Gummy Stem Blight of Greenhouse Cucumber

March, 2018

Gummy stem blight (GSB) is caused by the fungus *Didymella bryoniae*, previously known as *Mycosphaerella melonis*. The fungus is known to infect cucurbits, including cucumber, pumpkin, squash, watermelon, cantaloupe and many others. Under favourable climatic conditions, the pathogen can infect all parts, except roots, of the cucumber plant at all stages of plant development. Infection at fruit development often leads to internal fruit rot that may go unnoticed at harvest. This raises concern among growers because the inevitable post-harvest fruit decay at the grocer creates a poor image for the distributor (packing house) and grower.

Symptoms

Most infections occur through wounds at pruning sites or other injured sites although new growth, flowers and uninjured fruits may also be infected. Typically, symptoms of GSB begin to appear towards the latter part of the crop cycle due to cropping stress. For a crop planted in December/January, symptoms can occur in April/May and for a crop planting in June/July, symptoms can occur in September/October.

Seedlings: The fungus can be carried in seeds. Under favourable conditions, the pathogen can cause pre- and post-emergence death and damping-off of young seedlings.

Leaves: Initial symptoms usually appear along the margin of the leaf as water-soaked areas surrounded by a yellow halo, and then extending into the leaf as V-shaped yellow-brown necrotic lesions (Figure 1). These infections are usually triggered by guttation, or where leaves at the top of the canopy are exposed to dripping water from condensation or over-head sprinklers.

Stems: Tan coloured lesions may develop at nodes where lateral shoots and leaves were pruned out, or where cucumber fruits were harvested. These lesions become enlarged, developed into brown-black cankers, crack and exude a characteristic amber-red coloured gummy sap (Figure 2). In addition, basal stem splitting/cracking caused by root pressure can also be subjected to infection. Cankers at the stem-base may enlarge and girdle the stem, causing wilt and eventual death of the plant. Plants that are propagated in cool climate (i.e. below 23°C) often have fleshy thick basal stems that are more prone to infection.

Fruit: Fruit can be infected at the stem-end or the flower-end before harvest. Pre-harvest infections are characterized by the appearance of soft black-green lesions with shrunken tissues externally on the fruit surface (Figure 3). Internal fruit rot is identified by a subtle tapering of the flower-end of the fruit (Figure 3 & 4). Pre-harvest internal fruit rot is not always noticeable because fungal growth may be retarded by an active chemical resistance mechanism in the fruit.

After harvest, this mechanism is no longer active and thus the fungus continues to spread. Internal fruit rot is characterized by yellowing and eventual rotting of the fruit (Figure 3 & 4). As the diseases progresses, the fungus begins to produce numerous spores within pinpoint black structures (fruiting bodies) on the infected

tissue. Spores are usually produced within 4 days of initial infection, and they soon begin a new cycle of secondary infections.

Other diseases that can be mistaken for GSB: Black rot, caused by *Phomopsis cucurbitae*, and botrytis rot. Black rot lesions need to be examined under a microscope to confirm the actual causal agent. Plant infected with *Botrytis* will produce grey, fluffy mycelial growth under high humidity.

Figure 1. V-shaped lesions on a leaf of cucumber plant infected with Gummy stem blight.

Figure 2. Tan-coloured lesions with black pinpoint spore-producing structures on a cucumber stem infected with Gummy stem blight.

Figure 3. Healthy cucumber fruit on left and two infected cucumber fruits on right with tapering end, indicating internal fruit rot.

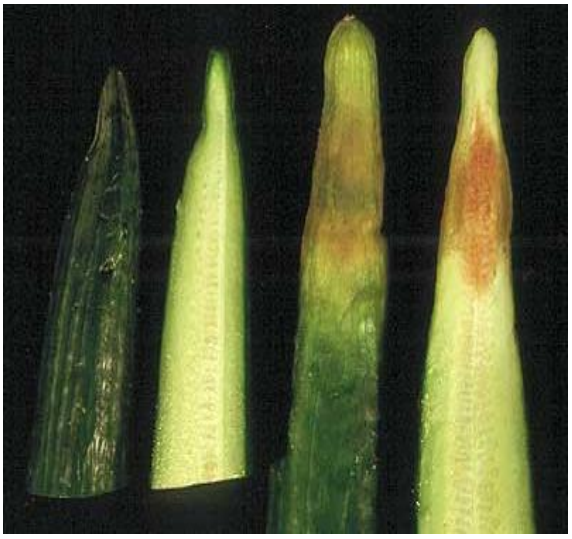

Figure 4. Two cucumber fruits on left with early symptoms of pre-harvest internal fruit rot, and two cucumber fruits on right with severe symptoms of post-harvest rot.

Disease Spread

The pathogen can be seed-borne and, thus, can spread by infected seedlings/transplants. The inoculum of the pathogen can also come from other cucurbitaceous host plants and weeds and infected plant debris in and around the facility. The pathogen produces two types of spores: asexually-produced pycniospores, and sexually-produced ascospores. Both types of spores are short-lived once they are released into the environment. However, the pathogen can survive up to 2 years as chlamydospores or mycelium on undecomposed, dry plant debris.

There are two main methods of disease spread. Under humid conditions, 1) pycniospores are spread by splashing water droplets; a film of water on the plant surface is necessary for spore germination and infection, and 2) ascospores are released into the environment with air-currents in the evenings. These spores germinate in the evening condensation or guttation droplets and grow under low light conditions. High root pressure associated with excess watering and fluctuating transpiration due to weather changes promotes guttation. Wounded tissues are more susceptible to infection than intact tissues. Greenhouse practices such as overhead sprinkler irrigation, pruning and improper crop handling greatly influence the spread of the fungus. Spores can also be dispersed on pruning knives, wet hands and clothing.

Both pycniospores and ascospores start new infections by germinating on plant surfaces that are wet for an hour or more. If there is inadequate moisture, the spores may stay dormant and germinate when moisture becomes available. After spore germination, conditions of high relative humidity, low light and temperatures between 20-28°C promote the growth and spread of the fungus. Disease symptoms appear within 4 to 8 days of initial infection. As soon as the symptoms can be observed, the fungus will have begun to produce spores which will be invisibly spreading through the greenhouse.

Disease Control

GSB is not easy to manage as greenhouse conditions are often favourable for disease development and spread, and there is constant occurrence of fresh wounds from pruning and harvesting that serve as new infection sites. There is no "silver bullet" approach for controlling gummy stem blight. Key strategies for disease management include good sanitation, thorough year-end cleanup, proper pruning and growing practices, multi-cropping and proper irrigation practices.

Prevention and Management

- Keep plants dry through growing season and maintain an open canopy to increase air circulation.
- Avoid root pressure increases to avoid stem split.
- Monitor for disease symptoms starting in March. Remove any suspected infected plant materials immediately from the greenhouse.
- Keep disposal piles away from the greenhouse.
- Prune to leave clean breaks that are flush to the stems. Avoid leaving stubs. Remove prunings from the greenhouse but be aware that removal will reduce the build-up of beneficial insect populations and adjust them accordingly.
- Disinfect pruning tools periodically with a 2 minute dip in 70% ethanol or a quick dip in an appropriate disinfectant (5% Virkon or 0.1 or 0.2% Chemprocide), noncorrosive to metals.
- Avoid pruning during periods of cloudy/dark weather.
- Do not grow squash or other cucurbits around the greenhouse. They can also harbour GSB.
- Perform a good year-end cleanup.

Cropping system

- Single cropping of cucumber plants is productive only for a certain period of time under current crop management practices. Production from crops planted in January tends to decline in early July. Although several short periods of high production can still be achieved with pruning, the act of pruning increases the number of wounds on the plant. These wounds are located in the canopy where the relative humidity is quite high and, thus, provide ideal sites for infection by the pathogen. Another consideration is that the stem tissue begins to age in July, reducing its ability to resist infection and lesion expansion.
- Double cropping (growing two crops per season) will result in more even production and higher quality fruit from July onward. Double cropping will extend deliveries until December, and the young crop will have few wounds which minimize the number of infection sites. Removal of the old crop before disease build-up will reduce the spore load during the fall cropping period.

Climate Management

- Avoid sudden changes in climate, especially relative humidity (RH).
- Target RH below 80%.
- Verify the RH and temperature readings by periodic calibration. Ensure their placement is near the active growing head.
- Maintain minimum pipe to provide VPD >3 grams/m3. Keep a narrow dead zone in the morning.
- During March/April, maintain a minimum pipe temperature of 45°C. Increase temperature to reduce RH especially when it is raining. Decrease pipe temperature with increasing light.
- Increase the temperature slowly in the early morning at 1°C per hour and ensure tissue temperatures are at day-time targets before sunrise.
- Put a grow pipe in the canopy at a maximum of 50°C. Decrease pipe temperature with increasing light.
- Vent early with 1/2 inch minimum once outside temperatures reach 5-6°C. Do not over-vent. Cold air coming into the greenhouse can promote GSB.
- Consider venting at night to avoid soft plants.
- Avoid spraying insecticides in the evening, as plant surfaces may remain wet long enough to allow fungus spores to germinate. If you must spray in the evening, turn up pipe heat after spraying.

Air Temperature	RH	Dew point Temperature
18°C	80%	14°C
18°C	90%	16°C
22°C	80%	18°C
22°C	90%	20°C

Avoid high root pressure

- Use higher EC levels (3.0) especially in the development of the plant to the wire. This encourages the development of stronger stem tissues which will be less prone to infection at leaf scars.
- Do not water early in the morning. Start watering 2 hours after sunrise or later on cloudy mornings, and over-drain by third or fourth drip-turn. Extend day watering period as the days become longer. Do not water after midnight.
- Reduce irrigation under low fruit loads. Keep over-drain to the third or fourth drip-turn.

- Even, regular pruning reduces problems with root pressure. Remove no more than 2 actively growing green leaves at one time.

Post-harvest handling

- Store fruit at 10 to 12°C shortly after harvest. Do not let cucumber fruit be stored with apples, tomatoes or bananas.

Crop-end Activities

- At the end of each crop, remove all crop debris from the greenhouse. Pay close attention to wires and temperature sensors.
- Take debris off site, compost or bury it.
- Clean/disinfect picking carts, machinery, totes, sprayers etc. at the end of each crop.
- Disinfest the structure at the end of the fall crop.

Chemical Control

Apply fungicides preventatively before the onset of disease or at the first sign of symptoms, or under conditions favourable for GSB (high RH, low light and high inoculum levels). Use fungicides (Table 1) in rotation to avoid development of resistance to a particular fungicide and to prolong fungicide efficacy.

Table 1. A summary of registered fungicides and label information. Please refer to Health Canada's Pest Management Regulatory Agency website on product for labels and information.

Product	Chemical or biocontrol ingredient	Chemical Group	Mode of Action	REI[1] (hrs)	PHI[2] (days)	Application guidelines
Manzate	mancozeb	M	protectant	NA	NA	Apply preventatively at 14-day interval.
Rovral	iprodione	2	protectant (non-systemic)	12	2	Apply preventatively at 7-day interval. Treated produce cannot be exported to the USA.
Nova	myclobutanil	3	protectant & curative (locally systemic)	until dry	2	Apply preventatively at 14-day interval. Do not exceed 6 applications per year or 2-3 applications per crop cycle.
Pristine	boscalid & pyraclostrobin	7 & 11	protectant & curative (locally systemic)	until dry	0	Apply preventatively in rotation with other fungicides at 7- to 14-day interval. Do not exceed 1 application per crop cycle.
PreStop	*Gliocladium catenulatum*	biological	suppressive	4	0	Apply preventatively, before onset or at first sign of symptoms, at 3- to 4-week interval.
Rhapsody	*Bacillus subtilis QST 713*	biological	suppressive	NA	0	Apply preventatively, before onset or at first sign of symptoms, at 7- to 10-day interval.

[1]PHI - pre-harvest interval
[2]REI - re-entry interval
NA – information is not available

Adapted from R. Young's Greenhouse Vegetable Factsheet "Gummy Stem Blight of Greenhouse Cucumber" 1995 with input on double cropping from Dr. Kees van den Berg.

For Further Information

- *Gummy Stem Blight - Cornell University*
- *Gummy Stem Blight Images - Forestry Images.org*

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