Cucumber mosaic virus (CMV) in vegetable crops

Cucumber mosaic virus (CMV, genus Cucumovirus) is an aphid-borne virus that was first reported in North America in 1916 causing mosaic disease in cucumber but is now known to occur worldwide including Australia. CMV has a large host range of more than 1,200 plant species including vegetables and various weed hosts. Some of the vegetable hosts infected by CMV include capsicum, carrot, celery, cucurbits, legumes, lettuce, onion, pepper, spinach and tomato. Diseases caused by CMV infection cause significant loss of quality and yield in vegetable crops.

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 (*Acyrthosiphon 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 vegetable species such as capsicum and spinach. It is also reported to be seed borne in some weed species and legumes, such as lentils and chickpeas.

Fig 1. Green peach aphid, currant sowthistle aphid and cabbage aphids (Photo: Cesar; Aphoto; UMass)

Disease symptoms

Disease symptoms associated with CMV infection in vegetables can vary considerably depending on the vegetable host, variety, time of infection and other growing conditions

Capsicum:

Disease symptoms associated with CMV in capsicum varies in glasshouse and field grown plants, but general CMV symptoms are leaf mosaic and fruit necrotic symptoms. In greenhouse produced capsicum, vein clearing patterns which are short-lived develop during initial stages of infection. In both field and greenhouse grown capsicum, leaf mosaic symptoms also appear during initial stages of infection which are followed by mosaic, mottling, yellowing, stunting and chlorotic flecks symptoms. Fruit of infected capsicum are small, wrinkled, deformed and show ringspots or chlorotic patches, with uneven colour and ripening. Fruit symptoms associated with CMV infection in capsicum may be confused with Tomato spotted wilt virus (TSWV) which also causes similar symptoms in capsicums.

Fig 2. Symptoms associated with cucumber mosaic virus infection in capsicum leaf and fruit (Photo: WA DPIRD)

***Celery*:**

CMV disease symptoms in celery is characterised by downward curling of young petioles making plants look flattened and brown sunken spots may also develop on petioles of young plants. Leaves in mature plants may develop vein-clearing and mosaic, and interveinal areas may become dark green and thick, making leaves look crinkled.

Fig 3. Cucumber mosaic virus symptoms in celery pant (Photo: T.A. Zitter, Cornell University)

***Cucurbits*:**

CMV infection in cucurbits is generally associated with severe stunting, leaf mosaic, malformation and shortening of internodes due to stunting. Disease progression results in downward curling of leaves and flowers become malformed with greenish petals. Leaf and flower symptoms intensity varies according to cubit species and variety. Infected cucurbit fruits often become small, distorted and discoloured.

Fig 4. Cucumber mosaic virus symptoms in cucumber (Photo: Wintermantel; Gilbertson, UC Davis; Jones)

Lettuce:

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

Spinach:

The most characteristic symptoms of CMV infection in spinach is leaf malformation in younger plants resulting in paper-thin twisted leaves with a shoe-string appearance. Growth in younger spinach plants is slowed resulting in severe stunting and death. In mature spinach plants, CMV is generally associated with 'spinach blight' symptoms which are characterised by stunting, yellowing, mottling and distortion of crown leaves with disease progression.

Fig 6. Cucumber mosaic virus symptoms in spinach (Photo: UCANR)

Tomato:

Similar leaf shoe-string symptoms observed in spinach is also observed in CMV infected tomato plants in initial stages of infections. Leaf yellowing, mosaic, mottling and upward rolling deformation is also observed. The leaf symptoms are found mainly on the bottom and top-most leaves while middle leaves remain symptomless. Early CMV infection in tomato plants results in no production of fruit and if fruit develop, they are small, have necrotic spots and delayed maturity.

Fig 7. Cucumber mosaic virus symptoms in tomato (Photo: Invasive org; Cornell University)

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 barriers such as corn or sorghum to prevent aphids from feeding on crops.
- Use of insecticides to control and protect crops from aphids.

Further information

For further information or submission of diagnostic samples please contact:

Project Leader: Cherie Gambley (cherie.gambley@daf.qld.gov.au or 0423 200 211)

Agriculture Victoria Research: Cliff Kinoti (cliff.kinoti@agriculture.vic.gov.au or 0452 404 107)

This project has been funded by Hort Innovation using vegetable industry levies and contributions from the Australian Government with co-investment from the Queensland Department of Agriculture and Fisheries; Victorian Department of Economic Development, Jobs, Transport and Resources; The Northern Territory Department of Primary Industry and Resources; the Western Australia Department of Primary Industries and Regional Development and the University of Tasmania. It is supported by a second smaller project led by the New South Wales Department of Primary Industries and similarly funded by Hort Innovation using vegetable industry levies and contributions from the Australian Government and NSW DPI.