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Barley Yellow Dwarf of Wheat, Barley, and Oats

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The symptoms, impacts and management of Barley Yellow Dwarf (BVD), a virus disease affecting small grains, are discussed.

Barley yellow dwarf (BYD) is considered the most economically important virus disease of small grains worldwide. Outbreaks occasionally reach epidemic proportions in some parts of Nebraska, as occurred in wheat and oats in 2007. The epidemiology of BYD and its effect on yield have not yet been studied in Nebraska. This NebGuide's information is based on observations of BYD in Nebraska wheat and oat fields in 2007 and on published research conducted elsewhere.

BYD is a disease complex that results from several different but related Barley Yellow Dwarf virus infections. It results from a complex interaction between multiple aphid vector species, multiple virus strains, numerous aphid and virus hosts in the environment, differential variety responses to infection, and environmental conditions. The BYD virus includes several related viruses grouped into five strains based primarily on which specific aphid species best transmits that particular strain. More than 20 aphid species can transmit the virus; however, only four aphid species are primarily responsible for vectoring the virus in Nebraska. The virus has a wide plant host range. It can infect over 80 species of annual and perennial grasses including barley, corn, oats, rye, and wheat, but yield impacts are restricted to wheat, barley and oats.

Symptoms

Symptoms of BYD are highly variable and can be confused with those of wheat streak mosaic, nutrient deficiency, root and crown diseases, and environmental stress. BYD is tentatively diagnosed in the field by the presence of aphids, leaf discoloration, and stunted plants grouped singly or in small patches (*Figure 1*).

Figure 1. Wheat stunted by BYD.

Figure 2. Yellowing of a wheat leaf caused by BYD virus infection.

Figure 3. Red-to-purple discoloration on a wheat leaf caused by BYD virus infection.

Figure 4. Bright golden yellowing on a barley leaf caused by BYD virus infection.

Figure 5. Leaf discoloration on oats caused by BYD virus infection.

Typically, leaf discoloration in shades of yellow, red, or purple occurs from the tip to the base or from the margin to the midrib. Definitive diagnosis requires a laboratory test such as the Enzyme-Linked Immunosorbent Assay (ELISA). This is a serological test in which an antibody specific to a virus carries with it an enzyme that releases a colored compound on reaction with a substrate. Release of the colored compound confirms presence of the virus.

- In wheat, leaves first appear pale yellow (*Figure 2*). Tissues immediately adjacent to the midrib may remain green longer. Depending on the wheat cultivar, a red-to-purple discoloration may accompany the yellowing (*Figure 3*).
- In barley, leaves develop a bright golden-yellow color (*Figure 4*). Necrotic brown flecking or spotting may accompany the yellowing.
- In oats, a distinctive red to purple discoloration usually occurs on leaves, but various shades of yellow, reddish-orange, reddish-brown, or purple may be seen (*Figure 5*).

Infection during the seedling stages of any of the cereal grains may result in severe stunting, bright-yellowing or reddening of older leaves, delayed heading or ripening, increased sterility, and fewer and lighter-weight kernels.

Post-seedling infections are progressively less severe to the point where only the upper leaves, or the flag leaves, show discoloration. Mildly infected wheat may not show any discoloration.

Leaves on infected plants are shorter, stiffer, and more erect than normal. The flag leaf may be severely shortened. Root systems are reduced and diseased plants are more easily pulled than healthy plants.

Stunted plants result from failure of the stem internode to elongate. This leads to a "telescoped" plant where the leaves may unfurl before fully emerging from the sheath of the previous leaf. Infected plants are "dwarfs" and have lost their normal conformation. Later the head, or panicle, may not emerge fully or properly.

Patterns of BYD in a field may be random within the crop or appear as circular or angular patches which reflect the aphid vectors' pattern of movement. Many of the infected plants ripen prematurely, after which they may be invaded by sooty molds. These molds give a dirty appearance to the plants and may lower germination of harvested seed.

Don't use symptom expression of the plants as a good predictor of the eventual yield impact. BYD yield impact is most severe if plants are infected during the seedling stage. Research shows that severe fall infections of winter wheat may result in 25-36 percent yield loss. Infections occurring

in the later growth stages or sparse field infections may result in reduced losses.

Disease Occurrence and Spread

The BYD virus' most important vectors in Nebraska are the bird-cherry oat aphid (*Rhopalosiphum padi*), the corn leaf aphid *(R. maidis*), the English grain aphid (*Sitobion avenae*), and the greenbug (*Schizaphis graminum*). For identification and life cycle information on these aphids, see NebGuide G1824, *Cereal Aphids*. The bird-cherry oat and the English grain aphid are the most important carriers of the virus in oats.

Barley Yellow Dwarf virus overwinters in infected winter cereals and in wild and cultivated grasses. Perennial grasses such as bluegrass, orchardgrass, tall fescue and little bluestem may serve as reservoirs for it. In most areas, winter cereals are more important than wild grasses as virus sources for infection of spring grains. Many native grass species have grown next to cereal grains in Nebraska for many years without causing serious outbreaks of the disease.

Oats and barley are very susceptible to the virus. If planted late for soil cover, wind erosion control, forage, or regrown as volunteer, they often are heavily infected. Therefore, they can be an important local source for migration of both aphids and virus into adjacent fall-planted wheat. If these crops are still green when winter wheat emerges in the fall, BYD virus infection can produce severe epidemics.

Aphids acquire the virus by feeding on infected plants. It normally takes 24 to 48 hours of feeding to acquire the virus, but once acquired the aphid remains a carrier of the virus for life.

Virus spread depends entirely on aphid movement. A very active aphid which feeds for short periods on different plants is a more harmful carrier than several stationary aphids. In the spring, aphids over-wintering as adults on winter wheat or perennial grasses are immediately active as carriers.

At this time, aphids generally do not over-winter in Nebraska. Epidemics of Barley Yellow Dwarf in Nebraska are normally caused by passive migrations of winged aphid vectors carried from south to north by low-level jet winds. Other aphids acquire the virus in the spring by feeding on infected grain cereals and grasses during migration. The virus and aphids also carry over the summer in volunteer cereals and weedy grasses, and cause fall infection of winter wheat.

The biology and behavior of these aphid vectors in Nebraska are not well-known. In the past, they were thought to over-winter further south under milder winter conditions. However, these species have been found to over-winter in parts of Nebraska during some of the recent mild winters experienced. The effects of a warming climate that allows these insects to regularly over-winter are not known, but will likely increase the incidence of the disease in Nebraska.

Damaging outbreaks of the virus are most likely in cool, moist seasons that favor grass and cereal growth as well as aphid reproduction and migration. A driving rain may spread aphids, but also reduce their population.

Management

Seeding dates: In the fall, early-planted winter wheat and barley have a greater risk of virus infection. Aphid vectors actively move in the agroecosystem during the early fall as summer crops and grasses mature. Delaying fall seeding of cereals until aphid populations decline will minimize BYD risks.

Early seeding of spring cereals allows plants time to develop past the seedling stage before they become infected. This significantly reduces the damage potential to the crop. Also, the risk of aphid movement into spring cereal fields increases later in the spring and early summer.

Optimum seeding dates for fall- and spring-planted cereals have been established for the various growing areas of Nebraska. These dates can be obtained from your local extension office.

Cultivar selection: An important strategy in managing the virus is to plant resistant or tolerant cultivars. High levels of resistance or tolerance are not available in wheat, but are available in barley and oats. Even though strong resistance is not available in wheat, commercial wheat cultivars vary in their susceptibility to the virus. Although the response of wheat cultivars to BYD is not known, growing diverse cultivars differing in genetic background will minimize the chance of a single cultivar being severely impacted by the disease (see UNL 'Wheat Variety Selection Tool' *http://citnews.unl.edu/winter_wheat_tool/index.shtml*).

Cultural control: Cultural methods of managing BYD include controlling grassy weeds, including volunteer cereals, within and near cereal production fields. In addition, don't plant small grains in midsummer as cover or companion crops in cereal-producing areas to minimize the virus and vector reservoir in the growing areas.

Chemical control: Fungicides have no effect on the virus and should not be applied to control the disease. Virus incidence is sporadic enough in Nebraska to limit the use of insecticides for aphid control. For winter wheat, seed treatments of imidacloprid (Gaucho® and other products) or thiamethoxam (Cruiser®) will reduce aphid presence through the fall, and therefore, reduce primary infections. However, the sporadic nature of aphid infestations in the fall limits the economic value of this practice unless planting in high-risk situations (e.g. early planting).

Foliar insecticide control of aphids in the fall would only be necessary if extreme populations of aphid vectors are present. These treatments may reduce the incidence of virus infections; but if aphids escape the treatments, or migrate in from untreated areas, insecticides are of little use except in reducing secondary spread within the field.

Base insecticide treatment to control aphid vectors in the spring on incidence and infestation estimates obtained from scouting. Threshold levels are available from your local UNL extension office or at: *http://entomology.unl.edu/instabls/waphids.htm*. Only treat cereal aphids if necessary because

they are often well controlled by natural enemies (lady beetles and other predators and parasites). Unnecessary controls can eliminate natural enemies and allow aphids and other pest species to develop unchecked.

Summary of Management Methods for Barley Yellow Dwarf

- Plant spring cereals as early as possible for your growing area.
- Delay planting winter cereals to avoid peak aphid populations.
- Use Barley Yellow Dwarf-resistant or -tolerant cultivars when possible.
- Control grassy weeds and volunteer cereals within and around cereal production fields during the late summer and early fall.
- Do not plant small grains in midsummer as cover or companion crops in cereal-producing areas.
- If foliar insecticides are used, they should be applied when scouting indicates sufficient aphid activity in the fields.

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