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Wheat streak mosaic and the wheat curl mite

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Symptoms

Wheat streak mosaic has a range of symptoms. The two main symptoms are leaf mottling (mosaic) and leaf streaking. The disease first appears as light green streaks running parallel to the leaf veins. These streaks turn yellow and develop into blotches, giving the leaf a green and yellow pattern called a 'mosaic'.

Tillers on affected plants tend to be less erect than those on uninfected plants.

Affected plants can die prematurely or fail to grow, becoming stunted relative to healthy plants.

Heads on infected plants can be sterile and contain no seed, or can contain small to shrivelled grain.

Affected plants often occur in patches or along the side of the crop closest to grasses that were growing when the crop emerged. In severe cases, the whole crop can be affected.

Symptoms of wheat streak mosaic develop at temperatures above 10°C, so they are masked during winter.

The wheat curl mite transmits wheat streak mosaic. Feeding by these mites can cause additional damage, with leaves curled upward and inward, sometimes trapping new leaves or the emerging head and resulting in rolled, twisted plants.

These symptoms can be confused with nutritional disorders, environmental effects and chemical damage. Positive identification of wheat streak mosaic and the wheat curl mite requires testing in a specialist laboratory.

Background

Wheat streak mosaic is caused by **Wheat streak mosaic virus** (WSMV) and transmitted by the **wheat curl mite** (*Aceria tosichella*), which also transmits **High plains virus** (HPV).

Plants with wheat streak mosaic are frequently yellow and stunted, with streaks and mottling. *(Photo: Jan Edwards.)*

Leaf streaks caused by wheat streak mosaic. These are often the first symptoms. *(Photo: Jan Edwards)*

WSMV occurs in several wheat-growing countries, including parts of North America, Europe and the Middle East. It was first identified in Australia in April 2003. Surveys in 2003 found it at low levels from southern Queensland to South Australia, where it appears to have been present for some years: it has not been found in Western Australia.

WSMV and the wheat curl mite survive year-round on living grasses. They are most serious in areas where there is an overlap of summer and winter-growing grasses and cereals.

High plains virus (HPV) has also been detected in eastern Australia. Overseas, the two viruses can occur together, causing greater damage. Very little is known about the status of HPV in Australia and it requires further study.

Effect on yield

Early infection by WSMV causes the greatest yield loss. Most infected seedlings die early. Plants infected between tillering and first node usually do not set any seed, while those infected between first node and booting have smaller seed. Later

Mosaic and streaking patterns on leaves caused by wheat streak mosaic. *(Photo: Jan Edwards)*

Death of the leaf beginning as elongated lesions. Wheat streak mosaic causes premature death of the plant. Symptoms overlap with other diseases and disorders. *(Photo: Jan Edwards)*

infections cause progressively less damage, with only slight losses expected with spring infections.

Overseas, severe losses can occur when:

- the previous summer has been favourable for survival of the wheat curl mite, and
- the autumn is favourable for mite movement into newly sown wheat.

In Australia, such conditions may occur in areas with mild wet summers such as the wetter slopes and tablelands in NSW, Tasmania, coastal regions of southern Victoria and the south-east of South Australia. Virus infections have been high in irrigation crops in southern NSW that were adjacent to drainage channels with summer-growing grasses.

Early infections cause severe stunting, with affected plants often in patches. *(Photo: Gordon Murray)*

Yield losses exceeded 50% in some irrigated crops in 2003 and up to 80% in some graze-grain wheat crops on the Central and South West Slopes of NSW in 2005. More work is needed before further conclusions on the economic losses from wheat streak mosaic can be made.

Disease cycle

WSMV survives year-round in grasses and cereals and is spread by wheat curl mites. Its severity depends on weather conditions that favour the winter and summer-growing hosts and the spread from one to the other by the mites.

Host range

WSMV infects wheat, other cereals and several grasses. Wheat is the preferred host of the wheat curl mite and the virus, and shows the most obvious symptoms and damage.

Barley, oats, millet and cereal rye can be infected but they do not show obvious symptoms or damage. Triticale is probably a host. Maize is susceptible to WSMV and the mites but is not seriously affected; it is more affected by HPV. Sorghum is a poor host of the mites and is immune to WSMV in the USA.

Grasses such as brome (*Bromus diandrus*), setaria (*Setaria verticellata*), blackgrass (*Eragrostis cilianensis*), crowsfoot (*Eleusine indica*), wild oats (*Avena fatua* and *A. sterilis*), annual ryegrass (*Lolium rigidum*), couch (*Cynodon dactylon*) and phalaris (*Phalaris aquatica*) are potential reservoirs of WSMV.

WSMV reproduces within the cells of wheat and other cereals and grasses, producing huge numbers of virus particles.

Spread

WSMV is unable to spread unaided. It can be transmitted from diseased to healthy plants by the wheat curl mite, in infected seed, and mechanically. The mite and the virus survive between wheat crops on grasses and volunteer wheat. In the USA, optimum temperatures for mite activity and virus transmission are 24 °C to 27 °C.

Wheat curl mite

The vector for WSMV is the wheat curl mite, known scientifically as *Aceria tosichella*. These mites are wingless and tiny, about 0.2 mm (0.1–0.3 mm) long, coloured whitish to light yellow, cigar-shaped, and with two pairs of legs located at the front. The mite's small size and secretive habits (it lives in leaf whorls) make it extremely difficult to detect even with a microscope. When detected, it is difficult to distinguish the wheat curl mite from other eriophyoid mites.

WSMV is one of about 3500 species of eriophyoid mites. Most of these are very host-specific, only feeding on one species of plant. The wheat curl mite is an exception because it apparently feeds on a large number of cereals and grasses. There are, however, several closely related species of mites, each feeding on a limited number of grasses, and this may make its range seem larger than it is. More study is needed to identify the eriophyoid mites on grasses and cereals and their respective roles in transmitting WSMV and HPV.

The wheat curl mite acquires the virus when it feeds on infected plants. Once acquired, the mite remains infective for about a week, perhaps for life, but does not pass the virus through the egg to its offspring. 'Viruliferous' mites transmit WSMV to healthy plants by feeding. Feeding mites can directly damage young growth, causing leaves to stay rolled and trap later leaves and the head.

Wheat curl mites can survive for months within living rolled leaves and shoots of wheat and other grasses. In cooler conditions, mites can survive for up to two weeks away from grass hosts. However, they die within a few hours if exposed to low humidity and moderate to high temperatures. Mild summers with adequate rain for grass growth favour mite survival and virus build-up between wheat crops.

The wheat curl mite (*Aceria tosichella*), highly magnified. (Black line is 0.1 mm long.) *(Photo: Danuta Knihinicki)*

Wheat curl mites are much less active when temperatures are below about 10°C and spread best at about 18°C when winds are greater than 25 km/h. These mites can crawl slowly from plant to plant, but depend on wind to move any distance. As a host plant nears maturity, the mites move to the outer edges of leaves and heads, where they stand upright so that they can be blown away by wind. Some mites can be blown for long distances, but most infestations occur within 1 km of the source. If mites land on a suitable plant, they begin feeding and can transmit the virus.

In the USA there are two main times for mite movement. Mites move off winter crops and grasses as they mature in the spring, and move off maize and other oversummering grasses as they mature in the late summer and autumn. Early sown crops that emerge and grow before temperatures fall below 10°C in autumn/winter will be the most liable to early infection if wheat curl mites are moving from oversummering hosts at that time. The mites survive freezing so, although inactive, they will survive most winter conditions. As temperatures warm in spring, mites become active and can again spread WSMV within the crop. The mites then ride the wind to newly growing grasses, where they oversummer.

March-sown winter wheats on the Central and South West Slopes were severely infected in 2005. Infection was greatest in heavily grazed crops. The role of grazing animals in transporting mites requires investigation.

Seed transmission

A low percentage of seed harvested from wheat infected with WSMV will carry the virus. This transmission would be important for introducing the virus to new areas, but this means of transmission is unlikely to be important in areas where WSMV already occurs. This is because the low number of infected seedlings growing from virus-infected seed will die early and neighbouring healthy plants will grow in their place. In addition, wheat curl mites are needed to transmit the virus from the infected seedlings; if mites are present, they would most likely already be carrying WSMV from their oversummering hosts, so there would be no increased disease from the seed-borne infection.

Growers should avoid using seed from heavily infected crops for sowing because it will often be pinched and of poorer quality for crop establishment.

Mechanical transmission

WSMV is the only wheat virus known to be transmitted in sap when an infected plant rubs against a neighbouring healthy plant, but this is not a major means of transmission in the field. (Researchers use this property to maintain cultures of the virus for study.) It is not known whether grazing stock can inadvertently spread the virus by this means.

Control

Field observations in 2005 were that wheat streak mosaic was less of a problem in crops where neighbouring paddocks had good summer grass weed control. March-sown wheat that had grassy borders had high levels of wheat streak mosaic.

Overseas, these controls are used:

- **Monitor the incidence** of WSMV and wheat curl mites in oversummering grasses. If these are high, some of the following control strategies would be recommended. (The value of this in Australia needs investigation and would require a specialist service.)
- **Break the disease cycle**. Control of oversummering volunteers reduces the numbers of mites that can invade autumn sown crops. (This appears a useful control method in Australia.)
- **Control grasses** growing on the borders before planting early sown wheat. (This appears useful in Australia.)
- **Delay sowing** in autumn until temperatures are too low for mite activity. This is not feasible for grazing wheat, as sowing would be too late, but is in fact the time when most grain wheat crops are sown anyway.
- **Use pesticides**. These have limited value because overseas work has shown that the mites are difficult to target and they develop resistance to the pesticides quickly.
- **Resistance**. Wheat varieties differ in their reaction to wheat streak mosaic so it is possible to breed for resistance. (The reactions of Australian varieties are presently unknown.)

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