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Data Sheets on Quarantine Pests

Xanthomonas vesicatoria

IDENTITY

Name: *Xanthomonas vesicatoria* (ex Doidge) Vauterin *et al.*
Synonyms: *Xanthomonas campestris* pv. *vesicatoria* (Doidge) Dye
Taxonomic position: Bacteria: Gracilicutes
Common names: Bacterial spot, bacterial scab, black spot (English)
Gale bactérienne (French)
Bakterielle Schwarzfleckenkrankheit (German)
Mancha bacteriana (Spanish)
Notes on taxonomy and nomenclature: *Xanthomonas vesicatoria* (Doidge) Dowson was long used as a name for the bacterial spot pathogen prior to the introduction of the Approved List of Bacterial Names (Skerman *et al.*, 1980). It was not used in the List, and the pathovar *X. campestris* pv. *vesicatoria* was proposed. More recently, in an extensive revision of the genus *Xanthomonas*, the name *Xanthomonas vesicatoria* (ex Doidge) Vauterin *et al.* was revived (Vauterin *et al.*, 1995).
Bayer computer code: XANTVE
EPPO A2 list: No. 157
EU Annex designation: II/A2

HOSTS

The principal hosts are tomatoes and *Capsicum*. Various other Solanaceae, mainly weeds, have been recorded as incidental hosts: *Datura* spp., *Hyoscyamus* spp., *Lycium* spp., *Nicotiana rustica*, *Physalis* spp., *Solanum* spp. (e.g. on fruits of potato). The forms of '*X. vesicatoria*' reported many years ago (Hayward & Waterston, 1964) to attack Brassicaceae as well as Solanaceae are now referred to *X. campestris* pv. *raphani* (see Notes on taxonomy and nomenclature).

Three pathotypes have been described (Cook & Stall, 1982), all attacking tomatoes: (1) tomato pathotype, giving hypersensitive resistance (HR) in all *Capsicum* cultivars; (2) *Capsicum* pathotype 1, giving susceptible reactions on *Capsicum* cvs Florida VR2 and Early Calwonder; (3) *Capsicum* pathotype 2, giving HR in Florida VR2 and susceptible reaction in Early Calwonder (*Capsicum* pathotype 2 was until recently reported from Florida (USA) only, but it has now been reported with the other two pathotypes in Taiwan (Hartman & Yang, 1990)).

GEOGRAPHICAL DISTRIBUTION

X. vesicatoria occurs widely in tomato- and *Capsicum*-growing areas in the warmer parts of the world. It is, however, absent from glasshouse production in cooler areas, at least in Europe.

EPPO region: Widespread in Egypt, Greece, Hungary, Israel, Italy (including Sardinia and Sicily), Romania, Russia (European, Siberia), Yugoslavia. Recorded in Austria, Belarus, Bulgaria, Czech Republic, France, Morocco, Poland, Slovakia, Slovenia, Spain, Switzerland (unconfirmed), Tunisia, Turkey. It probably occurs all over the Mediterranean area. Found in the past but not established in Azerbaijan, Germany (Griesbach *et al*., 1988), Kazakhstan.
Asia: At least in China (Jilin, Xinjiang), India (Andhra Pradesh, Delhi, Karnataka, Maharashtra, Rajasthan, Tamil Nadu), Israel, Japan (Honshu), Korea Democratic People's Republic, Korea Republic, Pakistan, Philippines, Russia (Siberia), Taiwan, Thailand, Turkey. Found in the past but not established in Azerbaijan, and Kazakhstan.
Africa: At least in Egypt, Ethiopia, Kenya, Malawi, Morocco, Mozambique, Niger, Nigeria, Réunion, Senegal, Seychelles, South Africa, Sudan, Togo, Tunisia, Zambia, Zimbabwe.
North America: Bermuda, Canada (British Columbia to Nova Scotia), Mexico, USA (Arizona, California, Florida, Georgia, Hawaii, Iowa, Michigan, North Carolina, Ohio, Oklahoma). *Capsicum* pathotype 2 is restricted to Florida (USA).
Central America and Caribbean: At least in Barbados, Costa Rica, Cuba, Dominica, Dominican Republic, El Salvador, Guadeloupe, Guatemala, Honduras, Jamaica, Martinique, Nicaragua, Puerto Rico, St. Kitts and Nevis, St. Vincent and Grenadines, Trinidad and Tobago, United States Virgin Islands.
South America: Argentina, Brazil (São Paulo), Chile, Colombia, Paraguay, Suriname, Uruguay, Venezuela.
Oceania: Australia (New South Wales, Queensland, Tasmania, Victoria, Western Australia), Fiji, Micronesia, New Zealand, Palau, Tonga.
EU: Present.
Distribution map: See CMI (1987, No. 269).

BIOLOGY

X. vesicatoria survives from one crop to another mainly on seed, but also in infected debris, e.g. stalks. It may be able to survive in the soil to some extent, possibly in the rhizosphere of non-host plants (Bashan *et al*., 1982a). Solanaceous weeds may act as alternate hosts.

In glasshouses, seed-borne infection is the only important consideration. Spread is primarily by rain-splash or by overhead irrigation, but handling of young plants is also important (Goode & Sasser, 1980). Viable bacteria have been detected in aerosols over commercial fields, showing the possibility of aerial dispersal (McInnes *et al.*, 1988). Leaves are infected through stomata, and fruits (which have no stomata) through small wounds, e.g. abrasions, insect punctures. Only young fruits are infected. The bacterium can multiply epiphytically on young plants in the absence of symptoms. Thinning of directly seeded tomato seedlings is reported to favour spread of the disease, and it is recommended to thin in the afternoon when plants are dry and to use prophylactic hand washes (Pohronezny *et al.*, 1990). On *Capsicum*, it can multiply as a slime on the surface of young fruits, without symptoms, and cause shedding (Bashan & Okon, 1986). Disease is favoured by heavy rainfall, high humidity (Diab *et al*., 1982a) and temperatures above 30°C, but not over 35°C (Diab *et al*., 1982b). The bacterium can survive on tomato and *Capsicum* seeds for periods of at least 10 years (Bashan *et al*., 1982b).

DETECTION AND IDENTIFICATION

Symptoms

Fruits of tomato show superficial corky spots or scabs, with water-soaked margins, oval or irregular in shape, 2-10 mm in diameter. *Capsicum* fruits rarely show symptoms, but may drop if infected early. The 'flecks' due to *Pseudomonas syringae* pv. *tomato* are distinctly smaller (diameter <1 mm). *Clavibacter michiganensis* subsp. *michiganensis* also, infrequently, causes spots on fruits, with a distinctive 'bird's eye' appearance (EPPO/CABI, 1996). Scabbing of fruit (but without water-soaking) may also be a symptom of the phytotoxicity of plant protection products.

On leaves of tomato or *Capsicum*, lesions appear as irregular water-soaked areas, at first green, later becoming brown and necrotic. Speck lesions (*P. syringae* pv. *tomato*) look similar initially but are surrounded by a more distinct yellow halo; lesions are often in streaks and the yellow haloes run together to give large chlorotic areas (Goode & Sasser, 1980).

Both *X. vesicatoria* and *P. syringae* pv. *tomato* can cause canker-like splits in stems, but these are not diagnostic, since similar symptoms may be caused by *C. michiganensis* subsp. *michiganensis* and *Alternaria solani*.

Morphology

X. vesicatoria is an aerobic, mobile, Gram-negative rod, occurring singly or in pairs, 0.6 x 1.0-1.5 µm, with a single polar flagellum. On yeast dextrose chalk agar and nutrient dextrose agar, colonies are large, smooth-domed, mucoid-fluidal and yellow with entire edges. Unlike *P. syringae* pv. *tomato*, they are non-fluorescent on King's medium B. *X. vesicatoria* is sensitive to triphenyl tetrazolium chloride and is oxidative.

Detection and inspection methods

X. vesicatoria produces characteristic lesions on cotyledons of young tomato or *Capsicum* seedlings incubated at high humidity. Semi-selective media have been proposed by McGuire *et al.* (1986). Sharon *et al.* (1982) and Bashan & Assouline (1983) have described a leaf enrichment method, particularly for detection of the bacterium in seed or in symptomless leaves. Cruz & Fernández (1979) first tried out immunofluorescence for seed testing. An EPPO quarantine procedure has recently been developed (OEPP/EPPO, 1992) involving a preliminary screen of seed extract by immunofluorescence (IF), followed by isolation, serological testing (slide agglutination, IF or dot-ELISA; Lazarovits *et al.*, 1987) and, if necessary, confirmatory pathogenicity tests on leaves.

MEANS OF MOVEMENT AND DISPERSAL

The pathogen moves principally on seeds of *Capsicum* or tomato, and possibly also on young seedlings of these crops. According to Bashan (1986), "nearly all accidental agents passing through the infested field may act as vectors" (including insects, tools, soil).

PEST SIGNIFICANCE

Economic impact

X. vesicatoria is widespread and damaging to *Capsicum* and tomatoes in field-grown crops in warm-temperate and tropical countries, especially under overhead irrigation. Losses of fruit yield are greatest when infection occurs early (e.g. tomato in USA, Dougherty, 1979; *Capsicum* in Israel, Bashan *et al.*, 1985). Damage to the leaves tends to expose fruits to the sun, increasing sunscald. While fruit lesions are often only superficial, they reduce quality

for sale fresh and also for processing. The significance of the bacterium as a quarantine pest, as with *Clavibacter michiganensis* subsp. *michiganensis* (EPPO/CABI, 1996), arises not in countries where these crops are field-grown, but in northern European countries where tomatoes and *Capsicum* are mainly grown under glass and the two bacteria have not become established. With relatively limited possibilities for survival in soil or glasshouses, it seems probable that the bacterium can be effectively excluded from glasshouse crops by strict controls on seed-borne infection.

In the EPPO region, bacterial spot is possibly less important and damaging than bacterial speck due to *Pseudomonas syringae* pv. *tomato*. However, the latter is widely distributed in all producing countries, whether in the field or under glass, and so can only be regarded as a quality, not quarantine organism. Nevertheless, measures taken against *X. vesicatoria* and *C. michiganensis* subsp. *michiganensis* will incidentally have the function of helping to control *P. syringae* pv. *tomato*. See also Calzolari (1986).

Control

Control relies principally on the production of plants from healthy (treated) seed (see Phytosanitary measures) and on care in handling young transplants to prevent spread at an early stage (Goode & Sasser, 1980). It is possible to treat with various plant protection compounds, especially copper-based products (Azaizeh & Bashan, 1984). Methyl bromide fumigation can be used to disinfect soil. Resistant cultivars of tomato and *Capsicum* are known, and breeding for resistance is very actively pursued.

Phytosanitary risk

X. vesicatoria has been listed as an A2 quarantine pest by EPPO, but not by any other regional plant protection organization (OEPP/EPPO, 1988). As indicated above, its quarantine status relates to a rather special need to exclude it from glasshouse crops in northern Europe.

PHYTOSANITARY MEASURES

A variety of treatments can be used to eradicate seed-borne infection (Dempsey & Chandler, 1963) as for *C. michiganensis* subsp. *michiganensis* (EPPO/CABI 1996): 0.8% acetic acid for 24 h, 5% HCl for 5-10 h (also for tobacco mosaic tobamovirus), 1.05% sodium hypochlorite for 30 min, 0.05% $HgCl_2$ for 5 min. Hot water treatment at 56°C for 30 min is another possibility. All imported seed should be treated by such a method, or tested by a suitable procedure (OEPP/EPPO, 1992). Alternatively (or additionally) the seed crop should have been found free from the disease (OEPP/EPPO, 1990).

BIBLIOGRAPHY

Azaizeh, M.; Bashan, Y. (1984) Chemical control of *Xanthomonas campestris* pv. *vesicatoria* in inoculated pepper fields in Israel. *Annals of Applied Biology* **104**, *Supplement on Tests of Agrochemicals and Cultivars* No. 5, pp. 60-61.

Bashan, Y. (1986) Field dispersal of *Pseudomonas syringae* pv. *tomato*, *Xanthomonas campestris* pv. *vesicatoria* and *Alternaria macrospora* by animals, people, birds, insects, mites, agricultural tools, aircraft, soil particles and water sources. *Canadian Journal of Botany* **64**, 276-281.

Bashan, Y.; Assouline, I. (1983) Complementary bacterial enrichment techniques for the detection of *Pseudomonas syringae* pv. *tomato* and *Xanthomonas campestris* pv. *vesicatoria* in infected tomato and pepper seeds. *Phytoparasitica* **11**, 187-193.

Bashan, Y.; Azaizeh, M.; Diab, S.; Yunis, H.; Okon, Y. (1985) Crop loss of pepper plants artificially infected with *Xanthomonas campestris* pv. *vesicatoria* in relation to symptom expression. *Crop Protection* **4**, 77-84.

Bashan, Y.; Diab, S.; Okon, Y. (1982a) Survival of *Xanthomonas campestris* pv. *vesicatoria* in pepper seeds and roots, in symptomless and dry leaves in non-host plants and in the soil. *Plant and Soil* **68**, 161-170.

Bashan, Y.; Okon, Y. (1986) Internal and external infection of fruits and seeds of peppers by *Xanthomonas campestris* pv. *vesicatoria*. *Canadian Journal of Botany* **64**, 2865-2871.

Bashan, Y.; Okon, Y.; Henis, Y. (1982b) Long-term survival of *Pseudomonas syringae* pv. *tomato* and *Xanthomonas campestris* pv. *vesicatoria* in tomato and pepper seeds. *Phytopathology* **72**, 1143-1144.

Calzolari, A. (1986) [Bacterial diseases of tomatoes: symptoms, epidemiology, diagnosis, control]. *Informatore Fitopatologico* **36**, 11-17.

CMI (1987) *Distribution Maps of Plant Diseases* No. 269 (edition 5). CAB International, Wallingford, UK.

Cook, A.A.; Stall, R.E. (1982) Distribution of races of *Xanthomonas vesicatoria* pathogenic on pepper. *Plant Disease* **66**, 388-389.

Cruz, M.; Fernández, A.I. (1979) [Immunofluorescence in the testing of seeds and leaves of plants with bacterial infection]. *Ciencias, Sanidad Vegetal* No. 17. Havana University, Havana, Cuba.

Dempsey, A.H.; Chandler, W.A. (1963) Disinfectant treatments for freshly harvested pepper seeds. *Plant Disease Reporter* **47**, 325-327.

Diab, S.; Bashan, Y.; Okon, Y.; Henis, Y. (1982a) Effects of relative humidity on bacterial scab caused by *Xanthomonas campestris* pv. *vesicatoria* on pepper. *Phytopathology* **72**, 1257-1260.

Diab, S.; Bashan, Y.; Okon, Y. (1982b) Studies on infection with *Xanthomonas campestris* pv. *vesicatoria*, causal agent of bacterial scab of pepper in Israel. *Phytoparasitica* **10**, 183-191.

Dougherty, D.E. (1979) Yield reduction in tomato caused by bacterial spot and disease control with copper sprays. *Proceedings of the Florida State Horticultural Society* **91**, 291-293.

EPPO/CABI (1996) *Clavibacter michiganensis* subsp. *michiganensis*. In: *Quarantine pests for Europe*. 2nd edition (Ed. by Smith, I.M.; McNamara, D.G.; Scott, P.R.; Holderness, M.). CAB INTERNATIONAL, Wallingford, UK.

Goode, M.J.; Sasser, M. (1980) Prevention - the key to controlling bacterial speck and bacterial speck of tomato. *Plant Disease* **64**, 831-834.

Griesbach, E.; Lattauschke, G.; Schmidt, A.; Naumann, K. (1988) [On the occurrence of *Xanthomonas campestris* pv. *vesicatoria* on pepper under glass and plastic]. *Nachrichtenblatt für den Pflanzenschutz in der DDR* **42**, 176-178.

Hartman, G.L.; Yang, C.H. (1990) Occurrence of three races of *Xanthomonas campestris* pv. *vesicatoria* on pepper and tomato in Taiwan. *Plant Disease* **74**, 252.

Hayward, A.C.; Waterston, J.M. (1964) *Xanthomonas vesicatoria*. *CMI Descriptions of Pathogenic Fungi and Bacteria* No. 20. CAB International, Wallingford, UK.

Kranz, J., Schmutterer, H.; Koch, W. (1977) In: *Diseases, pests and weeds in tropical crops*, pp. 71-73. Paul Parey, Berlin, Germany.

Lazarovits, G.; Zutra, D.; Bar-Joseph, M. (1987) Enzyme-linked immunosorbent assay on nitrocellulose membranes (dot-ELISA) in the serodiagnosis of plant pathogenic bacteria. *Canadian Journal of Microbiology* **33**, 98-103.

McGuire, R.G.; Jones, J.B.; Sasser, M. (1986) Tween media for semi-selective isolation of *Xanthomonas campestris* pv. *vesicatoria* from soil and plant material. *Plant Disease* **70**, 887-891.

McInnes, T.B.; Gitaitis, R.D.; McCarter, S.M.; Jaworski, C.A.; Phatak, S.C. (1988) Airborne dispersal of bacteria in tomato and pepper transplant fields. *Plant Disease* **72**, 575-579.

OEPP/EPPO (1988) Data sheets on quarantine organisms No. 157, *Xanthomonas campestris* pv. *vesicatoria*. *Bulletin OEPP/EPPO Bulletin* **18**, 521-526.

OEPP/EPPO (1990) Specific quarantine requirements. *EPPO Technical Documents* No. 1008.

OEPP/EPPO (1992) Quarantine procedures. *Xanthomonas campestris* pv. *vesicatoria* - seed-testing method. *Bulletin EPPO/EPPO Bulletin* **22**, 247-252.

Pohronezny, K.; Moss, M.A.; Dankers, W.; Schenk, J. (1990) Dispersal and management of *Xanthomonas campestris* pv. *vesicatoria* during thinning of direct-seeded tomato. *Plant Disease* **74**, 800-805.

Sharon, E.; Okon, Y.; Bashan, Y.; Henis, Y. (1982) Detached leaf enrichment: a method for detecting small numbers of *Pseudomonas syringae* pv. *tomato* and *Xanthomonas campestris* pv. *vesicatoria* in seed and symptomless leaves of tomato and pepper. *Journal of Applied Bacteriology* **59**, 371-377.

Skerman, V.B.D.; McGowan, V.; Sneath, P.H.A. (1980) Approved list of bacterial names. *International Journal of Systematic Bacteriology* **30**, 255-420.

Vauterin, L.; Hoste, B.; Kersters, K.; Swings, J. (1995) Reclassification of *Xanthomonas*. *International Journal of Systematic Bacteriology* **45**, 472-489.