

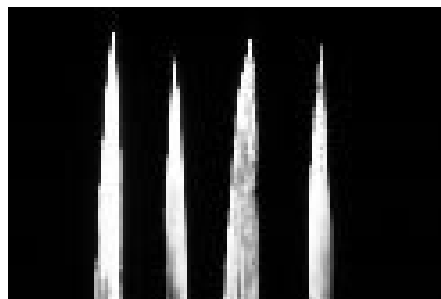
*P*lanting winter wheat as early as possible, particularly under dryland conditions, can increase yields by 10 percent or more, but also increases the risk for several serious pest problems that can cause major yield losses.

Early planting can create a situation called a green bridge where pests and disease move from maturing cereals or volunteer grain into the emerging fall crop.

This publication discusses the most common arthropod-associated problems that occur when winter wheat is planted too early, including Russian wheat aphid (*Diuraphis noxia* (Mordvilko)), barley yellow dwarf (BYD), and wheat streak mosaic (WSM). Biology/epidemiology, prevention, detection, and control of each pest problem are covered.

# Fall Pest Problems of Winter Wheat

Russian Wheat Aphid  
Barley Yellow Dwarf  
Wheat Streak Mosaic



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# Russian Wheat Aphid

## Biology

Feeding secretions of Russian wheat aphid are toxic to wheat plants, resulting in leaf rolling and purple or white streaking on damaged leaves. In the fall, streaking is usually purple on winter wheat (fig. 1). The aphids themselves are pale green and spindle shaped (fig. 2). The siphunculi (paired projections on the posterior end of most aphids) are very short and not obvious. The diagnostic supracaudal process (looks like a wart above the tail) can be seen with a hand lens (see CIS 816 for more information on aphid identification).

Unlike many aphids, Russian wheat aphid has a very simple life cycle in North America. To date, evidence indicates that all Russian wheat aphids in North America are females. During the growing season, females give birth to living young, either winged or wingless. As colonies become crowded, generations of winged forms are produced that then infest other wheat, barley, or grass plants. Russian wheat aphids in North America overwinter as live-bearing females, sequestered near the bases of plants, often in damaged rolled leaves. Winter mortality is usually very high, thus, infestations in the fall usually do not translate into spring infestations unless the winter is mild and dry.

## Prevention

Heavy infestations of Russian wheat aphids in the fall can often be traced to a nearby source of infestation. Heavily infested volunteer grain, or more often, a very late planting of spring barley or wheat, will be responsible for an infestation in emerging winter wheat. Thus, the major ways to prevent Russian wheat aphid infestations in winter wheat in the fall are to destroy volunteer grain at least 2 weeks prior to planting and to delay planting until surrounding crops have dried down completely. Growers who must plant before Russian wheat aphid flights have subsided should consider using an at-planting systemic insecticide. There are several insecticides currently labeled for use.

## Detection

Russian wheat aphids are readily detected by the obvious damage in the field. Seedling wheat (pretillering) can be severely damaged by Russian wheat aphid infestations, becoming streaked and having extensive rolling. After tillering begins, plants can tolerate many more aphids without economic injury to the crop in the fall. For sampling in the fall, we recommend walking through the field, randomly selecting at least 100 plants, and scoring them for presence or absence of Russian wheat aphids.

## Control

Russian wheat aphid is the easiest to control of the three pest problems discussed here. Russian wheat aphid is not implicated in spread of viral pathogens in North America. Transmission of several viruses has been documented, but only under conditions very unlikely to occur under Pacific Northwest field conditions. Plants that are not too badly damaged by Russian wheat aphids will recover after the aphids are controlled, as damage is due to aphid feeding rather than pathogen multiplication in the plant.

We recommend foliar insecticide treatment if 10 percent or more of the plants are infested prior to tillering. After tillering, treatment is not recommended unless the crop appears obviously stressed. Most labeled foliar insecticides will do an excellent job in the fall. However, some work better than others if conditions are especially cool. Consult your local extension educator about the most appropriate product for your situation.

Winter wheat that was heavily infested in the fall should be inspected just after the crop breaks dormancy in the spring for reproducing Russian wheat aphid colonies and fresh damage. In most years, Russian wheat aphids do not overwinter in high numbers, but if they do overwinter, extensive damage can occur very quickly in early spring. We recommend insecticide treatment if 5 percent of the plants have reproducing colonies or fresh Russian wheat aphid damage before the wheat starts to joint. (Use fall sampling procedures described above.)

# Barley Yellow Dwarf (BYD)

## Epidemiology

Barley yellow dwarf is a disease of small grains and many grasses that is caused by a complex of closely related viruses collectively known as barley yellow dwarf virus (BYDV). The BYD viruses are all transmitted by aphids, but the aphid species that are capable of transmitting a given isolate depends on the specific virus. In Idaho, BYD viruses are unusually diverse, with a very wide range of aphid vector combinations.

The viruses also differ in serological assay reactions. BYDVs can be classified by serological reaction into five serotypes. All five serotypes occur in Idaho. It is likely that all five serotypes also occur in the Ontario area of Oregon. Only PAV and RMV have been confirmed in Washington and the Oregon Columbia Basin. BYDV is not seed transmitted, and plants cannot become infected from soil or from contact with infected sap.

Acquisition and transmission of BYDV by aphids can occur in as little as 30 minutes, but feeding times of six hours or longer are often required. This limits the range of potential aphid vectors in cereals to species that colonize

the crops. Twenty-four aphid species have been reported as vectors, of which only five are significant in the Pacific Northwest. These include bird cherry oat aphid (*Rhopalosiphum padi* (L.)), greenbug (*Schizaphis graminum* (Rondani)), corn leaf aphid (*Rhopalosiphum maidis* (Fitch)), English grain aphid (*Sitobion avenae* (Fabricius)), and rose grass aphid (*Metopolophium dirhodum* (Walker)).

Epidemiology of BYD is quite complex because of the variations in vector specificity for BYD viruses and the wide host range of the pathogens. A fairly reliable relationship exists between serotype and aphid vector specificity, but no relationship between serotype and plant host specificity has been shown. Therefore, the prevalence of various serotypes in a given host plant species (such as wheat) depends on plant host preferences of aphid vectors rather than on the host specificity of the virus. The relative importance of the various strains in different regions of Idaho depends on whether there are suitable hosts for both the virus and strain-specific vectors throughout the year.

A significant factor in the epidemiology of BYD in the Pacific Northwest is the presence or absence of corn production. Corn is a symptomless host of BYDV and an excellent host of the bird cherry oat aphid (fig. 3). Corn can also act as a reservoir of both virus and aphid vectors between cereal harvest in July and planting of winter wheat in September or October.

The percentage of infected corn plants in fields in southern Idaho can reach 55 percent; however, the percentage of infective aphids on corn in the Pacific Northwest is usually very low (0.0-2.2 percent), occasionally (1 year in 6) reaching 11 percent transmission from late planted corn. If the autumn season is long and warm, aphid infestation and BYDV infection can continue to increase in winter wheat. Early planting increases crop exposure to vectors and virus and increases the risk of loss to BYD.

In the absence of corn production, BYD occurs primarily when there is overlap between harvest of one crop and planting of the winter wheat crop for the next year, or when moisture conditions or irrigation practices allow persistence of volunteer cereals in the interim between harvest and planting. Under these conditions, other species of aphids besides bird cherry oat aphid become more important.

In southeastern Idaho, the greenbug was the major vector in an epidemic that occurred in 1984-85. The probable reservoir was the maturing 1983-84 wheat crop. Research in eastern Idaho indicates that reservoirs of BYDVs also exist in riparian areas in perennial sedges (*Carex* spp.). The extent to which these reservoirs provide a source of infection for crops is unknown. The most common aphid species found on *Carex* are host specific and do not colonize crops.

Other aphid species that can be significant vectors of BYDV in wheat are the English grain aphid, the rose grass aphid, and the corn leaf aphid. The English grain aphid and the rose grass aphid do not form large colonies on corn or other weed hosts and tend to occur in low numbers in winter wheat in the fall. It is probably for this reason that the serotype of BYDV specifically transmitted by English grain aphid and rose grass aphid (MAV) is rare in southwestern Idaho. However, English grain aphid and rose grass aphid probably do play a role in transmission of two other serotypes (PAV and RMV) in the spring and summer, because these aphid species are very abundant on spring crops.

The role of the corn leaf aphid in Idaho BYD epidemiology is especially complex. Corn leaf aphid populations can be separated by chromosome number and host preference. Clones of an eight-chromosome form colonize corn but not barley or barnyardgrass; whereas clones of a ten-chromosome form colonize barnyardgrass, barley, and certain other grasses but are rarely found on corn. The latter form is the predominant form of the corn leaf aphid that occurs in Idaho.

Corn leaf aphids and the serotype of BYD virus they transmit (RMV) increase in barnyardgrass and witchgrass during August and September in southwestern Idaho. Rates of transmission can be as high as 26 percent. Small ephemeral colonies of corn leaf aphids form on winter wheat in the fall, and sometimes individuals collected from these colonies can transmit BYDV. Some of the variants of RMV are also transmitted by bird cherry oat aphids, which are often very abundant on winter wheat. At least theoretically, these viruses could spread further in the wheat crop and cause losses.

## Prevention

Epidemics of BYD in winter wheat can be prevented by planting crops late enough to avoid potentially infective aphid vectors. In the fall of 1985, a severe epidemic of BYD in southeast Idaho caused by infective greenbugs was largely avoided by delaying planting until after greenbug flights had subsided or by using systemic insecticides when early planting was necessary for agronomic reasons.

Similarly, in southwestern Idaho, winter wheat should be planted after corn has been harvested for silage or has dried down. Destruction of volunteer grain is also a key to preventing losses from BYD. Fields of volunteer grain should be destroyed at least a week prior to planting.

There are no agronomically-adapted winter wheat varieties for Idaho with resistance to BYDV. Current efforts at producing resistant varieties involve genetic engineering to transfer a resistance gene from barley into wheat or to transfer the coat protein of the virus into wheat. Resistance due to incorporation of viral coat protein into plants has been shown to confer virus resistance in other crops.



Figure 1. Russian wheat aphid damage on winter wheat in the fall. Note purple streaking and rolled leaves. (Photo by S. Halbert)



Figure 2. Russian wheat aphid. The short projection above the tail (far right on photo) gives the aphid a double-tailed appearance characteristic of this species. (Photo by S. Halbert)



Figure 3. Bird cherry oat aphids on corn. Bird cherry oat aphid populations can be very high on corn. As corn matures, aphids leave the plants and can form colonies on winter wheat, sometimes carrying barley yellow dwarf virus (BYDV) with them. (Photo by G. Bishop)

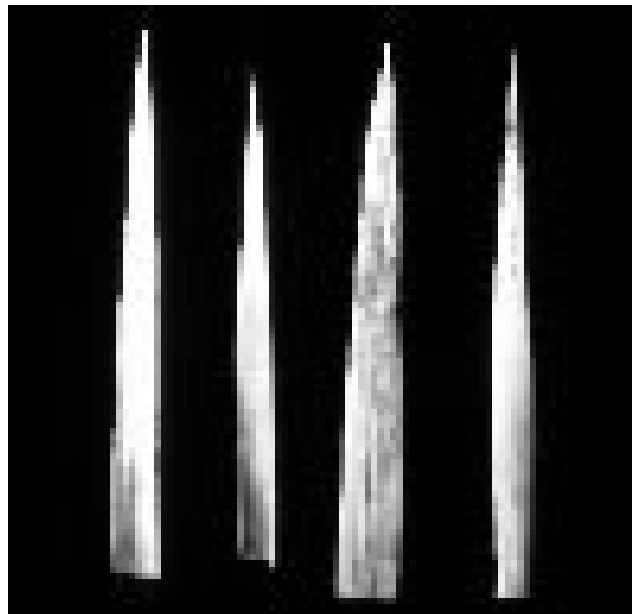


Figure 4. Symptoms of barley yellow dwarf (BYD) in wheat include reddish yellow leaf tips; stiff pointy leaves; and stunting. BYD is caused by a complex of viruses transmitted by aphids to winter wheat and other plants. (Photo by R. Forster)

## Detection

BYDV causes damage by partially plugging the phloem of infected plants. Diagnosis based on symptoms is particularly difficult in wheat as symptoms resemble drought or nutrient stress. Symptoms in wheat include yellowing or reddening of leaves (fig. 4) and stunting. Root growth may be severely curtailed. Leaves of infected plants are often stiff and sharply pointed at the tip in comparison with healthy plants. Aphid vectors must be present for an epidemic to occur, but the presence of aphids does not necessarily indicate the presence of BYDV and their absence at a later date (e.g., in the spring) does not preclude a BYD diagnosis. Positive diagnosis of BYD can only be obtained through serological assays and/or confirmation of aphid transmission.

## Treatment

There is no effective treatment after plants become infected with a virus. However, even in fields where a high proportion of plants are infected, losses seldom exceed 50 percent, and plow-down is not recommended unless there are extenuating circumstances. Infected plants will respond to fertilizer and moisture; thus agronomic practices minimizing stress are advised.

Grazing does not retard spread of BYDV. Over all, the most important fall vectors are bird cherry oat aphids and greenbugs. Both these species colonize the lower parts of the plants, and bird cherry oat aphids often colonize below ground. Thus, grazing does little to retard increase of aphid populations. Grazing will have no effect on the virus infection because it is systemic.

Insecticide treatment for aphid management may be beneficial in retarding an epidemic. Initial infection in a field (primary spread) occurs when infective winged aphids colonize the crop. Insecticide may not affect primary spread because immigrant aphids may transmit BYDV before they succumb to the insecticide. However, infectivity rates for winged aphids during planting season are generally low (less than 7 percent).

Most crop damage occurs when aphid populations increase and the aphids spread BYDV within a field (secondary spread). At-planting and foliar-applied insecticides have been shown to be effective in retarding secondary spread. In general, at-planting systemic insecticides are not recommended unless crops must be planted before flights of aphid vectors have subsided to safe levels.

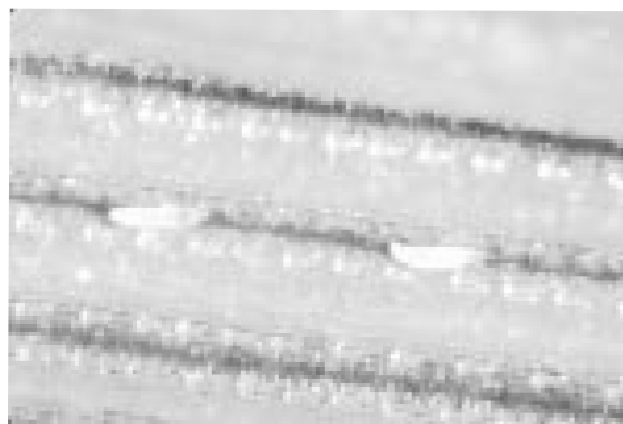


Figure 5. Microscopic wheat curl mites (on dark green stripe) on wheat leaf. Wheat curl mites can transmit wheat streak mosaic virus (WSMV), a very serious disease of wheat. (Photo by J. Kalish)



Figure 6. Early symptoms of wheat streak mosaic appear as hairline streaks on the newest leaves. Streaks broaden and become bright yellow as leaves mature, as shown here. (Photo by R. Forster)

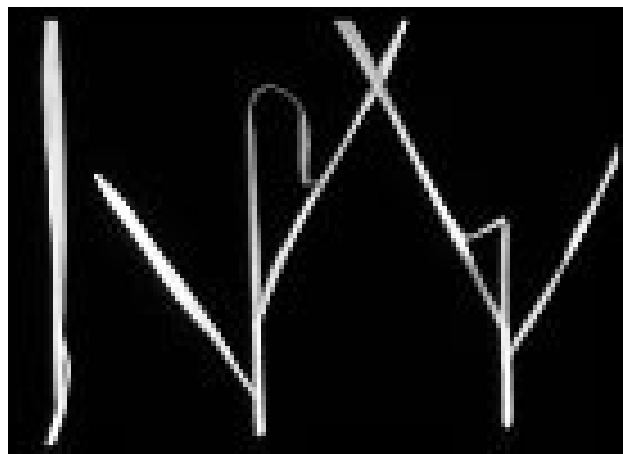


Figure 7. Wheat curl mite (see fig. 5) damage on wheat is characterized by tight curls at leaf margins and trapped leaves. (Photo by R. Forster)

# Wheat Streak Mosaic

## Epidemiology

Wheat streak mosaic (WSM) is the most serious of potential carryover problems because no chemical protection is available. Crops with high rates of infection may sustain yield losses approaching 90 percent. WSM is caused by wheat streak mosaic virus (WSMV), which is transmitted by microscopic wheat curl mites (*Aceria tosichella* Keifer) (fig. 5). In Idaho, the disease most commonly occurs when there is an overlap between the maturation of cereal crops and the planting of winter wheat. When winter wheat emerges before the previous crop is mature, infective mites are blown off the maturing crop into the new crop, resulting in WSMV infection. Localized WSM epidemics can also occur when hail-shattered wheat at the soft dough stage falls to the ground and produces volunteer grain under the canopy prior to maturation of the crop. Virus-carrying mite populations develop on the volunteer grain and serve as a source of infection for emerging winter wheat. Maturing corn can also be a source of mites and WSMV.

Wheat curl mites cannot survive more than about a day without a living host plant. Thus, for a WSM epidemic to occur, mites must move from one living host to another living host within a short time. Conditions that allow this movement to occur are referred to as a green bridge. The virus may be present in a wide variety of grass species, but epidemics in the Pacific Northwest can usually be explained by a source of vectors and virus in wheat or corn. Barley, rye, and oats are hosts for WSMV, but are very poor hosts of the mite. Therefore, these crops are probably not significant sources of WSMV infective mites. Grassland conservation plantings are not apt to be sources of WSMV because the popular varieties of wheatgrasses used in conservation programs are immune to the virus. Broadleaf plants have not been tested, but they are very unlikely hosts for either the virus or its vector.

Research in Kansas indicates that fields adjacent to infected volunteer wheat were affected most severely by WSM, that severity decreased with distance from the source, and that WSM was consistently worse where winter wheat had been planted early. Experience in Idaho also indicates that fields with high incidence of disease usually have been planted exceptionally early (early- to mid-August) or were planted very close to a major source of infection, such as an infected winter wheat cover crop planted the previous spring.

The wheat curl mite is so small that it cannot be seen with the naked eye. Mites are elongated and white, with four legs near the front end. Mites can usually be found in characteristic tight curls at the leaf margins, or inside leaf whorls near the base of the plant. Nearly all mites are female and reproduce by laying eggs. The complete life

cycle occurs in 8 to 10 days. An early researcher in Nebraska estimated that one mite could produce about 180 quadrillion descendants in 50 days. Wheat curl mites do not have wings and probably do not spin webs. Their sole means of transport is the wind. Our observations indicate that wheat curl mites can overwinter in Idaho on wheat.

Wheat curl mites can acquire the virus by feeding on a diseased plant for 15 minutes, but longer feeding times increase the percentage of infective mites. Mite transmission of WSMV can also occur in about 15 minutes, but infection rate increases with feeding time. Mites retain the virus for life but cannot transmit it to their offspring.

Another disease caused by an unknown pathogen has recently been discovered in wheat and corn in Idaho and other states. Symptoms are similar to WSM but more severe, especially in combination with WSM. The two diseases often occur together because both are transmitted by wheat curl mite. Epidemiology of the new disease is very similar to that of WSM because they share the same vector. However, little is known about the plant host range of the newly discovered pathogen. If it has a wider host range than WSMV, additional potential reservoirs of mites and virus would have to be considered.

## Prevention

Delayed fall seeding is the best way to prevent WSM. Even a short delay in planting can prevent serious infection because mite survival is so limited without green host-plant tissue. Surveys of eastern Idaho winter wheat in October 1993 indicated that, in one case, a delay of just 11 days in planting made the difference between low incidence of WSMV (6 percent) and over 80 percent infected plants. We recommend waiting 2 weeks after local cereal crops have matured before planting winter wheat. This will greatly reduce the risk of WSM.

Evidence from Idaho in the fall of 1993 suggests that primary spread of WSMV may be much more important than subsequent secondary spread in a wheat crop under southeastern Idaho highland conditions. A total of 500 wheat plants without symptoms were collected from six fields in high risk areas in Rockland and Arbon Valleys in late October 1993. Plants were grown indoors for several weeks to monitor symptom development. Each plant was then indexed to a healthy wheat seedling using mechanical inoculation to determine if transmissible virus was present. Only 1 of the 500 plants developed characteristic symptoms of WSM, indicating that very little spread from initial infection foci had occurred during the fall. Thus, most WSMV infection of 1994 wheat in the fall of 1993 in the southeast Idaho highlands was probably the result of primary spread as the 1993 crop matured. This further underscores the importance of delayed planting to avoid wheat curl mite infestation and WSMV infection in winter wheat.

Destruction of volunteer grain is also important in preventing WSM, particularly if the volunteer problem is caused by hail damage at dough stage. Growers who intend to plant winter wheat should be very observant about possible nearby sources of mite infestation and virus infection. Winter wheat fields have been destroyed by WSM when winter wheat was planted near a crop of maturing corn or an infected cover crop of spring-planted winter wheat.

There are no adapted winter wheat cultivars that have resistance to WSMV or the wheat curl mite. Limited efforts at breeding resistant wheat varieties have focused on mite resistance and transference of genes from WSMV resistant grasses into wheat.

## Detection

WSMV produces characteristic streaks in wheat (fig. 6). Early symptoms are intermittent hairline streaks on the newest leaves. Streaks broaden into bright yellow bands that form a yellow-green mosaic as leaves mature. In a plant that has been infected for several weeks, the lower leaves become bright yellow with green streaks. Fields with high incidence of WSMV infection have an off-color yellow cast from a distance.

Mites cause damage to wheat apart from the effects of WSM (fig. 7). High populations can cause the edges of leaves to curl tightly around developing mite populations. Damage differs from Russian wheat aphid damage in that wheat curl mites tend to curl leaf edges very tightly, while Russian wheat aphids curl the entire leaf. Leaf damage caused by wheat curl mites is more likely to trap the tips of emerging new leaves than damage caused by Russian wheat aphids.

Wheat curl mite damage is often accompanied by streaking caused by WSMV, which makes the curled leaves resemble Russian wheat aphid damage; however, streaks caused by the virus are usually thinner and shorter in length than streaks caused by Russian wheat aphid feeding. WSMV and wheat curl mite damage is never purple, whereas Russian wheat aphid damage is frequently purple in the fall. It is very rare to find large Russian wheat aphid infestations on WSMV infected plants.

When winter wheat becomes infected by WSMV in August, symptoms are obvious in October. However, warm temperatures are required for symptom expression, thus, fields infected later in the fall may remain symptomless until spring. Fields that have symptoms in the fall may appear to recover after spring green-up, but as the weather warms, infected crops deteriorate very rapidly. Similarly, fields that were asymptomatic but infected in the fall may green-up normally in the spring. Symptoms develop in infected wheat plants as the weather warms, and plants will produce very little grain.

Symptom expression in the spring requires several days with temperatures exceeding 70° F. If plants become infected in the fall, but remain asymptomatic until spring, symptom expression may occur too late for a grower to destroy the infected wheat and plant a profitable spring crop. Thus, growers need to determine percent WSMV infection in winter wheat crops in the fall or very early in the spring.

To determine the extent of infection in the fall or early spring, we recommend collecting 100 plants without symptoms from fields in high risk situations. Crops with a high risk for WSM include those planted prior to harvest of the previous wheat crops in the area, those that were planted near a suspected source of WSMV and wheat curl mites, and those in which 2 percent or more of the plants already have symptoms of WSM or wheat curl mite damage in the fall. Each collected plant should be potted in potting soil, fertilized, and kept in a warm indoor area that is well lighted. Diagnostic symptoms should show up in 4 to 6 weeks in the fall and in 1 to 3 weeks in the early spring. This method works better in the spring because symptoms develop more quickly, and because aphids and fungi that accompany plants collected in the fall make WSM symptoms difficult to assess. The aphids and fungi are much more of a problem in fall samples than in spring samples.

## Control

There is no effective chemical control for wheat curl mite or WSMV. Infected crops often do not respond to fertilizer, moisture, or any other agronomic practices. Grazing is not effective for control of mites, and because the virus infection is systemic, grazing has no effect on WSM. Severely infected wheat crops often have to be destroyed completely and replanted.

One notable exception occurred in Idaho, Washington, and Montana in the fall of 1993, when winter wheat fields were observed to be nearly 100 percent infected in the fall under classical epidemiological conditions, yet subsequent yield losses were not nearly as high as would be expected from the literature and based on previous experience in Idaho. The reason for this is unknown, but there are several possible explanations. First, the 1993-94 season was characterized by abundant moisture and excellent growing conditions for winter wheat. It is possible that the plants outgrew the infection. Second, yield loss could be dependent upon interactions with other plant pathogens that were not recognized by diagnostic techniques used to assess earlier epidemics. A third possible explanation for the discrepancy in yield loss may be differences in strains of WSMV. In any case, the 1993-94 season appears to be an exception to historical experience with WSM epidemics. Growers that elect not to destroy infected crops are taking a significant risk.

If a grower decides to destroy infected wheat crops or volunteer wheat, it should be done as quickly as possible. Plow-down, or a combination of chemical control followed by light but thorough tillage within a few days, will work. Chemical control alone is not recommended if it is expected that there will be susceptible crops growing in the vicinity before the treated wheat dies completely. Mites carrying WSMV could leave the dying plants and be carried by wind to a nearby commercial crop.

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## Further Reading

To order the following publications, contact the University of Idaho Cooperative Extension System office in your county or Agricultural Publications, University of Idaho, Moscow ID 83844-2240; (208) 885-7982.

*Aphids Infesting Idaho Small Grain and Corn*, CIS 816, 35¢

*Russian Wheat Aphid*, CIS 817, 50¢

*Barley Yellow Dwarf*, CIS 672, 40¢

*Russian Wheat Aphid: Biology, Damage, and Management*, PNW 371, \$4.00