

Barley Yellow Dwarf Virus in Idaho Cereal Crops

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Introduction

Barley yellow dwarf (BYD) is a serious and widely occurring viral disease of cereal crops and other grasses. Important economic hosts include wheat, barley, oats, and occasionally rice and corn. Although BYD may affect both winter and spring cereals, it is often a greater concern in winter crops.

BYD virus is spread by aphids that colonize and reproduce on grassy host plants. BYD virus strains are efficiently transmitted by different species of cereal aphids in a persistent fashion. The predominant BYD virus strain in the 2012–13 southern Idaho epidemic was identified with molecular techniques by Alex Karasev, University of Idaho virologist in Moscow, as PAV. This strain was originally designated PAV based on the aphid species most efficient at transmitting the virus.

Unusual weather conditions during the fall of 2012 contributed to the BYD epidemic in southern Idaho winter wheat and barley. A long, frost-free fall promoted large, healthy growth of cereal crops going into the winter. What appeared to be ideal conditions for winter crop development were also very favorable for the aphid vectors and BYD virus development. Consequently, widespread BYDV-infected winter wheat and winter barley became evident throughout the Magic Valley from Buhl to Murtaugh during April and May 2013 (figures 1 and 2). The extent and severity of the outbreak were unexpected and very unusual in our production systems.

Symptoms

Symptom expression of the PAV strain of BYDV can vary widely. The most characteristic symptom is yellowing and/or reddening of leaves (figure 2) starting at the leaf tip and moving toward the base and inward from the margins. BYD-affected plants exhibit stunting of both foliar and root tissues. Affected plants produce relatively small, irregular heads. Seed size is also reduced, resulting in low test weight.



Figure 1. Winter barley infected with barley yellow dwarf virus, Burley area, May 1, 2013. Plants along center pivot tire tracks are often the most severely affected. Photo by Juliet Marshall.



Figure 2. Stephens soft white winter wheat infected with barley yellow dwarf virus near Kimberly, Idaho, May 30, 2013. Photo by Juliet Marshall.

Often, field edges and the edges along center pivot tire tracks are most severely affected by the disease (figure 1). BYD incidence declines along a gradient toward the center of the field. Additional symptoms may include notching of the leaf margins, twisting, leaf tip scorch, and abnormal development of emerging leaves. Infected weedy grasses in nearby ditch banks, which act as alternate hosts for the virus and aphid vectors, may also exhibit yellowing or a very characteristic reddening of leaves (figure 3). Symptom development in the host plant is greatest at temperatures below 75°F (59°–65°F) and at high light intensity.



Figure 3. Weedy grass species can act as alternate hosts for the aphid vectors and barley yellow dwarf virus. Photo by Juliet Marshall.

Yield loss due to BYD occurs both through reduced grain production and reduced test weight. Early fall infections immediately following emergence can lead to the greatest impact on production, approaching 70 to 100% yield loss in severely affected fields. However, such high yield losses are unusual. Yield reductions of 10 to 20% are more common; thus, it is often economically feasible to maintain the current crop rather than plow it under and replant with other crops such as beans or corn. In 2012, fall infection occurred in late September and early October when large populations of aphids migrated from other crops (likely corn) onto newly emerged wheat and barley. Fields showing less than 40% infection in the spring of 2013 had yield reductions of about 20%.

Aphid Vectors and BYD Virus Spread

Barley yellow dwarf virus can be transmitted only by aphid vectors; there is no evidence of mechanical or seed transmission. Several species of aphid can carry and transmit the virus. The most common culprits include bird cherry-oat aphid (*Rhopalosiphum padi*) and English grain aphid (*Sitobion avenae*). Greenbug (*Schizaphis graminum*) and corn leaf aphid (*Rhopalosiphum maidis*) can also transmit BYD viruses, but they are less efficient vectors than bird cherry-oat and English grain aphids.

Aphids acquire the virus by feeding on infected plants (figure 4). Following successful acquisition, BYDV circulates within the insect's body but does not replicate, persisting in the aphid for the rest of its life. The now "viruliferous" aphid disperses,

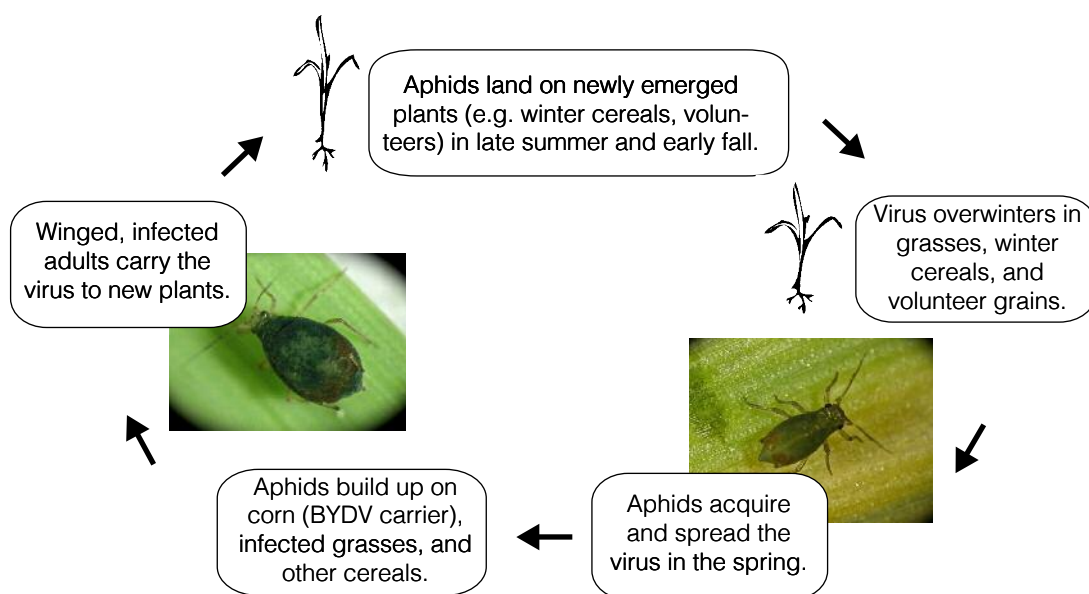


Figure 4. Disease cycle of barley yellow dwarf. Photos by Arash Rashed.

colonizes new hosts, and passes the virus to healthy plants as it continues to probe and feed. However, the virus is not passed from the mother to their young. A recent study by Ingwell and others (2012) at the University of Idaho has shown that while non-viruliferous aphids (*R. padi*) prefer BYDV-infected plants, after acquiring the virus they start to colonize healthy plants instead. Thus, virus-induced behavioral manipulation enhances BYDV spread within a field.

Aphids may acquire BYDV from infected wild and cultivated grasses, volunteer cereals, and corn. Corn is a “silent carrier” of BYDV; in other words, BYDV in corn does not cause disease or produce distinct symptoms.

Aphids are attracted to the lush wheat or barley growth that occurs under irrigation; they often show less of a tendency to colonize plants in dryland corners, often due to timing of emergence. For winter crops, plants emerging earlier or planted earlier are more likely to attract viruliferous aphids. Mild fall temperatures may lead to increases in aphid populations before a hard frost finally reduces their numbers, impact, and subsequent transmission of the virus.

Control

The most effective way to control this disease would be through the use of resistant varieties. To date, however, there are no known resistant varieties among PNW wheat cultivars. The following recommendations have proven helpful in reducing the risk of BYD virus infection.

Comply with recommended planting dates in your region

In general, the idea is to avoid peak flight activity of the aphid vectors and to minimize the time window available for vectors to colonize and infect plants.

Avoid early planting in fall. As summer crops mature, aphids start to seek new host plants. Later fall planting dates increase the likelihood that the emerging seedlings will miss the aphids’ peak activity. Later seeding dates also provide less time for aphids to feed and transmit BYD virus before fall temperatures start to drop. Although many of the 2012–13 infected fields were not planted early, mild fall temperatures persisted well into December 2012, which may have contributed to the BYD outbreak.

In contrast to fall planting, planting earlier in the spring provides enough time for plants to grow out of the most susceptible seedling stage before aphids move into the crop. This would reduce the extent of damage since crops would be older and more established at the time of infestation, later in spring or early in summer.

Eliminate green bridges

Overlapping cropping cycles and the presence of volunteer grasses and other grass crops can provide local sources of infection for the virus and their aphid vectors. Eliminating volunteer wheat and barley and providing a week or two without any host crop may reduce infection rates in the following cropping cycles. Controlling aphid flights from populations in other crops (like corn) will also reduce the green bridge effect.

Consider insecticidal treatments

Insecticidal seed treatments may, to some extent, reduce the initial spread of BYD in wheat and barley. In the absence of an effective aphid-monitoring program, however, predicting the exact time of primary infection (infections initiated by aphids arriving from long distances) can be challenging. Viruliferous, migrating aphids may transmit the pathogen later in the fall as the effectiveness of insecticidal treatments diminish. Reducing vector populations via insecticidal seed treatments also decreases the risk of secondary spread within the field.

Monitoring aphid numbers within fields is necessary prior to applying any additional insecticides. This is because under natural circumstances, natural enemies such as lady beetles and parasitoid wasps keep aphid numbers mostly in check. Unnecessary foliar application of chemicals can dramatically reduce populations of natural enemies, which could result in an increase in aphid numbers.

Minimize stress

As in any agricultural system, the impact of infection on crop yield can be reduced by minimizing stress factors; the greater the stress, the larger the impact on infected plants and yield. Therefore, maintaining excellent crop health with appropriate fertilization and irrigation is recommended. Fortunately, the virus is not seed-borne and will not be carried into the next season within host plant seed.

Control recommendations at a glance

Adjust planting schedules to reduce the risk of infection.

- Avoid early fall planting of wheat and barley to avoid aphids migrating from maturing summer crops.
- Plant spring grains early. Large and established plants tolerate infection better than small seedlings.

Avoid green bridge situations.

- Control volunteer wheat and barley and weed hosts.
- Spray corn with insecticides prior to planting winter grain to reduce aphid movement from corn into newly planted winter grain.

Do not leave borders fallow.

Bare black soil contrasting with green foliage along field edges may attract migrating aphids.

Maintain excellent crop health

Apply adequate amounts of water and fertilizers.

Consider insecticide treatments

- If bird cherry-oat or English grain aphids are present in high numbers, insecticidal seed treatment is recommended to reduce infections (imidacloprid or thiamethoxam as seed treatments).
- Foliar insecticides may reduce secondary spread within the field.

Use virus-resistant varieties

Virus-resistant varieties provide the best control. BYD-resistant oats are available.

There is no remedy once plants are infected with BYDV. Applying fungicides will NOT cure the problem.

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