Clavibacter michiganensis subsp. michiganensis (bacterial canker of tomato)

1. Identity: Bacterial canker of tomato

Preferred Scientific Name:

- *Clavibacter michiganensis subsp. michiganensis (Smith 1910)* Davis et al. *1984*

Preferred Common Name:

- Bacterial canker of tomato

Synonyms:

- *Aplanobacter michiganensis (Smith) Smith 1914*
- *Bacterium michiganense Smith 1910*
- *Corynebacterium michiganense (Smith 1910) Jensen 1934*

Figure 1. Fruits affected by *Clavibacter michiganensis subsp. Michiganensis*.Photo by Heinz USA:

- *Corynebacterium michiganense pv. michiganense (Smith) Dye & Kemp 1977*
- *Corynebacterium michiganense subsp. michiganense (Smith) Carlson & Vidaver 1982*
- *Erwinia michiganensis (=michiganense) (Smith) Jensen 1934*
- *Mycobacterium michiganense (Smith) Krasil'nikov 1941*
- *Phytomonas michiganensis (Smith) Bergey et al. 1923*
- *Pseudomonas michiganense (Smith) Stevens 1913*
- *Pseudomonas michiganensis (Smith) Stevens*

Taxonomic Position:

- **Class**: Actinobacteria
- **Order:**Actinomycetales
- **Family:** Microbacteriaceae

2. Hosts/species affected

The main host of economic importance is tomatoes, but the pathogen has also been reported on other Lycopersicon spp. and on the wild plants Solanum douglasii, S. nigrum and S. triflorum. A

number of solanaceous plants are susceptible on artificial inoculation (for details see Thyr et al., 1975). Doubtful reports from other hosts include Phaseolus beans, peas and maize. Stamova & Sotirova (1987) have also reported wheat, barley, rye, oats, sunflowers, watermelons and cucumbers as hosts on artificial stem inoculation.

3. Growth stages affected

Seedling stage, Vegetative growing stage, Fruiting stage and flowering stage

4. Biology and Ecology

The spread of bacterial canker of tomato under glass or in the field is favoured by water (rainsplash, irrigation) and cultural practices (prunning, chemical sprays). The bacterium enters plant tissue through stomata and other natural openings, as well as wounds and roots. Young plants have been shown to be more susceptible to the bacterium (Van Vaerenbergh & Chauveau, 1985). Nevertheless, under natural conditions, tomato plants seem to be susceptible to *C. michiganensis* subsp. *Michiganensis* throughout their entire life (Rat et al., 1991). After infection, there is a long latent period before any symptoms appear. The bacterium is located in the xylem vessels (Leyns & De Cleene, 1983) where it can cause lysigenous cavities (cavities formed by the destruction or dissolution of cells). Infected vessels contain viscous granular deposits, tyloses (are outgrowths of parenchyma cells that expand into adjacent tracheary elements through the pits in xylem vessels) and bacterial masses (Marte, 1980). The pathogen also produces a toxic glycopeptide which has biological activity (Miura et al., 1986). The bacterium survives for a long time in plant debris, soil and on equipment and glasshouse structures. It probably does not survive long in soil per se. However, it remains viable for at least 8 months in seeds. More recently, Hadas et al. (2005) described from 0.05 to 4% incidence of bacterial canker in tomato seedlings grown from seed lots containing from 58 to 1,000 Colony Forming Units (CFU)/g seed, finding a high correlation between CFU/g seed and disease incidence. However, disease incidence does not depend solely on the inoculum concentration present in seeds because *C. michiganensis* subsp. *michiganensis* can be mechanically transmitted by cultural practices during transplant production, with a subsequent strong effect on disease incidence in the field.

Figure 2. Photo of disease cycle: by Research gate

5. Symptoms

Contaminated seeds usually give rise to apparently healthy seedlings, symptoms only appearing as plants approach maturity. The first symptom is a reversible wilting of leaves during hot weather. Leaves may show white then brown necrotic interveinal areas.

Figure 3. Entire plant wilted**.** Photo by Mary Ann Hansen , Virginia Polytechnic Institute and State University, Bugwood.org

Figure 4. Wilting leaves**.** Photo by Heinz USA , Bugwood.org

Figure 5: Leaves dieback and pith decay within stem.(credit: Paul Bachi, University of Kentucky Research & Education Center)

Figure 6: Canker symptoms on tomato fruit .Photo credit:Sally A. Miller, The Ohio State University

Wilting quickly becomes irreversible and the whole plant desiccates. In the field, the first symptom is desiccation of the edge of the leaflets mainly on lower leaves. The plant slowly desiccates, usually without showing wilting. At an advanced stage, small whitish pustules appear on leaf veins and petioles. Brown stripes may appear on stems and petioles. They may split to expose yellowish to reddish-brown cavities, giving a canker symptom. Fruits may fail to develop and fall, or ripen unevenly. They also often show external marbling and internal bleaching of vascular and surrounding tissue. Infrequently, fruits may show characteristic "bird's eye" spots. Initially slightly raised and white, these spots develop light-brown roughened centres surrounded by a flat whitish halo. On cutting stems, petioles and peduncles, particularly at their junctions, a creamy-white, yellow or reddish-brown discoloration of vascular tissue and pith and cavities within the pith will be evident. These discolorations are only visible at advanced stages of the disease. At the beginning of its development, the pathogen causes no change in the vascular tissue.

6. Means of movement and dispersal

Seed is the main long-distance vector of the pathogen. The seed trade has facilitated the worldwide distribution of the disease. Locally, transfer of contaminated equipment may allow transmission of the disease from one glasshouse, field or farm to another. Infected tomato seeds give rise to contaminated seedlings. Where studied, not more than 1% seed transmission occurred (Grogan & Kendrick, 1953).

7. Impact

Since the first report of the disease in the USA in 1910, bacterial canker has spread throughout the world and causes serious losses to both greenhouse and field tomato crops either by killing the young plants or reducing marketable yields. Reduction in yield may be associated with direct plant loss, reduced numbers of fruit or fruit size. Recorded yield losses include: 20% or more in Ontario,

Canada (Dhanvantari, 1989; Dhanvantari and Brown, 1993); 20-30% in France (Rat et al., 1991); 46% in Illinois, USA (Chang et al., 1992c); and a 10-fold yield reduction after plant loss in Queensland, Australia (Dullahide et al., 1983). In North Carolina (USA), a 70% reduction in yield has been recorded in some years.

8. Movement in trade

Movement in international trade is mainly on infected vegetative organs, roots, fruits, seed and infected stems.(CABI,2016)

9. Phytosanitary significance

C. michiganensis subsp. *michiganensis* is an economically important pathogen that is seed transmitted. It should be considered of moderate phytosanitary risk due to its worldwide distribution and the availability of seed treatments to reduce seedborne inoculums (CABI, 2016). The bacterium causes one of the most serious diseases of glasshouse tomatoes, which can moreover readily be controlled by phytosanitary measures. EPPO has listed *C. michiganensis* subsp. *michiganensis* as an A2 quarantine pest (OEPP/EPPO, 1982), and CPPC and IAPSC also consider it of quarantine significance.

10. Detection & Inspection Methods

The use of semi-selective media for isolation of the pathogen from seed extracts (Fatmi & Schaad, 1988; Shirakawa & Sasaki, 1988) is usually not sensitive enough because of the presence of many antagonists in the saprophytic flora. Serological methods are sensitive (Rat, 1984) but there are difficulties in obtaining sufficiently specific sera. New methods including fatty acid profiles (Gitaitis & Beaver, 1990), molecular hybridization (Thompson et al., 1989) and protein profiles (Bruyne et al., 1987) are now suggested.In cases where more rapid results are required or initial isolation from samples with typical symptoms is supplementary, screening methods involving immunofluorescence (IF) or polymerase chain reaction (PCR) may be useful to identify the potential location of the bacteria in infected plants (OEPP/EPPO, 2013)

11. Management

- Use of healthy seeds for planting is the first and most important condition for controlling the disease.
- Only seeds that have been acid extracted or undergone treatment of seeds with acid or other disinfectants or hot water should be used (Thyr et al., 1973).
- Chemical treatment of the seed (Dhanvantari, 1989). There are no specific chemicals registered in Kenya against bacterial canker in tomato (PCPB, 2016)
- Strict hygiene measures such as, Eradication of infected plants and isolation of infected rows, rinsing hands/gloves and pruning tools with a disinfectant after working each row, and disinfection of structures and equipment .
- Production of tomato transplants in greenhouses planted in soilless medium in plastic trays, has been found to be feasible and more reliable than field-grown transplants for reducing the risk of bacterial canker (Gleason et al., 1993).
- Copper-based chemicals are usually sprayed on tomato for controlling bacterial diseases but their effect on canker is poorly documented. There are no specific chemicals registered in Kenya against bacterial canker in tomato (PCPB,2016)
- Prophylactic measures (destruction of crop residues through deep ploughing, a 2 year rotation cycle with non solanacious crops, disinfection of structures and equipment) are essential to prevent out breaks in protected crops.
- Use of tolerant or resistant cultivars (Van Steekelenburg, 1985).

12. References

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