

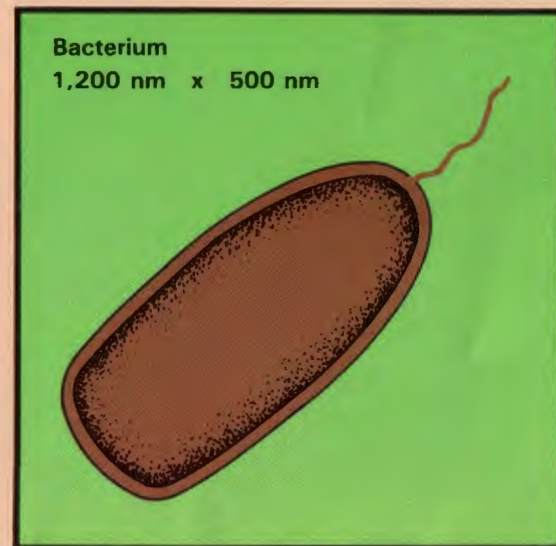
COMMON CEREAL VIRUSES

Viruses are the smallest of pathogens. The infectious viral particle is called a virion, which is a stable, nonmultiplying stage by which the virus is transferred from one plant to another. Viruses multiply in the host plant, and transmission may occur via several means: by insects and mites (especially sucking insects, such as aphids), nematodes, seed, pollen, fungi, soil, and mechanically.

Viral diseases are often difficult to detect because infected hosts may not display visible symptoms, or symptoms may closely resemble those of various physiological disorders or genetic abnormalities. Identification can be facilitated by determining which vectors are present and the host range; in many cases, positive identification requires the use of an electron microscope and serological techniques.

	Length	Diameter
WSMV	700 nm	x 15 nm
BaYMV	275 nm 550 nm	x 13 nm
SBWMV	140 nm 290 nm	x 20 nm
BSMV	100 nm 150 nm	x 20 nm
BMV	●	26 nm
BYDV	●	24 nm

┃ 100 nm



Relative sizes of the six virions compared with a bacterium



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Barley Yellow Dwarf Virus (BYDV)

Plant Symptoms

Affected plants show a yellowing or reddening (on oats and some wheats) of leaves, stunting, an upright posture of thickened stiff leaves, reduction in root growth, delayed or no heading, and a reduction in yield. The heads of affected plants tend to remain erect and become black and discolored during ripening due to colonization by saprophytic fungi. Symptoms are usually mildest in wheat and more severe in barley and oats. High light intensity and relatively cool temperatures (15-18°C) usually markedly accentuate the symptoms. Symptoms generally appear 2-3 weeks after infection.

The symptoms of barley yellow dwarf (BYD) vary with the infected (affected) crop cultivar, the age of the plant at the time of infection, the variant of the virus, and the environmental conditions. Symptoms often are masked by or confused with other problems.

Virus

The virions are small isometric particles approximately 24 nanometers (nm) in diameter and contain single-stranded RNA. BYD includes several related viruses that are all persistently aphid-transmitted.

Vectors

More than 20 species of aphids may act as vectors. Oats and barley are good diagnostic species. There is specificity between virus and vector. The main ones are as follows:

- RPV transmitted specifically by *Rhopalosiphum padi*.
- RMV transmitted specifically by *R. maidis*.
- MAV transmitted specifically by *Macrosiphum avenae* now called *Sitobion avenae*.
- PAV transmitted nonspecifically by *R. padi* and *S. avenae*.
- SGV transmitted specifically by *Schizaphis graminum*.

Other variants with different specificities are being discovered in different parts of the world.

Hosts

BYDV attacks wheat, barley, oats, triticale, maize, and rice as well as many other grass species.

Distribution

BYDV is probably the most widely distributed viral disease of cereals in the world. It has been recorded wherever cereals are grown.

Importance

If infection occurs early in the crop cycle, yield losses of more than 20% can result.

P. A. Burnett



G. Johnstone



Soilborne Wheat Mosaic Virus (SBWMV)

Plant Symptoms

Symptoms range from mild-green to prominent-yellow leaf mosaics. The unfolding new leaves show mottles and streaks. Stunting can vary from moderate to severe and certain strains of the virus can cause rosetting of plants. Generally, as the young leaves unfold, they appear mottled and develop parallel streaks. The symptoms, which are more pronounced in low-lying areas because these areas favor the fungal vector, are most prominent in early spring growth and rarely appear in the autumn.

As temperatures rise in the spring, disease development slows and eventually stops. When this happens, symptoms will often be confined to the lower leaves. Temperatures of 15°C (range 10-20°C) promote SBWMV. At temperatures above 20°C, the disease's progression is stopped.

Virus

The virions are hollow, rigid rods of 20 nm in diameter and of two lengths (110-160 nm and 280-300 nm), which contain single-stranded RNA. It appears that both long and short rods must be present for infection to occur.

Vector

SBWMV can be sap-transmitted, but the natural vector is *Polymyxa graminis*, a soilborne fungus.

Hosts

Normally this virus is only a problem in autumn-sown wheats, however it may infect rye, barley, and hairy bromegrass (*Bromus* spp.). Spring wheats are susceptible, but very seldom show symptoms of SBWMV infection in nature.

Distribution

SBWMV has been recorded in the eastern and central USA, Japan, Egypt, Italy, Argentina, and Brazil.

Importance

The virus is most prevalent in the USA where entire fields or areas of a field may be so badly infected they do not warrant harvesting. In some years, the damage this virus causes probably rivals that caused by barley yellow dwarf virus (BYDV).

C.C. Gill



J. Martin



Wheat Streak Mosaic Virus (WSMV)

Plant Symptoms

Infected plants are stunted with mottled green and yellow-streaked leaves. Streaks are parallel, but often discontinuous. Isolates give a symptom range from mild mosaic to severe chlorosis. Symptoms vary with wheat cultivar, strain of the virus, time of infection, and environmental conditions. Heads may be sterile. Leaves can become necrotic. Often, infections appear at the margins of a field first because of the movement of the virus's mite vector. Infections may occur in the winter, but symptoms often don't appear until the spring temperatures rise to above 10°C.

Virus

The virions are flexuous rods 700 nm long and 15 nm in diameter and contain single-stranded RNA.

Vectors

The wheat curl mite, *Aceria tulipae* (syn *Eriophyes tulipae*) and *E. tosichella* (in Yugoslavia) are the only known vectors of WSMV. WSMV is carried in the mid- and hind-gut of the mite, but is not passed through the egg.

Hosts

The virus and the mite vectors persist in wheat, maize, millet, and some grasses.

Distribution

The virus occurs in the USA, Canada, Jordan, eastern Europe, and the USSR.

Importance

The virus is most prevalent in the USA, where in the Great Plains it at times can cause complete losses. The incidence can be quite variable, from a few fields to large affected areas.

C. C. Gill



J. Martin



Brome Mosaic Virus (BMV)

Plant Symptoms

The symptoms of brome mosaic virus (BMV) are similar to those of WSMV. Yellow or white spots and streaks rapidly spread over the leaves initially born a yellowish mosaic pattern. The leaves will rapidly become bright yellow. Infected plants may be slightly stunted and produce shrivelled grain. Young plants exhibit the most obvious symptoms and these often become less apparent as the plants grow older. Some wheat lines may be symptomless carriers.

Virus

The virions, which are easily sap-transmitted, are hollow isometric particles with a diameter of about 26 nm and contain single-stranded RNA.

Vectors

In the laboratory, nematodes of the genus *Xiphinema* have been shown to transmit this virus. Laboratory transmission by aphids and mites has been unsuccessful, but recently, the aphid, *Diuraphis noxia*, has been reported to transmit the virus.

Hosts

BMV infects wheat, oats, maize, barley, rye and in additional species of *Bromus*, *Lolium*, *Phleum*, *Agropyron*, *Agrostis*, and *Poa*. Diagnostic species are: maize (*Zea mays*), in which the seedlings of most lines show primary lesions or streaks followed by necrosis and death, and *Chenopodium* spp. BMV is one of the few grass viruses that cause local lesions on *C. amaranticolor*, *C. hybridum*, and *C. quinoa*.

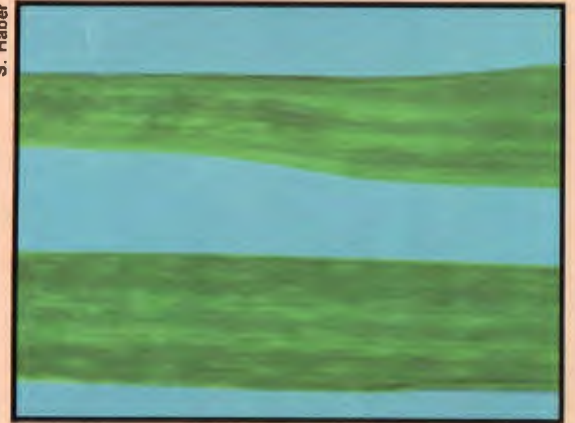
Distribution

BMV has been reported occurring in nature in Finland, South Africa, central USA, Canada, USSR, and Yugoslavia.

Importance

BMV had not been thought to be important or to cause economic loss in cereals, but recent reports suggest it may be much more widespread than thought and may be damaging in South Africa.

S. Haber



S. Haber



Barley Yellow Mosaic Virus (BaYMV)

Plant Symptoms

Infected barley plants show a mosaic and may be stunted. The leaves may also show yellow spots and short streaks. Later the leaves turn completely yellow beginning at the leaf tip. Necrotic spots may appear on the leaves and the leaves may die prematurely. The disease generally appears as pale green to yellowed patches of plants in the field. The severity usually depends on the cultivars and the environment. These symptoms are very obvious in the spring and then disappear.

Generally symptoms will not express themselves at temperatures above 18°C. This virus is generally a problem of winter barley.

Virus

The virions are flexuous, rod-shaped particles that come in two lengths, 275 and 550 nm. They are 13 nm in diameter and contain single-stranded RNA.

Vectors

BaYMV is sap-transmitted, but in nature transmission occurs through infected soil. The soilborne fungus, *Polymyxa graminis*, is the vector. The infectivity of the soil is retained for a number of years.

Hosts

Barley is the only known host as well as being the only known diagnostic plant. BaYMV is not readily inoculated mechanically, but can be if the plants to be inoculated are kept below 18°C.

Distribution

First described in Japan, BaYMV is now widespread in Europe.

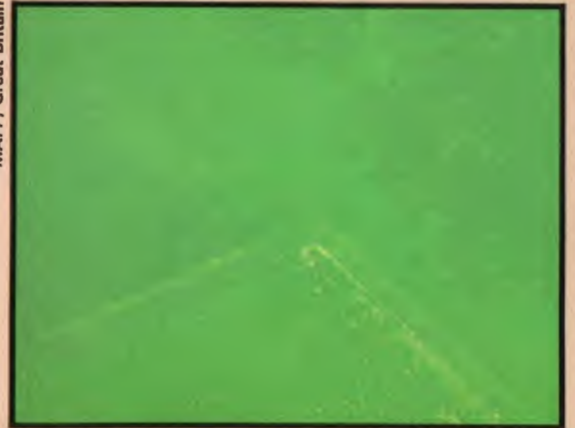
Importance

BaYMV can cause losses of up to 50% in yield in susceptible cultivars.

Rotherhamsted



MAFF, Great Britain



Barley Stripe Mosaic Virus (BSMV)

Plant Symptoms

BSMV causes yellow to white mottling, spotting and streaking on the leaves of infected plants. Often dark brown stripes form an inverted 'V' or 'W' of necrotic tissue on the leaf blade. The area of the leaf on the side of the stripe nearest the leaf tip remains a healthy dark green color, where as the portion of the leaf enclosed by the V or W shows a pale green mottling or chlorosis. Plants grown from BSMV-infected seed may show symptoms as early as the 2- to 3-leaf stage—usually a diffuse chlorotic mottling. In addition to leaf symptoms, infected plants may have poorly developed heads and some sterility. Some symptomless carriers exist.

The symptoms depend on the strain of BSMV, the barley cultivar, temperature, light intensity after infection, and the stage of cultivar development at the time of infection.

Temperatures above 25°C favor disease development. Lower temperatures limit symptom expression, probably because of the slow systemic spread.

Virus

The virions are hollow rods normally 20 nm in diameter and from 100-150 nm long, and contain single-stranded RNA. At least 20 strains are known.

Vectors

BSMV can be seedborne and mechanically and pollen transmitted. There is a single report of it being transmitted by the aphid species *Diuraphis noxia* and *Rhopalosiphum padi*.

Hosts

Barley is the principle host of the virus. The virus is readily transmissible to many cereals including wheat, oats (both cultivated and wild), sorghum, millet, rye, maize, and rice plus a number of other grasses.

Diagnostic species include barley, wheat, and oats which show systemic stripes and mosaics of different types. *Chenopodium amaranticolor*, *C. quinoa*, and *C. album* show large chlorotic yellow lesions that are not systemic. *Beta vulgaris* (beet) has chlorotic yellow lesions that are not systemic. Some strains produce systemic infection in maize, mosaic in *Spinacea oleracea* (spinach), and local chlorotic lesions in *Nicotiana tabacum* cv. Samsun (tobacco).

Distribution

Historically BSMV has been very widespread in the North American prairies. It has been recorded in most countries in the world. It is the subject of seed quarantine regulations.

Importance

BSMV can cause quite severe losses in yield, but, in most parts of the world, has been greatly reduced by the use of virus-free seed.

P.A. Burnett



T. Carroll

