During moist periods, these lesions become blackened by tremendous numbers of conidia and the leaves appear watersoaked. Lesions commonly coalesce to form large diseased areas. Concentric rings often occur in the older lesions.

Black lesions develop on the stems and petioles. In wet seasons these elongate, coalesce, and frequently girdle entire stems and petioles causing death. Later in the growing season, flowers and seeds may become infected. Infected seeds occasionally are shriveled and dark-colored, but more often the symptoms are less obvious. Deformed pods typically result from floral infections.

Host Range

Stemphylium botryosum comprises more than one race (3). Isolates from *Medicago sativa* severely attack *M. sativa*, *M.*

hispida, *Melilotus officinalis*, and *Trifolium hybridum* (2) They also attack *T. pratense* and *T. repens*, but not so severely. It appears that the race or races occurring on alfalfa are more pathogenic on alfalfa than isolates from red clover and vice versa.

Disease Cycle (2)

The fungus overwinters as immature perithecia on plant debris and in dormant plant tissues. Ascospores usually are most of the primary inoculum. Some conidia develop in early spring. These become more abundant as the summer progresses. From mid-July to well into the fall, perithecial initials form in the lesions on mature plants and on plant debris, and the life cycle is repeated. Optimum conditions for initial infection are 18°-22°C with 100% relative humidity for

at least 12 hours. Subsequent disease development is also greatest at these temperatures. The disease is found in humid climates throughout the world. Spore germination and host penetration are similar for both ascospores and conidia. Penetration is usually through stomata but may be directly between cells or through wounds (3).

Control

Little attempt has been made to control this disease. Cutting and removal of infected growth in the fall or burning of leaves and stubble in early spring help reduce inoculum. Cut crop for hay instead of saving it for seed in infection is heavy.

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3. Smith, O. F. 1940. Stemphylium leaf spot of red clover and alfalfa. J. Agr. Research 61:831-846.

Rust



Cause: Caused by the fungus *Uromyces straitus*.

Rust is usually considered a minor disease of alfalfa, but it may cause important damage in seed fields. The extent of losses depends largely upon the amount of rainfall during the summer and fall. Warm conditions

21°-29°C and high humidity favor the disease (3). Rust is general on alfalfa in North America and Europe, and is probably world wide in the humid temperature zones.

Symptoms (3, 4)

Reddish-brown spore masses develop within the leaf tissue,

rupture the epidermis, and appear as powdery masses (pustules) on the surface. Sometimes a yellow halo surrounds the lesion. Pustules are commonly scattered over the leaf surface, but may be arranged in a circle about ¼ inch in diameter. When the spores are touched, many adhere to the fingers. Similar pustules may also develop on the stems and petioles.

Epidemiology

Rust is often prevalent on alfalfa during late summer and fall. The rust fungus overwinters in the southern United States and advances northward through the season. High humidity and temperatures between 70° and 85°F favor rust development. These limitations usually delay rust development until late summer or fall.

Alfalfa Mosaic



Cause: Alfalfa mosaic virus (AMV).

Symptoms

It causes mottling and yellow streaks between the leaflet veins. Leaflets are often stunted and crinkled and the whole plant is sometimes stunted. Symptoms are most severe during cool weather in spring and disappear during

the summer.

Epidemiology

AMV is most severe in the northern parts of the Midwest, but can be found over the whole area. There are numerous strains of the virus with varying symptoms. The virus infects other forage legumes and other plants and is transmitted by aphids. It can be seed-borne. No practical field controls have been developed. The economic impact of AMV has been difficult to determine.

Anthracnose

Cause: The fungus *Colletotrichum trifolii*.

Symptoms

From a distance infected plants appear straw colored and are scattered through out a field. Leaves are frequently yellow and later turn tan after death. Frequently the tip of diseased stems bends over to form a shepherd's crook. Grayish-brown lesions with purple borders form on the lower portions of stems. Tan centers of lesions form a back ground for black dots that are fruiting structures of the anthracnose fungus. Lesions can run together to cause extensive areas of necrotic tissue. The pathogen can progress into the crown causing crown rot that is usually blue-black in color.

Epidemiology

The pathogen survives in infected alfalfa crowns or infested

hay brought into the field on harvest equipment. Warm, wet weather favors the disease. The disease does not appear in the first harvest but intensifies into fall. The disease can appear in any age stand, but is most prevalent in stands following the seeding year. Anthracnose reduces yield by reducing plant numbers and crown size.

Control: Resistant varieties are the only practical control. Varieties with moderate to high resistance offer excellent control of this disease.

Reducing Losses from Leaf and Stem Diseases

Losses in yield from leaf and stem diseases can approach 20-30%, but more typically fall in the 5-10% range. Reduction in protein and carotene content has also been noted. While it has been possible to effectively control diseases by spraying with fungicides, it is probably not economical as a regular practice with current prices and chemicals. Complete control of leaf and stem disease losses is not possible, but the following practices can reduce losses.

1. **Harvest in late bud and early bloom stage.** Leaf loss from disease is usually minimal up to this stage, but increases very rapidly from this stage on. Scout fields for leaf and stem diseases; harvest fields first that show the greatest disease severity. Cutting before leaf drop maintains the quality of the hay and removes diseased leaves that are a source of inoculum for infection of regrowth.
2. **Grow adapted varieties resistant to diseases.** (Consult state recommendations for resistance ratings.)

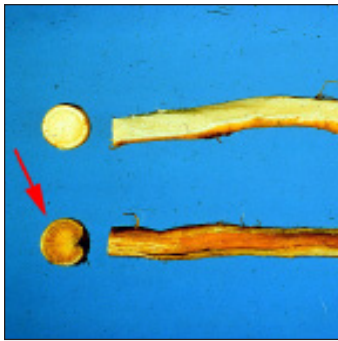
While breeding and selection for resistance to many leaf and stem diseases have not developed high levels of resistance, even moderate differences in reaction can reduce disease in the field. Avoid planting known highly susceptible varieties like 'Lahontan' in humid climates.

3. **Irrigate soon after cutting before much new growth has developed.** Avoid excessive sprinkler irrigation especially after a canopy has developed.
4. **Practice balanced soil fertility.** Maintain an adequate amount of Potash in the soil, based on a soil test.
5. **Kocide 101 and Kocide 606 are registered fungicides for leaf disease control.** Their performance has not been evaluated in Wisconsin.

Vascular Wilts

Three vascular wilt diseases of alfalfa are recognized in Wisconsin. Their incidence and economic impact differ by year, geographic area (topography, soil type, climatic conditions), variety planted, management practices and length of stand life desired. The progress of bacterial wilt, Fusarium wilt and Verticillium wilt is slow the first two years of a stand. Although present early, each disease steadily infects and kills plants and in 3-5 years can render an alfalfa stand uneconomical.

Bacterial Wilt



Cause: Caused by the bacterium *Corynebacterium insidiosum*.

Symptoms

Bacterial wilt causes a stunting and yellowing of the entire alfalfa plant. Diseased plants are dwarfed with numerous fine chlorotic shoots emerging from the

crown. Leaflets are cupped, small, rounded at the top, and are light green (chlorotic). Diseased plants may wilt during the heat of the day and recover temporarily during the cool of the night. Plants may wilt and die during warm, dry weather. Plants are increasingly stunted with each harvest. Infected plants usually die from midsummer into the next year. Diseased plants rarely survive the winter.

Root symptoms are very diagnostic. Roots are discolored, yellow to dark brown in the outer vascular tissue of the taproot underneath the bark of the root. Healthy roots are creamy white internally. In time, diseased roots become discolored throughout the root and become soft and mushy. Taproots of dying plants deteriorate rapidly from invasion by secondary rot organisms.

Epidemiology

Causal bacteria survive in living or dead plant tissue in the soil. Bacteria are released into the soil when plants die. Surface water, harvest equipment, and seed spread the wilt bacteria. Infection occurs during cool, wet weather in spring and early summer. Bacteria enter plants through wounds in roots and crowns or through cut ends of stems as a result of mowing. Bacterial wilt occurs more commonly where soil drainage is poor. It develops slowly with the first symptoms showing the second summer after seeding and gradually renders a stand non-economical within 3-5 years after seeding. Because the disease does not usually become destructive until the third crop year, it is rarely important where alfalfa is grown in short rotation.

Control

1. Host varieties available today have a level of resistance that allows alfalfa to be maintained for 3 or more years if bacterial wilt is present. However, plants within varieties with high levels of resistance (50%) may express bacterial wilt, but the disease will have a minimal impact on yield and stand life.
2. Good management can improve the effectiveness of resistant varieties. Frequent harvest results in a more rapid death of infected plants. Fall management can influence the performance of resistant varieties. High soil fertility and proper soil pH help maintain vigor of plants to slow the progress of bacterial wilt development.

Fusarium Wilt



Cause: Caused by the fungus *Fusarium oxysporum* f. sp. *medicaginis*.

Symptoms

Symptoms are yellow, wilted, dead shoots and a thinned stand. These overlap bacterial wilt symptoms except extreme dwarfing or stunting is not caused by

Fusarium. Bleaching of the leaves and stems follow and a reddish tinge often develops in leaves. Often, only one side of a plant may be affected at first, and after several months and repeated cuttings the plant dies. Diseased plants often do not survive the winter, especially if snow cover is sparse. Diseased plants exhibit diagnostic internal root discoloration. Dark or reddish brown streaks occur in the vascular tissue, appearing in cross section as partial or complete rings. In advance stages of the disease, the outer ring of the vascular tissue or the center vascular tissue may be discolored and the plant dies.

Epidemiology

Fusarium wilt occasionally affects alfalfa in the warmer growing areas of Wisconsin. *Fusarium* wilt is a more destructive disease in states to the south of Wisconsin. However, the disease can cause localized damage in Wisconsin, especially in sandy loam soils that presumably have higher temperatures during the growing season. The *Fusarium* wilt fungus produces specialized spores (chlamydospores) in the soil and plant debris. Soil may remain infested almost indefinitely. The fungus infects roots and enters the vascular system of the plant causing reduced growth and eventual death. The disease usually progresses slowly in alfalfa stands as scattered plants. However, considerable stand loss may occur over several years. Like for bacterial wilt, the disease has less of an economic impact if shorter stand life is desired.

Control

Because the pathogen survives indefinitely in the soil, crop rotation is not an effective control. Planting resistant alfalfa varieties is the only practical control. There is a limited number of resistant varieties that are adapted to Wisconsin.

Verticillium Wilt

Cause: Caused by the fungus *Verticillium albo-atrum*.



Symptoms

Early symptoms of *Verticillium* wilt are temporary wilting of leaves on warm days, and a tan, yellow or pinkish orange discoloration on terminal leaflets. Chlorotic, v-shaped lesions at the leaf tip and following the leaf midrib are common. Entire leaflets become bleached and twisted leading to defoliation. Stems often remain green and erect long after all its leaflets have dessicated. No external symptoms of the disease appear on the roots. Internally, the taproot can show yellow to brown vascular discoloration immediately below the bark of the root.

Verticillium wilt is initially characterized by individual plants showing symptoms and are interspersed amount

symptomless plants. In time a high number of plants can express foliar symptoms.

Epidemiology

The pathogen does not survive for long periods of time in the soil. It is introduced into alfalfa fields by infested alfalfa debris carried on harvest equipment, infested seed, infested hay and wind blown spores from other fields. Once plants are infected the pathogen is moved within fields by harvest activities, wind and possibly insects.

Verticillium wilt is rarely observed in the seeding year. However as stands age, the chances of observing the disease greatly increase. *Verticillium* wilt is favored by cool to moderate air temperatures and ample soil moisture. Thus, symptoms are expressed most in the first harvest and early fall or late summer. This disease can deplete an alfalfa stand and not be evident enough to be blamed. Most plant death occurs during the winter months.

Control

Planting resistant, winter hardy varieties offers the best control for this disease. Crop rotation is effective, but the disease will occur again unless resistant varieties are planted. Harvesting younger stands first can slow the disease in younger fields, but has limited value.

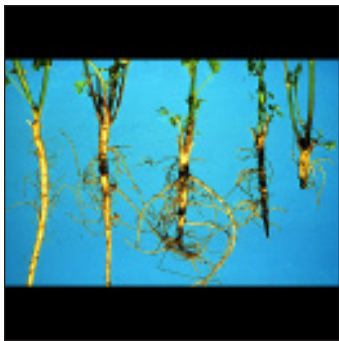
Root and Crown Rots

Many different fungi cause decay of roots and crowns of alfalfa. Some are aggressive pathogens and cause distinctive enough symptoms for easy identification. Most, however, occur in complex interactions with several other fungi and it is very difficult to positively identify causal organisms without microscopic examination, isolation and tests for pathogenicity. Some fungi invade roots and crowns but do not cause disease symptoms until the plant is weakened or stressed from poor management, deficiency or excess of water, insects, fertility imbalance or winter injury. Some root and crown rot can be found on most alfalfa plants but, if vigorous, they can tolerate it by producing new roots to survive. When the pressure from disease and stress become

too severe, plants die, the stand is thinned, weeds invade and yield and quality of forage is reduced.

Alfalfa grown in Wisconsin is subject to damage by several root and/or crown diseases. Root and crown disease problems are often the result of a complex of pathogens that can act alone or in combination. Several diseases have characteristic symptoms and are readily diagnosed. However, this is not the case for others, especially in the later stages of disease development. The possibility of non-recognized root and crown-invading pathogens being present is great. The following root and/or crown diseases are recognized in Wisconsin.

Phytophthora Root Rot



Cause: Caused by a soil-borne fungus called *Phytophthora megasperma* f. sp. medicaginis.

Symptoms

Alfalfa is susceptible to Phytophthora in all stages of growth, but seedlings are more susceptible and die at a faster rate than mature

plants. Severely infected plants suddenly become yellow, wilt, and eventually die and turn brown. Some plants may have infected roots, but will not show apparent shoot symptoms. Such plants are less productive and may die if the root decay progresses into the crown. Diseased plants may be scattered throughout the field or, in some cases, every plant in irregular patches may be infected.

The aboveground symptoms described above may be similar to other alfalfa disorders, thus, roots need to be examined for accurate diagnosis of Phytophthora root rot. Initially, discrete yellow-brown lesions develop on taproots and become black with time. These lesions can be readily detected on the white roots of younger plants. When roots are cut open, a brown discoloration progressing from the exterior root tissues to the center of the root will correspond to the external lesions. Often roots do not decay entirely, but the root below the lesion is severed from the top portion of the root system. The tip of the severed root is pointed and has a black discoloration. Lateral roots develop from the remaining taproot, but the root system is less extensive and shallow. When decay is near the crown, the diseased plant can be pulled easily, leaving the rotted taproot in the soil.

Epidemiology

Phytophthora root rot (PRR) is one major cause of reduced alfalfa stands and productivity in Wisconsin throughout the state, especially on heavier soils during wet seasons. Infected plants may more readily succumb to other diseases or stresses caused by adverse weather conditions. Yield and quality losses due to PRR often go undetected. They are frequently misdiagnosed as “winter injury,” “drought,” “flooding,” or other disorders. Phytophthora root rot is caused by a fungus that persists in the soil for years and is most active in soils that are water-logged for periods of 5-10 days. Consequently, Phytophthora root rot is most prevalent in soils with internal drainage problems, bedrock or where erosion has left a clay topsoil with poor drainage. Even fields with well drained soils may have Phytophthora problems during periods of high rainfall.

Control

Alfalfa varieties with increased levels of PRR resistance are now available to Wisconsin growers. Growers should be aware that alfalfa varieties rated as PRR “resistant” do vary greatly in degrees or levels of resistance. Growers should carefully assess the PRR potential on their farms and plant “resistant” varieties in fields or areas of fields where PRR has been diagnosed, or in areas where poor internal drainage enhances the probability of PRR. When Phytophthora root rot potentials are high, varieties rated as resistant (>35% resistance) are necessary to minimize forage loss due to the disease. Varieties rated with moderate to low resistance should be planted in fields with corresponding low to moderate potentials for Phytophthora root rot. For a yearly update, consult the current University of Wisconsin-Extension Publication, Forage Crop Varieties and Seeding Mixtures (A1525) or Pest Control in Forages and Small Grains (A1981).

Tilling and land-leveling, where practical, can reduce PRR by improving surface and subsurface drainage.

Recommended management practices can prolong the productivity and life of infected plants since not all PRR-infected plants may be killed in the initial infection phase. Maintaining high soil fertility can promote extensive lateral root development above the diseased region of the root. Avoid untimely cuttings that will place added stress on the plants. Damage by leaf-feeding insects and leaf diseases can stress plants and render them more susceptible to PRR. Crop rotation is of little value for PRR control because the

Phytophthora fungus can survive indefinitely in the soil. PRR is often most severe in the seeding year. Michigan studies suggest that PRR is less for early planting dates, but is increased at high seeding rates (15 lbs/acre or higher). Lower PRR severity has been observed for establishment with a companion crop compared to direct seeding. A fungicide is registered as a seed treatment for control of seedling disease caused by Pythium and Phytophthora. It is most effective when used in conjunction with moderate to high levels of Phytophthora-resistance. Varieties which are susceptible to Phytophthora will be protected by the fungicide for only 6-8 weeks.

Phytophthora - Aphanomyces Root Rot Complex

Maximum alfalfa performance is achieved when grown on deep, well drained soils, while severe stand and yield losses can occur on soils that are imperfectly drained. Farmers may have an option to avoid cultivation of alfalfa in poorly drained soils. However, this practice is difficult in Wisconsin since nearly half of all forage production is on soils that are classified as somewhat poorly drained. Although red clover is less difficult to establish in slowly drained soils, many producers favor alfalfa over red clover.

Knowledge has expanded of factors that affect the performance of alfalfa grown in wet soils. This is especially true regarding diseases that reduce productivity of alfalfa in slowly drained soils. Although once believed to be the sole cause of alfalfa root rot, Phytophthora root rot is now believed to form a complex with Aphanomyces root rot resulting in poor seedling and root health of alfalfa when wet soil conditions prevail. These root rot diseases can cause a total establishment failure, but more likely cause a chronic affect on alfalfa health and productivity. The discovery of Aphanomyces and Phytophthora root rots provided a partial explanation of poor alfalfa productivity in many wet soil environments.

The cost of alfalfa establishment has increased in recent years and repeated attempts to establish satisfactory stands can be an expensive endeavor. Thus, it is critical to accurately diagnose causes of poor plant health in the establishment year. In addition to escalated establishment costs, the progressive interaction of stress factors results in a cumulative stress load that degrades plant health in the long-term. Seedlings whose health has been compromised by pathogens are less able to compete and establish during the establishment phase of a forage stand. The effects of seeding year stress can result in lower forage yield the succeeding year or beyond. Thus, it is critical to long-term productivity to get alfalfa stands off to a healthy start. Symptoms of the Aphanomyces/Phytophthora complex will differ depending on the level of Phytophthora root rot resistance in the variety planted and duration of water

saturated soils. Phytophthora root rot is characterized by distinct brown to black lesions on tap roots. These lesions generally girdle and sever the root resulting in a short taproot with a black pointed tip. These symptoms are not common for an alfalfa variety with a moderate or greater resistance rating to Phytophthora root rot. Aphanomyces root rot causes a general decline in health and numbers of lateral roots. Restricted brown lesions on the taproot surface provide evidence that lateral roots were present, but have been rooted back to the taproot by the pathogen. The loss of lateral and fibrous roots comprises the health and efficiency of the alfalfa plant. Distinct lesions are not common on taproots, but rather large sections of the taproot express a soft yellow-brown decay. The absence or presence of decayed nodules is typical of Aphanomyces root rot. Foliage of infected plants becomes chlorotic and resembles symptoms of nitrogen deficiency. Infected plants are often slow to, or may fail to resume growth after harvest or winter dormancy. Thus, a major symptom of Aphanomyces root rot is poor seedling vigor in the seeding year, and less than expected forage yield. The Aphanomyces/Phytophthora complex is more difficult to diagnose in established stands.

Alfalfa establishment problems may involve soil pH, herbicide carry over, poor seed bed preparation, autotoxicity and plant pathogens. Thus, it is important to conduct a thorough investigation of the situation. One approach is to test soils for the presence of the Aphanomyces root rot fungus. Collect one gallon of soil from problem areas in a field. Thoroughly mix the soil and reduce the sample volume to one pint/20 acres of land. Place the soil in a sealed plastic bag or, if a paper bag is used, place this bag inside a plastic bag for shipment. It is not necessary to refrigerate soil samples, but samples should keep away from excessive heat. Send samples to the Plant Pathogen Detection Clinic, 1630 Linden Drive, Department of Plant Pathology, University of Wisconsin-Madison, Madison, WI 53706. A \$25 fee is requested and the test takes 2 weeks to complete. A positive test for Aphanomyces indicates that alfalfa varieties resistant to

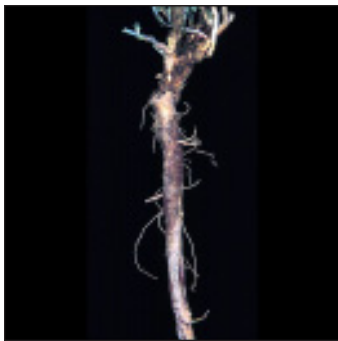
Aphanomyces should be considered the next time the field in question is planted to alfalfa.

The discovery of the Phytophthora/Aphanomyces root rot complex provided alfalfa breeders additional information for their effort to develop alfalfa cultivars that are better adapted to wet soils. Alfalfa cultivars with dual resistance to Phytophthora and Aphanomyces root rots are available from most companies marketing alfalfa seed. Alfalfa varieties with resistance to both diseases repeatedly express superior forage yield and persistence when grown in the presence of this disease complex. It is evident that in environments where Phytophthora and Aphanomyces root rot were severely suppressing yields, the penalty for low resistance to these pathogens is very great. Through genetic improvement of

alfalfa for root rot resistance, the expansion or renewal of alfalfa production into regions where slowly drained soils have limited the success of alfalfa establishment and long term productivity. Alfalfa varieties with resistance to Phytophthora and Aphanomyces root rot are required to maximize stand establishment, plant vigor, and forage yield in Wisconsin. The improved stand survival and long term root health gained through resistance to Phytophthora and Aphanomyces root rot results in increased yield potential in a broad range of environments.

Apron treated seed is offered by many seed companies. Apron is a fungicide product that reduces the risk of seedling mortality especially in the preemergence phase of seedling development.

Violet Root Rot



Cause: Caused by the fungus *Rhizoctonia crocorum*.

Symptoms

Symptoms are sudden dying of plants beginning about the time of the second cutting. The disease is primarily a root rot. The main root system becomes completely

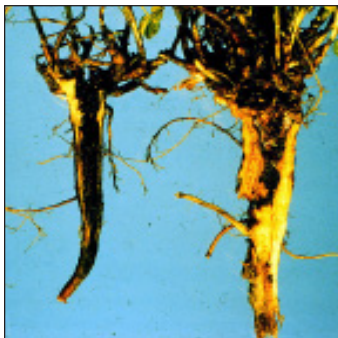
invaded by the parasitic mycelium and rapidly ceases to function. At the points of penetration, small aggregations of mycelium, the "infection cushions", may be seen. Minute black sclerotia, just visible to the naked eye, are found on the dying roots. The *Rhizoctonia* stage appears from late summer onwards as a compact felt mat which closely covers the roots and may be recognized readily by its characteristic violet color and its white margins. The mycelium may extend 8 or more inches below the soil line and is abundant also in

the crowns of infected plants. The roots rot, their bark becomes loose, and their central cylinders soft and shredded. The plants may become somewhat stunted, turn yellow or brown, and die in circular to irregular patches which enlarge as the disease progresses.

Epidemiology

It is of little economic importance except under unusual conditions. The disease usually occurs in low areas subject to flooding. It frequently follows root injuries. The fungus apparently survives unfavorable periods as sclerotia in the soil. Violet root rot frequently occurs just prior to the harvest of the second cutting. This occurs most frequently in soils with pH lower than 6.5. Crop rotation to corn, or small grains, gives some control. The violet root rot fungus infects other forage legumes, thus they are not good rotational crops. Liming soils to pH 6.8-7.0 offers some, but not complete control. No varietal resistance has been reported.

Fusarium Root and Crown Rots



Several *Fusarium* species caused alfalfa root and crown rots. Lesions on established plants often start with injuries from freezing, harvesting or insect feeding. They are irregularly shaped, reddish to dark brown and occur anywhere on the crown, taproot or lateral roots. Rot of the center of the

crown extending down into the taproot is called heart rot or hollow crown. Rot develops slowly and affected tissues are moist to dry and remain firm so plants often survive moderate amounts of damage. Stress from pea aphid and potato leafhopper increases *Fusarium* severity. Good soil fertility, especially high levels of potassium, reduce *Fusarium* crown rot. Winter-hardy varieties often have less crown rot.

Management to Reduce Root and Crown Rot Losses

Management of the growing alfalfa for maximum vigor is the key to reducing cold injury and root and crown rot losses. High levels of stored food reserves in the roots are directly related to the plant's ability to withstand and overcome these problems. Variety, soil fertility, soil moisture, harvest time, cutting intervals, irrigation timing and injuries all are part of this complex interaction which affect vigor.

Alfalfa is a heavy user of phosphorus and potash and adequate supplies of these reduce root rot losses. Preplant applications are most effectively utilized. Topdressing established stands is necessary in many areas to achieve maximum yields.

Harvest time and interval very strongly affect carbohydrate reserves in roots, vigor and consequent winter injury and root and crown rot. These effects have been well documented by research with many varieties, climates and growing conditions. Short harvest intervals (frequent cutting at the bud stage) weakens plants, reduces root reserves and encourages cold injury, root rots and stand depletion. Long harvest intervals, especially at the last harvest allow plants to build root reserves and resist these problems.

Under ideal growing conditions it takes about 3 weeks of regrowth (to about the early bud stage after cutting or coming out of winter dormancy) for the new shoots to manufacture enough food to begin replenishing root reserves. Then there is a rapid build-up of root reserves with the maximum reached at about full bloom. Short harvest intervals appear to be tolerated better during mid-season than in early spring or late fall. It is most important to time the last cutting at least 4 and preferably 6 weeks before the first killing frost to permit at least 8-10 inches of top growth to develop. When alfalfa is cut or frozen into dormancy in the late fall while root reserves are depleted, the plants go into winter weakened and unable to withstand freezing and root rot attack. Low yields and thinned stands may result the following year. While it is well established that long harvest intervals will reduce root rots and prolong stands there are some negative results. Protein and carotene decrease and fiber increases after bloom begins. Leaf and stem disease losses increase rapidly. Therefore, selection of cutting time is a compromise between high quality forage along with weakened plants from early cutting and greater yields with better stand maintenance but poorer quality forage with later cutting. It appears that the old rule of thumb to cut at 1/10 bloom strikes the best balance.

