EB1378

PLANT DISEASE

Strawbreaker Foot Rot or Eyespot of Wheat

Strawbreaker foot rot, which is also called eyespot, is a common and serious disease of winter wheat throughout most of eastern Washington, especially in the high rainfall regions. Yield loss varies considerably depending upon when plants are infected and the percentage of plants infected, but can range up to 50% in commercial fields when disease is severe.

Disease symptoms

Symptoms of eyespot are usually observed first in early spring, shortly after plants break dormancy and begin to grow. On young plants, symptoms consist of elliptical or eye-shaped lesions on leaf sheaths in the crown near the soil surface. Lesions frequently occur below the soil surface. One or several lesions can occur on a stem. When several lesions are present, they can coalesce, leading to a general discoloration of stems in the crown (Figs. 1, 2). Individual lesions are yellow-brown in color and may have dark-colored "scurf" in the center of the lesion (Figs. 3, 4). As plants develop, the fungus colonizes successive leaf sheaths and eventually the stem, which can be weakened and fall over, resulting in lodging (Fig. 5), or die standing, forming "whiteheads" (Fig. 6). Lodging of stems caused by eyespot typically occurs in multiple directions as opposed to one direction, such as occurs after wind or rain. The mulit-direction lodging is known as "strawbreaker." Lodged stems often break off at the soil line when pulled. Examination of the broken stems reveals a dark brown, charred appearance, also with the presence of "scurf." Eyespot only affects stems—roots are not colonized.

Cause

Eyespot is caused by two closely related fungi; *Tapesia yallundae* and *Tapesia acuformis*, which were formerly known as the wheat- and rye-types, respectively, of *Pseudocercosporella herpotrichoides*. These

Figure 1. Winter wheat plants infected with eyespot in the spring. Infected plants have discolored leaf sheaths when removed from the soil.

Figure 2. Winter wheat plants infected with eyespot in the spring. Washing the plants with water before removing the leaf sheaths makes it easier to see the lesions.

Figure 3. Eyespot lesion(s) on bases of winter wheat plants after stem elongation. Note the yellow-brown color, elliptical ("eyespot") shape of the lesion, and the dark-colored "scurf" in the center of the lesion.

Figure 4. Close-up of an eyespot lesion showing the yellow-brown color and scurf in the center of the lesion.

fungi persist between crops only in the stubble of previously infected plants. Infection is favored by cool and moist conditions; therefore this disease is often most serious in the lower areas of a field, such as toeslopes and flats. When conditions are favorable, these fungi produce spores on infested plant debris in soil. Splashing raindrops spread spores short distances where they contact a plant and germinate. Upon germination, the fungus infects the outer leaf sheaths and eventually grows into the stem.

During colonization, the fungus forms masses of mycelium (scurf) on the leaf surface and between leaf sheaths, giving the lesions a charred appearance. If infection occurs early in the autumn, extensive colonization of the plant occurs and it is unable to obtain the water required to fill the kernels, resulting in shriveled kernels, whiteheads, and lodging. Less damage occurs when infection takes place later in spring because the pathogen does not have enough time to colonize the entire stem.

Because the fungus sporulates abundantly and infects most readily in cool, wet conditions, eyespot is most severe where fall rains are frequent. Relative humidity near the soil surface where infection takes place is very important and cultural practices that result in higher humidity around the crowns of plants will increase the severity of eyespot. For example, early seeding results in large plants that shade the soil, leading to increased humidity during periods of cool damp weather. High seeding rates and spring tillage accentuate this effect. Disturbing the soil in the spring results in soil being pushed around the bases of the plants, thereby creating small moist chambers in which humidity is high and infection and colonization are favored. Conversely, drying winds may reduce the severity of eyespot by reducing moisture at the soil surface.

Disease control

Older plants are more susceptible to infection by the fungus, and so early seeding can encourage development of eyespot. Delaying seeding reduces disease, but may result in more severe soil erosion and also increases the probability of winter injury. Where eyespot is a problem, seeding should be early enough to be consistent with good cultural practices and take advantage of agronomic yield potential determined by local environmental conditions, and spring tillage should be avoided.

Crop rotation is not completely effective in controlling eyespot, but it can reduce the amount of colonized straw (inoculum) present in soil and can be of value where the disease is severe, or in preventing inoculum build-up in fields where it is not so damaging yet. Unfortunately, even a small amount of inoculum can multiply to a point where damage occurs. Because of this, winter barley is not an effective rotation crop with wheat. Although barley is less susceptible than wheat, these fungi can develop enough on barley to create a threat to subsequent winter wheat crops. Spring seeded grains, although susceptible, are not usually affected by eyespot in the Pacific Northwest and are effective rotation crops, as are peas, lentils, chickpeas, and canola.

Fertilizer does not increase the amount of eyespot directly, but can increase plant growth and lead to higher humidity that favors disease development. Ground application of fertilizer with shanks in the spring should be avoided, but dry or liquid fertilizer applied by aircraft or spread from ground equipment does not favor disease development.

Burning wheat stubble is not effective in controlling eyespot. Even though the fungus survives on straw in the soil, enough colonized straw is protected by the soil, or otherwise escapes destruction, to cause subsequent infection. Other residue

Figure 5. Lodging of winter wheat as a result of eyespot infection can be extensive. Typically, stems fall in different directions when eyespot is the cause, compared with wind or rain that pushes most stems in the same direction.

Figure 6. Lodging of winter wheat with dead standing stems known as "whiteheads." Whiteheads may be caused by other diseases, so it is important to look for lesions on stem bases to make an accurate diagnosis.

management techniques, including tillage, also affect eyespot. In general, reducing tillage reduces the severity of eyespot. This effect results from the later seeding dates that are typical of conservation tillage systems in the Pacific Northwest, and from interference with splashing of spores due to the presence of standing residue or residue-covered soil surface.

Disease-resistant varieties are the most economical and reliable control for eyespot. Several winter wheat varieties with resistance are available (Table 1). Consult the Washington State Crop Improvement website (http://www.wscia.com/variety_characteristics.htm) or the Washington State University Variety Testing Program (http://variety.wsu.edu/) for current variety descriptions.

Table 1. Winter wheat varieties with resistance to eyespot, adapted to the Pacific Northwest.

Variety	Market Class[1]	Release date	Eyespot reaction[2]
Chukar	SW Club	2001	R
Coda	SW Club	1998	R
Temple	SW Club	1998	MR
Finch	SW	2001	R
Foote	SW	1998	R
Madsen	SW	1988	R
MJ-4	SW	2000	R
Mohler	SW	2002	R
ORCF-101	SW	2003	R
ORCF-102	SW	2004	R
Tubbs	SW	2001	R
Weatherford	SW	1998	R
Residence	HR	1994	MR

[1]SW=soft white wheat; HR=hard red wheat
[2]R=resistant; MR=moderately resistant

Fungicides to Control Eyespot

Fungicide seed treatments have not been effective in controlling eyespot. Foliar fungicide sprays are effective, but the occurrence of fungicide-resistant strains of the pathogen, as well as consolidation in the agrochemical industry, has resulted in availability of only a few registered products. Currently, only Tilt® and Topsin-M® are registered for eyespot control. Applying these fungicides in combination is more effective in limiting the development of fungicide-resistant strains of the pathogen than applying Topsin-M® alone. Growers should contact their local agrochemical company for information regarding availability of these products.

Wheat producers face two questions in deciding whether to apply a fungicide.

1. *Should a spray be applied, i.e., is a spray needed?*

Three criteria are helpful in answering this question:

1) Has eyespot caused losses in this field in the past?
2) Was the wheat growth better than average going into the winter?
3) Is the variety planted in the field susceptible to eyespot?

The eyespot fungus is generally distributed in the wheat-growing areas of the Pacific Northwest and once established in a field, will remain there indefinitely. Therefore, occurrence of eyespot in the past indicates a good possibility that the disease will reoccur. Factors that promote a lush canopy of foliage in the fall, such as early seeding, early emergence, or a prolonged fall growth period, and seeding of a susceptible variety increase the likelihood of eyespot infection.

The occurrence of these factors (past history of eyespot, lush plant growth in the fall, and susceptible variety) suggests that a grower should consider fungicide application in early spring. If there is uncertainty, growers can examine a sample of plants from the field to determine the relative amount of infection before spraying.

A sample of at least 10 plants with a total of 50 tillers should be selected from representative parts of the field and the crowns and lower stems washed free of soil. Examine the tillers for the characteristic early lesions of eyespot. The outer leaf sheath(s) will have a "dirty" appearance (Figs. 1, 2). When the outer sheath is removed, the tissue beneath will be yellow- or tan-colored, often in an oblong (eyespot) shape (Fig. 3, 4). Black specks (scurf) sometimes occur on the eyespot. The tissue above and below the lesion is usually white, as are the roots, which are not affected by eyespot. However, other pathogens can be present that discolor these areas, but should not be confused with eyespot.

If 5 of 50 tillers have obvious lesions in early spring (early March to mid-April), spraying should be considered. This represents a 10% level of infection and it is likely that for every visible infection at this stage of plant growth, there is another one that is not apparent.

2. *When should the spray be applied?*

The fungicide should be applied prior to stem elongation (jointing) to prevent the pathogen from moving into the true stem. If the spray is applied too early, effectiveness of the fungicide may wane before jointing is complete; if applied too late, the fungus will have penetrated the stem and done its damage. The actual application time will vary depending on the growing area—fields in the earlier harvest areas, such as Horse Heaven Hills in south-central Washington as well as lower elevations in general, may be sprayed as early as mid-February to early March. Fields in far eastern Washington and at higher elevations may be sprayed as late as April or early May.

Weather conditions may also influence the time of spraying. Fungicide applications will occur later following a prolonged, cool, wet spring than an early, warm, dry spring. In most years, however, fungicide sprays will be from mid-March to mid-April.

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