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Field Guide for Diagnosing Common Wheat Maladies of the Pacific Northwest

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This field guide provides an overview of basic plant pathology concepts that are relevant to disease identification in wheat. It introduces tools to help distinguish between biotic and abiotic injuries, and discusses patterns of biotic injury in the field to help determine whether the possible cause of the disease is a seed-borne, foliar, or soil-borne plant pathogen.

The document concludes with two diagnostic keys that provide photographs and brief descriptions of common wheat diseases of the Pacific Northwest. Each key is a simplified version of a complex disease- and pest-identification process. While the use of this document may help determine a provisional cause of poor growth or crop injury, a formal diagnosis is not considered complete without supporting evidence acquired from a plant disease clinic.

Plant diseases occur as a result of a dynamic and specific interaction between

1. a susceptible **host** cultivar,
2. a conducive **environment**, and
3. a virulent **pathogen**.

Plant disease is therefore prevented by eliminating any one of the three contributing components:

1. Eliminate the susceptible host
- Plant a resistant cultivar
- Fallow to break the cycle of some diseases
- Rotate to a non-host crop
- Limit the green bridge by controlling volunteers and weedy host species

2. Alter the environment that is conducive for disease
- Modify planting date (influences seed-zone temperature, soil moisture, and seedling exposure to splash-dispersed pathogens in fall rains)
- Understand which diseases will thrive in certain conditions

3. Limit the pathogen
- Use seed treatments
- Apply fungicide
- Sanitize to reduce or eliminate sources of inoculum

Patterns of biotic versus abiotic injury

The first step in identifying the cause of crop injury is to determine if the injury is due to a **biotic** or **abiotic** stressor.

Biotic stressor: a living organism such as a fungal, viral, bacterial, insect, or nematode pest

Abiotic stressor: a non-living factor such as frost, heat, herbicide, or nutrient damage

It can be difficult to distinguish between biotic and abiotic damage, but they often display remarkably different symptoms that provide hints for identification.

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Typical biotic symptoms

1. Varying size and stage of infection (indicative of a continuous biotic process)
2. Irregular arrangement of injury
3. Diffuse transition from healthy to damaged tissue

Figure 1. Stripe rust (left) and Rhizoctonia root rot (right) infection on wheat displaying typical biotic injury patterns: varying size and stage of infection, irregular arrangement of injury, diffuse transition from healthy to damaged tissue.

Photos: (left) Christina Hagerty, © Oregon State University; (right) Richard Smiley, © Oregon State University.

Typical abiotic symptoms

1. Often, no spread is observed
2. Regular (non-random) distribution of injury
3. Clear lines demarcating healthy versus damaged tissue

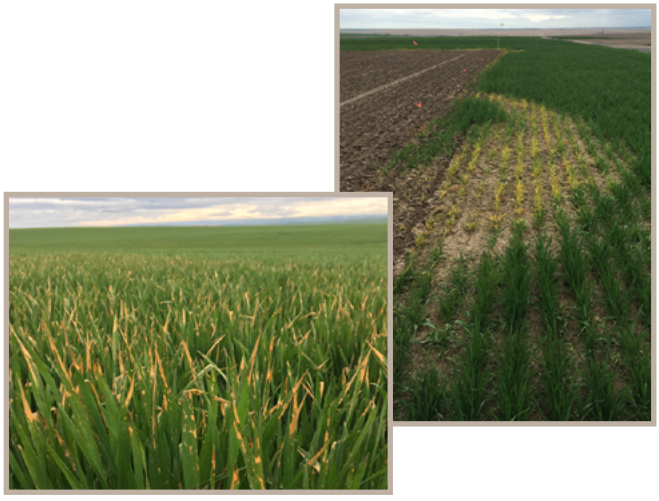


Figure 2. Herbicide injury on wheat displaying typical abiotic injury patterns: no spread of injury, regular distribution of injury, and clear lines demarcating healthy versus damaged tissue.

Photos: Christina Hagerty, © Oregon State University

Patterns of plant disease

Population-level patterns of plant disease in the field indicate the pathogen's mode of transmission and dispersal: seed-borne, soil-borne, or foliar.

Random distribution in the field = **seed-borne** or early symptoms of foliar disease

Photo: Richard Smiley, © Oregon State University

Patch distribution in the field, often defined by soil type or field drainage patterns (soil-borne pathogens usually require soil moisture for replication and plant infection) = **soil-borne**

Photo: Christina Hagerty, © Oregon State University

Aggregated or "contagious" distribution in the field = **foliar**

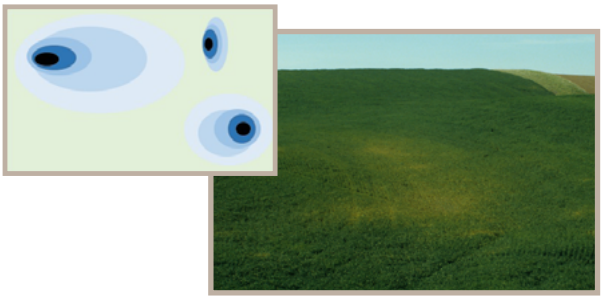


Photo: Richard Smiley, © Oregon State University

The following two diagnostic keys use visual symptoms to help determine potential causes for maladies affecting wheat at two different stages of growth.

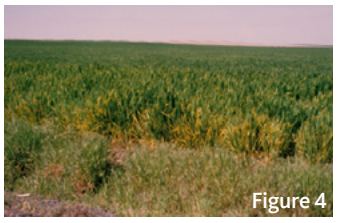
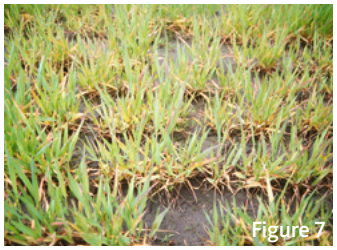
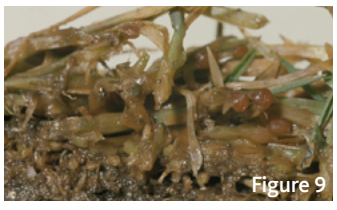
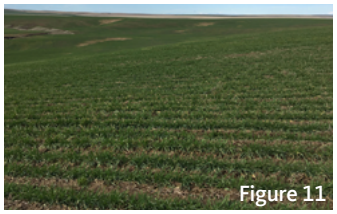
Problems occurring in seedling wheat (pages 3–7)
Whiteheads occurring in mature wheat (pages 8–11)

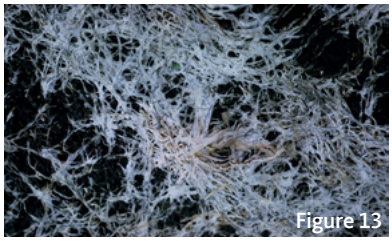
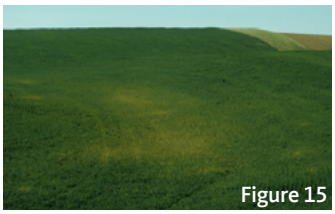
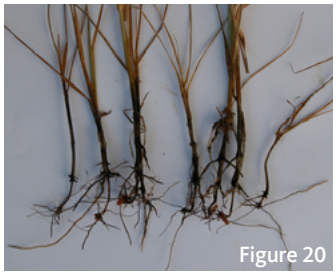
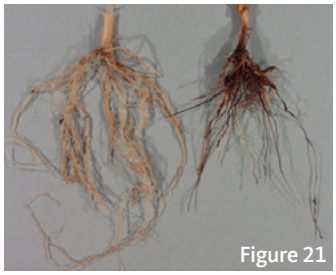
These keys include causes of reduced growth and yield that may occur in the Pacific Northwest.

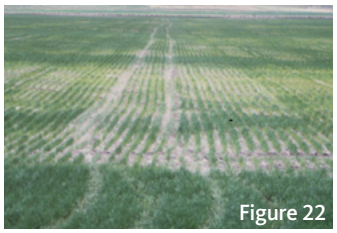
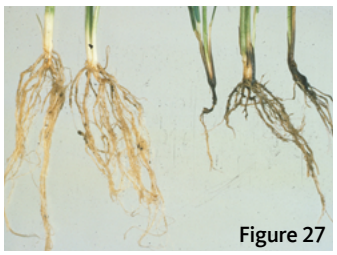
Diagnosing problems that occur in seedling wheat

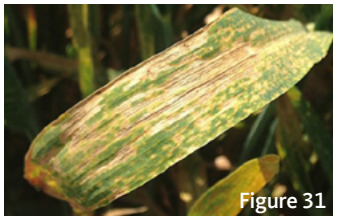
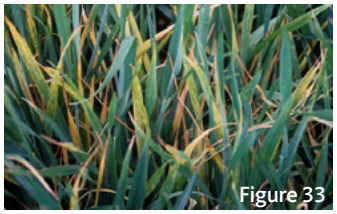
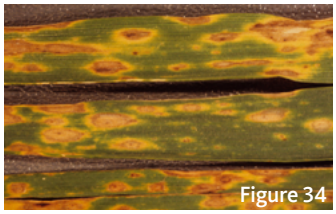
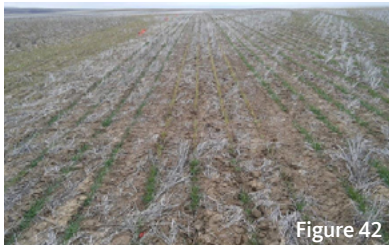
Diseases of young wheat plants are easily confused with abnormal growth caused by certain insect pests, mammals, and environmental problems such as low or high temperature, inadequate nutrition, excess water, or drought. Characteristic symptoms are not always visible or easily found in fields affected by some soil-borne root diseases.

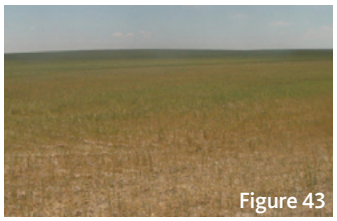
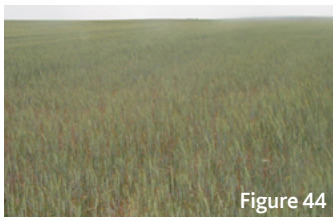
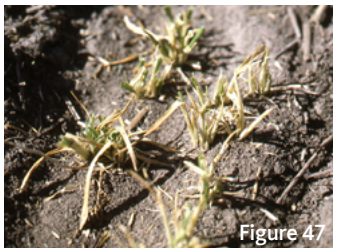
The following abbreviated key provides visual descriptions and photos to help identify the common reasons that wheat seedlings lack vigor or exhibit symptoms of disease or other anomalies in the Pacific Northwest.

Key to visual symptoms	Illustration of severely affected plants		Possible cause
I. Affected plants occur first in patches but may become more uniformly distributed with time.			
A. Symptoms are visible in foliage.			
Leaves are red, yellow, or purple, especially near the tips, often without the plants being stunted.	 Figure 3	 Figure 4	Barley yellow dwarf
Leaves have a chlorotic yellow and green mosaic pattern, and plants are stunted.	 Figure 5	 Figure 6	Soil-borne wheat mosaic or wheat spindle streak mosaic
Leaves contain yellow streaks.	 Figure 7	 Figure 8	Wheat streak mosaic or High Plains Disease
Older leaves are dead and contain tiny brown to black spherical bodies (sclerotia) following an extended snow cover.	 Figure 9	 Figure 10	Gray snow mold
Leaves are dead and bleached white or may have a pinkish tinge after cool, wet weather; snow cover is not required.	 Figure 11	 Figure 12	Pink snow mold

Key to visual symptoms	Illustration of severely affected plants	Possible cause
Older leaves are dead and bleached white; small brown to black sclerotia are visible on dead leaves. Leaves are brittle and disintegrate on touch.	 Figure 13	Speckled snow mold
Leaves contain streaks of orange pustules on the surface.	 Figure 14  Figure 15	Stripe rust
B. Patches of unthrifty plants with or without foliar symptoms; stunting or death may occur after the stand has established.		
Roots have a brown rot, often with few branches and pointed tips where parts of the root have rotted off.	 Figure 16  Figure 17	Rhizoctonia root rot
Lower leaves may be rotted and brown; roots may have few secondary or lateral roots.	 Figure 18  Figure 19	Pythium root rot
Intact roots are discolored and can be blackish; under wet conditions, discoloration can extend above the soil line onto the lower stem. Black lesions at the base of the stem are shiny. Roots are brittle.	 Figure 20  Figure 21	Take-all

Key to visual symptoms	Illustration of severely affected plants	Possible cause
Roots are shortened, stubby, and have prolific but short branching patterns.	 Figure 22  Figure 23	Cereal cyst nematode
Roots are severed, and underground stem tissue has feeding damage; leaves may have holes or notches. Older leaves remain green and whole; newest leaves and plant crown are dead.	 Figure 24  Figure 25	Wireworm
Loss of stand due to feeding on green foliage (voles) or newly planted seed (mice).	 Figure 26	Voles and mice
II. Affected plants tend to occur randomly in the plant canopy.		
A. Specific symptoms are not present in foliage of seedlings.		
When crown tissue is cut lengthwise, a brown-colored dry rot is apparent; roots or the subcrown internode may also be brown.	 Figure 27  Figure 28	Fusarium crown rot or Common root rot
B. Symptoms are present in foliage.		
Yellowish and dirty-colored lesions appear on the leaf sheaths, stem, and on lower nodes above the soil line.	 Figure 29  Figure 30	Eyespot (strawbreaker foot rot), and Sharp eyespot

Key to visual symptoms	Illustration of severely affected plants	Possible cause
Distinct leaf lesions contain tiny light- to dark-brown spherical bodies (pycnidia).	 Figure 31  Figure 32	Septoria leaf spot
Distinct lesions occur in leaves, but lesions do not contain pycnidia.	 Figure 33  Figure 34	Physiologic leaf spot (chloride-deficient leaf spot)
Leaves have tufts of white to gray fungal growth, typically most severely on the lower leaves and stems.	 Figure 35  Figure 36	Powdery mildew
Leaves with one to three elongated white to yellow stripes that extend down the sheath on the stem; leaves are not distorted.	 Figure 37  Figure 38	Cephalosporium stripe
Leaves with elongated white to yellow stripes; leaves often twisted; heads can be goose-necked (trapped).	 Figure 39  Figure 40	Russian wheat aphid
Leaves may have white stripes or entire plants may be bright white because they lack chlorophyll.	 Figure 41	Albinism
Leaf tips become yellow or mottled after cold nights, particularly soon after herbicide application.	 Figure 42	Cold stress

Key to visual symptoms	Illustration of severely affected plants	Possible cause
White bands across the leaf; excess heating of embryonic tissue on hot days deactivates enzymes required for chlorophyll.	 Figure 43  Figure 44	Heat stress
Insect feeding between the leaf veins; grubs, adults, eggs, or fecal matter often found on leaf surface.	 Figure 45  Figure 46	Cereal leaf beetle
Seedling leaves eaten; leaf fragments may lie on soil; leaves keep growing.	 Figure 47  Figure 48	Armyworms and Cutworms
Twisted leaves and/or goose-necked heads or awns.	 Figure 49	Aphids during booting, or hail during stem elongation

Diagnosing causes of whiteheads in nearly mature wheat

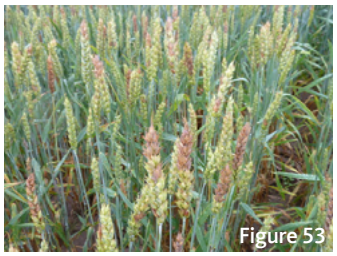
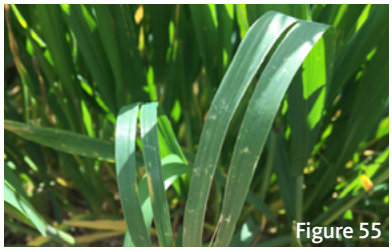
Wheat heads that die prematurely are called whiteheads. Whiteheads are typically seen 1 to 2 weeks before foliage of apparently healthy plants starts to dry down. Affected heads compress easily when squeezed between the fingers because they contain shriveled grain kernels or may even lack kernels. Whiteheads may be distributed uniformly among healthy heads or may occur as clusters in parts of the field.

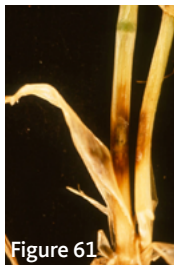
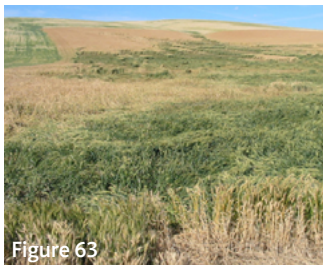
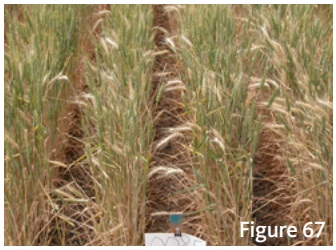
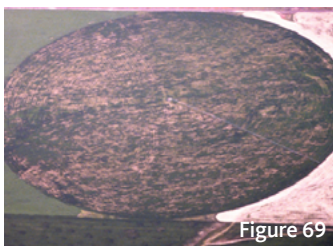
After the first whiteheads appear, their percentage increases daily. They become very difficult to distinguish when the surrounding healthy heads begin to ripen and dry down for harvest. While there is a variable relationship between yield and whiteheads, as a general rule, the yield is often reduced by the same percentage as the percentage of whiteheads in a continuous section of drill row (e.g., if 1 percent of the total number of heads in a row are whiteheads, the overall yield will be reduced by approximately 1 percent).

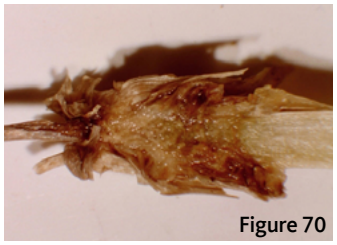
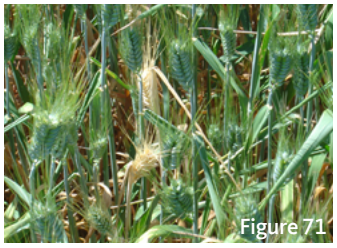
In side-by-side comparisons, whiteheads occur at different times for different varieties, likely in response to inherent differences in genetic maturation time for each variety. Maximum numbers of whiteheads occur just before the main crop starts to mature. The following is an abbreviated key to determining a potential cause for the occurrence of whiteheads.

Photos: (left) Richard Smiley, © Oregon State University; (right) Phil Sloderbeck, Kansas State University.

Key to visual symptoms	Illustration of severely affected plants	Possible cause
I. Whitehead and stem pull away from the plant with minimal resistance; stem is dead down to the top node; the rest of the plant remains green.	 Figure 50  Figure 51	Stem maggot
II. Whitehead and stem are not easily pulled out of the leaf sheath.		
A. Generally, only a portion of the head is affected; stem remains green.		
Parts of the head are white to gray; awn tips are generally white and often bent.	 Figure 52	Frost

Key to visual symptoms	Illustration of severely affected plants	Possible cause
Sections of the head are white or, less commonly, the entire head may be white; the color may be pink during extended wet weather or high humidity.	 Figure 53  Figure 54	Fusarium head blight (head scab)
Broken heads; leaves shredded, pockmarked, or broken; heads may become goose-necked.	 Figure 55	Hail
Heads with dislodged or partially eaten kernels.	 Figure 56  Figure 57	Hail, grasshopper, wheat head army worm, gopher, or birds
B. Entire tillers die prematurely.		
Lodging of stems is common.		
• Small brown to black flaxseed-like structures (a puparium) are found underneath the leaf sheath, just above one or more of the lowest stem nodes; lower stem may become greatly weakened and brown.	 Figure 58  Figure 59  Figure 60	Hessian fly

Key to visual symptoms	Illustration of severely affected plants	Possible cause
• Dirty-colored lesions occur on the lower internode, below the leaf sheath; stem becomes very weak or collapsed in the lesion, often with a very dark fungal layer that is easily removed by scraping it with your fingernail.	 Figure 61  Figure 62  Figure 63	Eyespot (strawbreaker foot rot)
Lodging is not common.		
• Lens-shaped lesions on the lower internode, below the leaf sheath; stem is not generally weakened to the point where it collapses to cause lodging.	 Figure 64  Figure 65	Sharp eyespot
• One to three leaf stripes occur in green leaves, and stripes extend down leaf sheath; vascular bundles in the leaf sheath are brown between each leaf stripe and the next lower node; nodes and stem tissue below each node may be dark brown	 Figure 66  Figure 67	Cephalosporium stripe
• Individual sections of roots or the entire root system become blackened and brittle; under wet conditions, the lower stem internode may also be shiny black under the leaf sheath.	 Figure 68  Figure 69	Take-all

Key to visual symptoms	Illustration of severely affected plants	Possible cause
• Peeling leaf sheaths off the stem reveals one or more lower nodes with a brown color; cutting open the crown tissue may also reveal a brown dry rot; subcrown internodes may also be light to dark brown.	 Figure 70  Figure 71	Fusarium crown rot (Fusarium foot rot, or dryland foot rot)
• None of the above.		Drought, shallow soil, hard pan, or other causes

Additional photo credits

Figures 3–4, 7–10, 13, 15–23, 27–30, 33–34, 37–41, 52, 58–59, 61–62, 64–71
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