Pepper mild mottle virus in Peppers

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This is an article containing relevant information for pepper growers about *Pepper mild mottle virus*.

Plants PMMoV can infect: [3, 11]

- Sweet and chilli peppers, *Capsicum annuum*
- Cayenne pepper, *C. baccatum*
- Hot bonnet peppers, *C. chinense*
- Tabasco or cayenne peppers, *C. frutescens*
- All other domesticated or wild *Capsicum* species
- Petunia, *Petunia hybrida* (asymptomatic)
- Basil, *Ocimum basilicum* L. (local lesions)
- Plants of mainly academic/research interest including: tobacco varieties (*Nicotiana clevelandii* Gray, *N. debneyi*, *N. glutinosa*, *N. sylvestris*, *N. tabacum*); *Datura metel*, *D. stramonium*, *Chenopodium amaranticolor*, *C. quinoa*

Plants PMMoV cannot infect: [3, 4]

- Tomato, *Solanum lycopersicum* L.
- Eggplant/aubergine/brinjal, *Solanum melongena* L.
- Cucumber, *Cucumis sativus*
- Beans, *Phaseolus vulagris*
- Many others

Symptoms in peppers [1, 3, 4, 7, 11]

Symptoms will vary depending upon pepper variety, virus isolate, plant age when infected, and environmental conditions.

Leaf symptoms:

- Mild mottle 10+ days after infection
- Strong mosaic symptoms (light and dark yellow or green patches) may appear 3+ weeks after infection in new apical leaves
- Necrosis (browning)
- Minor or no symptoms
- Stunting

Fruit symptoms:

- Deformed and irregular shapes
- Sunken yellow or white spots and stripes
- Premature flower and fruit abscission leading to no fruit development

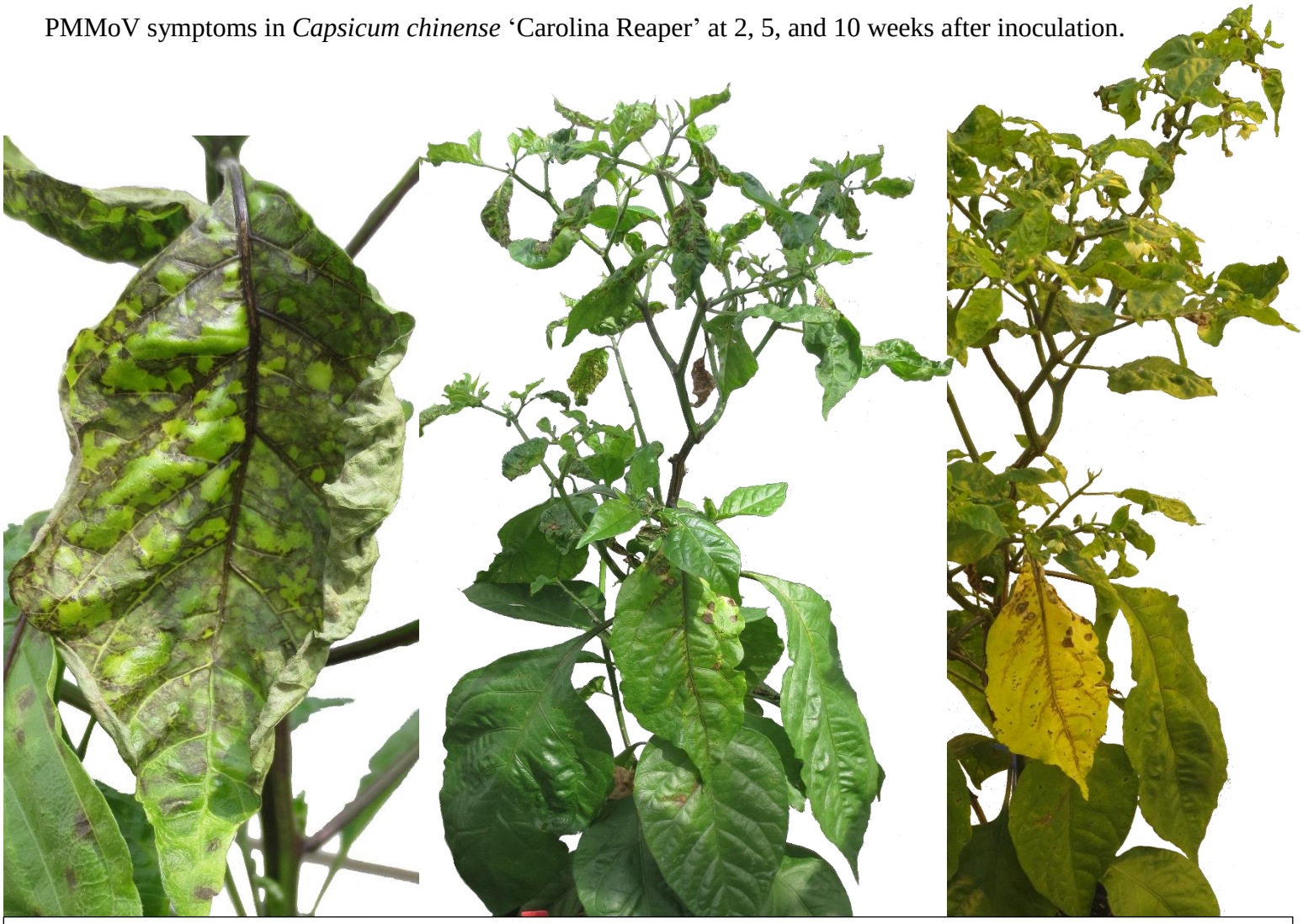
Symptom pictures of PMMoV in Carolina Reaper peppers are on page 2 and additional photos are available on the web article for this virus.

Yield impact

PMMoV causes high losses because plants infected by PMMoV are often stunted and if any fruit are produced they are not saleable due to their irregular shape and color. In 2002 jalapeno peppers in Georgia, USA were infected by PMMoV which resulted in a yield loss of 50-100%.[7]

PMMoV is distributed world-wide and can be difficult to detect early due to minor leaf symptoms.[4] Producers of transplants should be aware of PMMoV because it is easily transmitted by infected sap and can rapidly infect an entire bench of pepper transplants if preventative cultural control methods are not practiced.

PMMoV symptoms in *Capsicum chinense* 'Carolina Reaper' at 2, 5, and 10 weeks after inoculation.



2 weeks	**5 weeks**	**10 weeks**
Brown circular pattern on some leaves	Leaf drop, spread of leaf pattern, distortion of new growth	Continued week 5 symptoms, stunting, flower and fruit drop Note: yellow tone due to HPS lighting

Transmission and spread of PMMoV

PMMoV can be transmitted through infected sap spread from an infected plant to healthy plants during: grafting, transplanting, pruning, trellising, or harvesting.

PMMoV is efficiently transmitted by seed with up to 100% seed infection rates.[5] Although some seed lots may be heavily infested with PMMoV, even a low seed transmission rate is enough to start an epidemic if preventative cultural control methods are not practiced.

Detection

PMMoV can be tested for on the farm by using rapid immunochromatographic dipsticks obtained online from commercial retailers or plant leaves or seeds can be mailed or dropped off at a plant disease diagnostic clinic.

Control

The most effective control method for PMMoV is to use preventative control measures to prevent PMMoV from infecting plants because there are no curative chemicals for viral infections in plants.

Seed control of PMMoV

Seeds without a coating can be disinfected using 2% lye (sodium hydroxide or caustic soda; NaOH) for 2 minutes at room temperature (~68°F)[10] or with 10% trisodium phosphate (Na_3PO_4) for 2.5 hours at room temperature.[5, 9] Both treatments should be mixed during soaking and then rinsed thoroughly with tap water and sown immediately. These treatments may reduce germination and increase the number of abnormal seedlings so it is best to test a portion of your seed lot with these treatments to determine if any effects occur with your specific variety.[5] Treatments will greatly reduce the amount of PMMoV on infested seeds but may not completely eliminate it on heavily infested seeds. These treatments will also eliminate other seed borne viral pathogens.[9]

Tool sterilization to prevent the spread of PMMoV [6, 8]

Tools and glove covered hands can be sterilized by dipping in a 10% solution of bleach (use bleach with a 5.25-6% NaOCl concentration and change the solution frequently, minimally every 2 hours) or 2% Virkon S solution between each plant or variety. Disinfection is immediate, no tool soaking is required. It is recommended to dry tools and hands before handling plants as the chemicals may damage plant tissue. Sap residue must be removed from tools as it can harbor infectious virus, even after a dip. These treatments also prevent transmission of other viruses and plant pathogens.

String used for trellising should not be reused. If wire must be used again, sterilize it by completely submerging in a 5% solution of trisodium phosphate (Na_3PO_4) for 10 minutes, or 0.1% caustic soda (also called lye and sodium hydroxide with a chemical formula of NaOH) for 10 minutes, or use dry heat (oven) of a minimum of 266° F (130° C) for 15 minutes.

Plant resistance to control PMMoV [2]

Resistant pepper varieties could be selected for use in the following years if PMMoV has been diagnosed-however there have been resistance breaking PMMoV strains identified that can infect and cause symptoms in peppers containing resistance genes. These four genes are called the L^{1-4} resistance genes. There have been no large trials to test the resistance claims that are made for pepper varieties but Cornell University has one of the most complete disease resistance charts for varieties currently on the market that can be used to choose resistant varieties. (http://vegetablemdonline.ppath.cornell.edu/Tables/TableList.htm)

Look-alikes

Other viruses cause similar symptoms to PMMoV but have different hosts and management methods. Testing and identification of the agent causing symptoms will allow for effective management solutions to be taken to reduce damage in the current growing season and the following ones as well. Mixed infections with more than 1 virus species present are also possible and can be identified by testing symptomatic plants.

Reference to commercial products or trade names is made with the understanding that no discrimination is intended of those not mentioned and no endorsement is implied for those mentioned.

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