

Virus diseases of lettuce in Australia

Viruses are very small microorganisms that are parasitic and can only multiply in living cells. One virus may infect many different plant species. Commonly, more than one virus may infect single plants at the same time producing a complex of virus disease symptoms. Some plant pathogenic viruses are transmitted in seed, but most enter plants with the assistance of vectors such as insects, mites, nematodes and fungi. Other viruses are transmitted mechanically from physical damage. Virus infections in plants cannot be cured – only prevented. Lettuce big-vein disease, lettuce necrotic yellows, lettuce tospoviruses, lettuce mosaic and cucumber mosaic, are currently the most important viruses of lettuce in Australia.

Lettuce big-vein disease

Lettuce big-vein disease (LBVD) is caused by Mirafiori lettuce big-vein virus (MLBVV, genus *Ophiovirus*), usually in combination with lettuce big-vein associated virus (LBVaV, genus *Varicosavirus*). LBVD can occur all year round but is more severe when temperatures drop below 16°C, particularly in wet and heavy soils. LBVD is widespread especially with close cropping in cool temperate growing regions.

How does the disease spread?

LBVD is spread in cool moist soil conditions by an *Ospidium* oomycete, which is a fungus-like organism that is common in many vegetable growing regions. The fungus itself does not damage lettuce but it produces water-borne zoospores that move through wet soil and transmit the viruses to lettuce roots. Viruses are spread from infected lettuce and nearby alternative hosts, including sow thistle, chickweed, spurry, cape weed and scrambling spell weed. This disease can remain in the soil for up to 25 years.

Infections of LBVD may also arise from nursery-produced seedlings where glasshouse hygiene is poor, and virus contaminated zoospores have been introduced. Field contamination or infection of plants may arise from movement of people or equipment in and around the seed sowing/germination areas, the seedling glasshouse, tray handling area and seedling transport processes.

Disease symptoms

Infected lettuces develop characteristic thickened veins, leaf blistering, malformed heads, and may have stunted growth (Fig 1). Severe plant stunting at an early stage can delay or reduce head formation. Later infections may only show big vein symptom in leaves.



Fig 1. Lettuce big-vein disease (LBVD) leaf symptom (left) and stunting from a LBVD infection (right)

Management options

- Maintain hygienic seedling growth conditions and use heat sterilised growth media.
- Restrict entry and movement around the glasshouse to essential staff.
- Thoroughly decontaminate footwear and any equipment returning from the field.
- Sow LBVD-resistant or tolerant lettuce cultivars, where available
- Avoid close rotations of lettuce and brassicas to reduce fungal vector populations in the soil.
- Avoid planting in poorly drained land or under cool wet climate conditions.
- Control nearby weed hosts.
- Soil treatments can include fumigation with metham sodium, solarisation with white polythene and the use of fungicides

Lettuce necrotic yellows

Lettuce necrotic yellows, caused by lettuce necrotic yellows virus (LNYV), occurs mainly in spring and summer particularly in temperate regions, and sometimes in sub-tropical areas in late summer autumn. LNYV can cause serious crop losses in some season.

How does the virus spread?

LNYV is only aphid transmitted. Virus transmission by the aphid is persistent, meaning once the aphid has acquired the virus it can continue to spread it for the remainder of the aphid's life. In all regions the sowthistle aphid is the major vector of LNYV and is often found in large numbers on the flower stalks of sowthistle. The virus also propagates within the aphid and may pass the virus to its offspring. The sowthistle aphid does not breed or colonise on lettuce but transmits virus within a lettuce crop as it moves through looking for a favourable weed host. In temperate areas other aphids also appear to spread LNYV, particularly the currant lettuce aphid which does infest lettuce heads and may walk between plants transmitting the virus. The false sow thistle aphid and the brown sow thistle aphid may also be a vector.

Other aphid and virus hosts include the native sowthistle prickly sowthistle, dune, prickly lettuce false sow-thistle, hawksbeard, chicory and London rocket.

Disease symptoms

Young lettuce plants may show leaf chlorosis and stunting (Fig 2). In mature plants, initial symptoms are browning of leaf veins) followed by partial death of the inner leaves. Infected plants are yellow and stunted, often with twisted and lopsided leaves. In advanced stages, the outer leaves wilt severely, giving the plant a flattened, stunted appearance. Mature lettuce heads often show internal necrosis symptoms and so cannot be marketed (Fig. 2).



Fig 2. Plant stunting and leaf yellowing from LNYV (left) and Internal necrosis of the lettuce head. from LNYV (right)

Management options

- Remove sow thistle, other weed hosts, volunteer lettuce plants and crop residues.
- A weed-free distance of 5 meters or more around crops can reduce LNYV incidence.
- Rapid removal/ploughing-under of harvested lettuce crops, to reduce surviving vectors and hosts.
- Barrier plantings of non-host crops between lettuce crops will reduce vector movement.
- Grow Nasonovia-resistant lettuces, especially over critical infection periods. Note that no lettuce variety is currently resistant to feeding by the sow thistle aphid.
- Scout for aphids and their predators to target an appropriate insecticide response

Lettuce Tospovirus

Tospoviruses, tomato spotted wilt virus (TSWV) and Impatiens necrotic spot virus (INSV), are both transmitted by thrips in lettuce. TSWV in particular is widespread in Australia among crops including capsicum, tomato, lettuce, potato and peanut along with many weeds and ornamental plants. TSWV can cause crop losses of up to 100%. INSV is less widespread but is also found in protected crops and ornamentals. Both viruses can cause significant damage to both indoor and outdoor lettuce crops.

How does the virus spread?

Thrips vectors of TSWV in vegetables include western flower thrips, tomato thrips, onion thrips, and melon thrips. INSV is transmitted by western flower thrips, onion thrips and tomato thrips. Thrips acquire the virus when larvae feed on infected plants and as adults, spread the virus as they move between neighbouring plants, weeds and crops. Virus transmission by the thrips is persistent, meaning once the thrips has acquired the virus and pupated it can continue to spread it for the remainder of the thrips life. Virus spread can also occur before larvae pupate, however, adult thrips cannot spread the virus unless it was acquired as a larvae. Plants do not recover once infected.

TSWV has a very wide host range of vegetable and ornamental crops including tomato, capsicum, peas, chrysanthemum, dahlia, petunia and weeds such as capeweed, Amaranthus, black nightshade, buttercup, sow thistle, and wild radish pigweed, mallow, blue fat hen, thornapple, purple top, shepherd's purse, scotch thistle, clover pasture blue porter weed or blue snakeweed. It is important to control these weed species in farming areas and seedling nurseries to minimise a build-up in thrips populations. INSV has only been reported on lettuce but can infect solanaceous vegetables and ornamentals.

Disease symptoms

TSWV symptoms include leaf yellowing and wilting and a distinct brown russetting, spotting necrosis of the leaves (Fig.3). Heart formation is often in-complete and plants may twist to one side (Fig 3). Infected seedlings may not show symptoms until the plant is maturing. INSV expresses similar symptoms in lettuce with severe stunting at rosette stage, necrotic ring spotting and margin necrosis of leaves (Fig 3).



Fig 3. TSWV leaf vein and necrosis symptom on lettuce (left), TSWV head necrosis and twisting of lettuce (centre) and INSV ring necrosis symptom on lettuce (right)

Management options

- Prevention is critical. Obtain transplants from a nursery using a management plan for TSWV and INSV
- Remove weed hosts and infected crops within about 75 m of the lettuce crop to reduce sources of thrips and tospovirus
- Barrier plantings of non-host crops between lettuce crops will reduce vector movement.
- Avoid side-by-side sequential plantings to minimise thrips flights between crops, especially if tospovirus is present.
- Rapid removal/ploughing-under of harvested lettuce crops, to reduce surviving vectors and hosts.
- Monitor plants for thrips using sticky traps, obtain identifications to determine if vector thrips and their predators are present to target an appropriate insecticide response.
- Note that insecticide resistance occurs in both onion thrips and western flower thrips and resistance management guidelines should be observed when using insecticides.
- If Tospovirus becomes persistent, periods without susceptible crops and weeds may assist in breaking the disease cycle

Lettuce mosaic virus (LMV)

Lettuce mosaic virus (LMV, genus Potyvirus) occurs all year round in lettuce but especially in spring, summer, and autumn. The main source of this virus is infected seed. LMV is also aphid transmitted within crops and may spread from nearby infected weed hosts. Infection rates are very variable, but severe infections may cause high crop losses.

How does the virus spread?

Virus infected seed is the main source of this virus. It may be further spread between crops by several aphid species from infected lettuce and weeds including groundsel, cape daisy, oxtongue and sow thistles. Spread is via adult aphids. Virus transmission by the aphid is non-persistent, meaning the aphid acquires the virus on its stylet (mouthpart) which takes less than a minute of feeding and the spreads the virus during subsequent feeding for a few hours, after which it loses the ability to spread the virus.

If the aphid feeds on a non-virus host it will lose the virus from its stylet which is why non-host barrier plants can help manage introduction of these types of viruses.

Disease symptoms

Early infected plants develop defined light green mottling or mosaic symptoms on the leaves Fig 4, causing restricted plant growth. In older plants, yellow mottling and a downward curl develop on the leaves. Plants are stunted and frequently fail to heart.



Fig 4. Lettuce mosaic virus associated with leaf mosaic on lettuce.

Management options

- Use seed that is tested free of LMV or varieties with resistance to LMV.
- Remove weed hosts, volunteer lettuce plants and crop residues.
- Rapid removal/ploughing-under of harvested lettuce crops, to reduce surviving vectors and hosts.
- Barrier plantings of non-host crops between lettuce crops will reduce movement of viruliferous aphids entering crops.
- Scout for aphids and their predators, to target an appropriate insecticide response

Cucumber mosaic virus (CMV)

Cucumber mosaic virus (CMV, genus *Cucumovirus*) is of some importance in lettuce crops in some seasons and usually infects only occasional plants, mainly in spring and summer. CMV may also be present with other virus infections of lettuce.

How is it spread?

CMV is transmitted by more than 80 aphid species including the green peach aphid (*Myzus persicae*) melon aphid (*Aphis gossypii*), cabbage aphid (*Brevicoryne brassicae*), sow thistle green aphid (*Hypermyzus lactucae*) and pea aphid (*Acyrtosiphon pisum*). CMV is non-persistently transmitted whereby an aphid acquires the virus under a minute of probing or feeding on infected plant and then spreads the virus for a few hours before losing the virus.

CMV has a wide host range that includes ornamentals and weeds such as nightshade, sow thistle, amaranths and other crops, and these can provide a reservoir of infection for vegetable crops. CMV is seed borne and transmitted in some vegetables but there are no reports of seed transmission in lettuce.



Fig 5. Green peach aphid, currant sowthistle aphid and cabbage aphids (Photo: Cesar; Aphoto; UMass)

Disease symptoms

CMV symptoms in lettuce are difficult to differentiate from those of *Lettuce mosaic virus* (LMV) which is also associated with mosaic and mottling symptoms in lettuce. However, the mosaic symptoms associated with CMV in lettuce is more intense and accompanied with middle leaf chlorosis, browning and necrosis at lower temperatures. The necrosis of middle leaves results in constriction on one side of the leaf giving a twisted leaf appearance and is also accompanied by stunting of the plant.



Fig 6. Cucumber mosaic virus symptoms in lettuce (Photo: Cornell; Zhang *et.al*/2020; John P. Fletcher)

Management options

Control of CMV is challenging due to its wide host range and CMV being transmitted in a non-persistent manner by aphids which makes them infective immediately after feeding on infected plant hosts. However, the following integrated diseases management approaches are effective in controlling CMV in vegetables:

- Planting virus free seed or seedlings to prevent introduction of virus into the farm
- Controlling of weed hosts and removal of infected plants which act as aphids and CMV reservoirs.
- Avoid overlapping production of new and old crops to prevent potential spread of virus to new plantings.
- Use of virus-resistant or virus-tolerant varieties to prevent CMV infection.
- Use of non-host barrier crops such as corn or sorghum to prevent aphids from feeding on crops.

- Use of insecticides to control and protect crops from aphids.

Lettuce necrotic yellows virus (LNYV)

Lettuce necrotic yellows disease is caused by lettuce necrotic yellows virus (LNYV). It is a seasonal problem in most lettuce growing regions of Australia but particularly in temperate cropping areas. LNYV is transmitted by the sowthistle aphid (*Hyperomyzus lactucae*). It transmits LNYV after moving into the crop from nearby virus infected weeds, especially sowthistle (*Sonchus oleraceus*), and related species. LNYV also may infect other crop species in Australia including, garlic, chickpea, lupin, safflower, *Medicago*, and peanut.

How is it spread?

The common sowthistle (*Sonchus oleraceus*) (Fig 7), is the major virus and vector host. Other host weeds include prickly lettuce (*Lactuca serriola*) and rocket (*Eruca vesicaria* ssp. *sativa*) (Fig 7). Control of host weeds prior to crop production and during the season is highly recommended.

Germination of sowthistle seed is more dependent on soil moisture than temperature, with most seeds germinating when soil moisture is close to field capacity. Periods of extended rain will trigger this germination and continued moisture will promote weed growth and flowering. Controlling the weed prior to flower stalk formation is the best option for aphid control. It will also prevent seed formation or reduce seed banks and emergence of new plants that act as reservoirs for the aphid vector and the virus.

LNYV is only aphid transmitted. The sowthistle aphid (Fig 8) is the major vector of LNYV and is often found in large numbers on the flower stalks of sowthistle. The virus also propagates within the aphid so it is infective throughout its life and may pass the virus to offspring. The sowthistle aphid does not breed on lettuce but can transmit virus within a lettuce crop as it moves through looking for a favourable weed host.

Disease incidences of up to 80% can be recorded in some seasons, especially in the cooler winter, spring and autumn growing periods. Disease spread is low at high temperatures.

Other aphid and virus hosts include the native sowthistle (*S. hydrophilus*), prickly sowthistle, (*S. asper*), dune thistle (*Actites megalocarpus*), prickly lettuce (*Lactuca serriola*), false sow-thistle, (*Reichardia tingitana*), hawksbeard (*Crepis capillaris*) chicory (*Cichorium intybus*) and London rocket (*Sisymbrium irio*).



Fig. 7. Common weed sowthistle (*Sonchus oleraceus*) (left) and Prickly lettuce (*Lactuca serriola*) (right)

The currant lettuce aphid (*Nasonovia ribisnigri*) (Fig 8) which infests lettuce heads is thought to spread LNYV, however, further research is needed to confirm this. *Hyperomyzus carduellinis* which lives on the false sow thistle can also transmit LNYV and the brown sow thistle aphid (*Uroleucon sonchi*) may also be a vector.

Aphids may be active all year round in Australia, particularly in warmer cropping areas. It is also important to note that aphid predators may also be active within the crop and on the weed hosts. These include the larvae of the brown lacewing larvae (*Micromus tasmaniae*) and green lacewing (*Mallada signata*), small hover fly (*Melanostoma fasciatum*) larvae, lady beetles (*Coccinella undecimpunctata*, *Hippodamia* spp.), damsel bug (*Nabis kinbergii*). Parasitic wasps such as *Aphidius colemani* and fungal pathogens of aphid can also control aphid populations.



Fig. 8. Winged sowthistle aphid (*Hyperomyzus lactucae*) (left) and Winged currant lettuce aphid (*Nasonovia ribisnigri*) (right)

Disease symptoms

LYNV infected young lettuce plants may show leaf chlorosis and stunting (Fig 9). In mature plants, initial symptoms of LYNV infection are browning of leaf veins (Fig. 9) followed by partial death of the inner leaves. Infected plants are yellow and stunted, often with twisted and lopsided leaves. In advanced stages, the outer leaves wilt severely, giving the plant a flattened, stunted appearance. Mature lettuce heads often show internal necrosis symptoms and so cannot be marketed (Fig. 9).

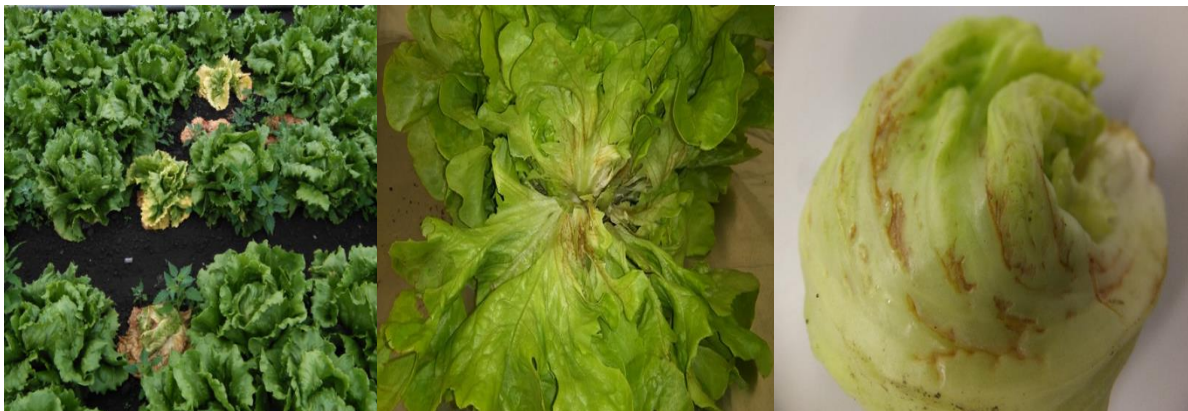


Fig 9. Typical Lettuce necrotic yellows virus (LYNV) symptoms in a young lettuce crop (left); Vein necrosis symptom on lettuce (centre) and internal head necrosis on lettuce (right)

Management options

The following integrated diseases management approaches are effective in controlling LYNV in vegetables:

- Removal of LYNV and aphid vector weed hosts in and around lettuce plantings is most important prior to crop production and during the season. Controlling weeds prior to flower stalk formation is the best option for aphid control.

- Growing *Nasonovia*-resistant lettuces, especially over the critical infection periods. Note that no lettuce variety is resistant to feeding by the sow thistle aphid.
- Rapid removal/ploughing-under of harvested lettuce crops, to reduce surviving vectors and hosts.
- Barrier plantings of non-host crops between lettuce crops, to reduce vector movement.
- Weekly scouting for aphids and their predators to target an appropriate insecticide response.
- Insecticide treatment of lettuce seedlings before planting.
- Check the Australian Pesticides and Veterinary Medicines Authority chemical database and permit database for chemicals registered or approved to control aphids on lettuce in your state or location. Always read the label and observe withholding periods.

Further information

For further information or submission of diagnostic samples please contact:

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