Bulletin OEPP/EPPO Bulletin (2016) **46** (1), 4–7 ISSN 0250-8052. DOI: 10.1111/epp.12273

European and Mediterranean Plant Protection Organization
Organisation Européenne et Méditerranéenne pour la Protection des Plantes

Data sheets on pests recommended for regulation
Fiches informatives sur les organismes recommandés pour réglementation

Xanthomonas axonopodis pv. *allii*

Identity

Scientific name: *Xanthomonas axonopodis* pv. *allii* (Roumagnac *et al.*, 2004a,b).

Synonyms: *Xanthomonas campestris* pv. *allii* (Kadota *et al.*, 2000).

Taxonomic position: Proteobacteria: Gammapropteobacteria: Xanthomonadales: Xanthomonasdaceae.

Common names: *Xanthomonas axonopodis* pv. *allii* is the causal agent of onion bacterial blight (syn. *Xanthomonas* leaf blight of onion).

EPPO code: XANTAA.

Phytosanitary categorization: A1 List no. 353.

Hosts

Although primarily associated with outbreaks on *Allium cepa* L. (onion) worldwide, *X. axonopodis* pv. *allii* was found to infect *Allium fistulosum* (Welsh onion), *Allium sativum* (garlic), *Allium porrum* (leek), *Allium schoenoprasum* (chive) and *A. cepa* var. *ascalonicum* (shallot) after artificial inoculation (Bowen *et al.*, 1998; Kadota *et al.*, 2000; Roumagnac *et al.*, 2004a,b). The three former hosts were also reported to be susceptible in the field in addition to *A. cepa* L. (Kadota *et al.*, 2000; Picard *et al.*, 2008). Non-*Allium* plant species (primarily citrus and legume species) have been reported as hosts under artificial inoculation (Gent *et al.*, 2005a; O'Garro & Paulraj, 1997) but no symptoms caused by *X. axonopodis* pv. *allii* have ever been reported from these species under field conditions, making their host status uncertain.

Geographical distribution

EPPO region: absent.

Asia: Japan (Kadota *et al.*, 2000).

Africa: Mauritius, Réunion (Roumagnac *et al.*, 2000), South Africa (Serfontein, 2001).

North America: USA (California, Colorado, Georgia, Texas) (Isakeit *et al.*, 2000; Schwartz & Otto, 2000; Nunez *et al.*, 2002; Sanders *et al.*, 2003).

Central America and the Caribbean: Barbados (Paulraj & O'Garro, 1993), Cuba.

South America: Brazil (Neto *et al.*, 1987), Venezuela (Trujillo & Hernandez, 1999).

Oceania: Hawaii(Alvarez *et al.*, 1978).

Biology

The bacterium can induce lesions on *Allium* leaves and scapes, but not on bulbs. Onion leaves are most susceptible at the bulb initiation period (Schwartz *et al.*, 2003; Roumagnac *et al.*, 2004b). Several putative primary inoculum sources have been identified: contaminated onion seed (Roumagnac *et al.*, 2000), volunteer onion plants, irrigation water and crop debris (Gent *et al.*, 2005b), seedlings used for transplant, contaminated equipment or clothes.

Bacterial blight outbreaks developed in fields established with onion seed contaminated at a rate of 0.04% in the cool season of a tropical environment (Roumagnac *et al.*, 2004b). Analyses of disease patterns indicated a likely seedborne origin for the inoculum associated with the early stages of epidemics (Roumagnac *et al.*, 2004b). Although not experimentally confirmed at that time, it was hypothesized that outbreaks in onion in Hawaii (Alvarez *et al.*, 1978) had a seedborne origin. Recent data also suggests that the pathogen was likely to have been introduced to Réunion Island from Mauritius via contaminated onion seed lots (Picard *et al.*, 2008). In onion seed production fields, seeds contaminated with *X. axonopodis* pv. *allii* were detected by semi-selective isolation and a nested polymerase chain reaction (PCR) test at levels up to 0.05%; the final disease incidence was 0.61. Contaminated seed originated from both diseased and asymptomatic plants (Humeau *et al.*, 2006). *Xanthomonas axonopodis* pv. *allii* can survive and retain some culturability for at least 10 years in association with onion seed stored in a cool place (4°C) (Robene-Soustrade *et al.*, 2005). *Xanthomonas axonopodis* pv. *allii* was not recovered from plants other than *Allium* in experimental sites in Colorado where an epidemic of *Xanthomonas* leaf blight did not occur the previous year (Gent *et al.*, 2005b,c), although it was recovered from the foliage of several asymptomatic cultivated (alfalfa, chickpea, dry bean, lentil and soybean) and weed (*Malva neglecta*) species. In Northern and Southern Colorado *X. axonopodis* pv. *allii* was recovered from infested onion leaves 9 months after they were placed on the soil surface or buried to a depth of 25 cm, but culturable populations of the pathogen decreased 10^4 to 10^6 more in buried leaves (Gent *et al.*, 2005b).

Disease development in onion is favoured by warm temperatures (Schwartz *et al.*, 2003), but daily mean temperatures as low as 21–22°C allowed disease to develop in field trials established in Réunion Island (Roumagnac *et al.*, 2004b; Humeau *et al.*, 2006). Over 3 years, disease development in Réunion Island was observed to be related to a succession of two climatic events – heavy rains followed by temperatures exceeding 20°C (Roumagnac *et al.*, 2004b). As for many xanthomonads, the length of the latent infection period depends on temperature. Fitting the β-binomial distribution and binary power law analysis indicated aggregated patterns of disease incidence data from onion bulb and onion seed production fields. Secondary foci were detected after occurrence of wind-driven rains, confirming the importance of such environmental conditions for bacterial spread (Roumagnac *et al.*, 2004b; Humeau *et al.*, 2006). Overhead irrigation (Roumagnac *et al.*, 2004a,b) or extensive nitrogen fertilization (Gent & Schwartz, 2005a,b) exacerbated disease development.

Fig. 1 Onion bacterial blight leaf lesions caused by *Xanthomonas axonopodis* pv. *allii*

Detection and identification

Symptoms

On onion, lesions consist of lenticular water-soaked leaf spots which turn into dry chlorotic lesions that eventually coalesce (Figs 1–3). When disease is severe, leaf dieback can occur, resulting in a reduction of bulb size. The morphology of leaf lesions on other *Allium* species is similar to those on onion (Picard *et al.*, 2008). *Xanthomonas axonopodis* pv. *allii* was also pathogenic to Mexican lime and grapefruit after bacterial infiltration, and produced lesions that were similar to citrus bacterial spot (i.e. water-soaked leaf lesions turning into necrotic spots) (Gent *et al.*, 2005a). Host specialization among strains remains largely unknown. However, no host specialization was found on strains collected in Réunion Island and originating from outbreaks on onion, leek and garlic, respectively, which could all infect the same range of *Allium* species when tested (Picard *et al.*, 2008).

Identification

Identification currently requires pure bacterial cultures. This is facilitated by the use of semi-selective media (Roumagnac *et al.*, 2000; Gent & Schwartz, 2005b). Identification at the genus level can be achieved through sequencing of *16S* rDNA (Moore *et al.*, 1997) or characterization of xanthomonadin pigments (Schaad, 1988). Formal identification at the pathovar level requires fulfilment of Koch's postulates, although molecular typing techniques such as repetitive sequence-based PCR (rep-PCR) and amplified fragment length polymorphism (AFLP) (Gent *et al.*, 2004; Roumagnac *et al.*, 2004a; Humeau *et al.*, 2006) can be used for preliminary screening of strains to be inoculated. A multiplex PCR protocol usable on seed macerates without any culture step is now available as a screening test (Robene *et al.*, 2015).

Pathway for movement

The most important pathway for long-distance movement of the pathogen is *Allium* seeds. *Xanthomonas axonopodis*

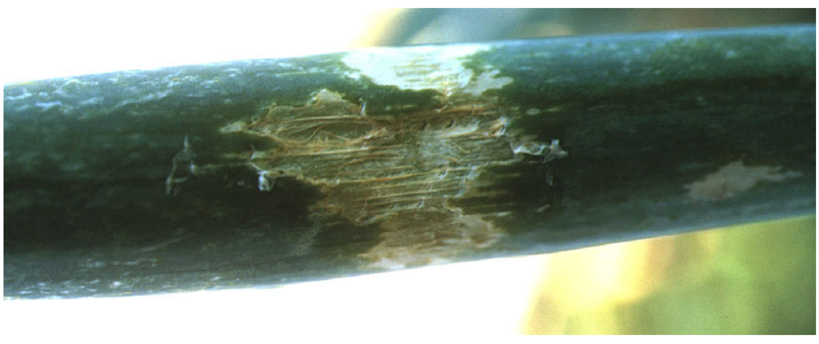

Fig. 2 Onion bacterial blight scape lesion caused by *Xanthomonas axonopodis* pv. *allii.*

Fig. 3 Onion bacterial blight lesions caused by *Xanthomonas axonopodis* pv. *allii* on a garlic leaf.

pv. *allii* may be spread over long distances via infected *Allium* seedlings used for transplant, but no documented cases are known. The pest is locally spread by wind-driven rains, irrigation water, humans, contaminated tools, equipment used in crop management and possibly via animals, although this has not been demonstrated.

Pest significance

Economic impact

Infection of the aerial parts of onion by the pathogen may lead to a reduction in bulb size. Yield losses for onion bulbs ranging from 10% to 50% have been reported in Continental USA (Schwartz & Otto, 2000; Nunez *et al.*, 2002; Sanders *et al.*, 2003). Although not precisely documented, the impact of the disease may be higher in tropical countries. Data from Barbados indicates cases where loss of an entire onion crop occurred (O'Garro & Paulraj, 1997). Severe reductions in onion bulb size have been recorded in South Africa (Serfontein, 2001).

Control

Control in the USA is most often partially achieved through a massive use of copper bactericides, sometimes with ethylenebisdithiocarbamate fungicides added, but this strategy is economically and environmentally unsatisfactory (Gent & Schwartz, 2005a). Alternative management programmes involving plant activators (acibenzolar-*S*-methyl), bacteriophages or antagonistic bacteria are being developed experimentally (Gent & Schwartz, 2005a; Lang *et al.*, 2007). However, these new management programmes are not currently as affordable as conventional programmes which also protect onion against other diseases (Lang *et al.*, 2007). Seed health testing should also be developed (Picard *et al.*, 2008).

Prophylactic measures usually implemented for the control of plant pathogenic bacteria should be used. Although not experimentally evaluated, the host range of *X. axonopodis* pv. *allii* suggests that crop rotation should be considered in Integrated Pest Management (IPM) programmes. However, the longevity of the pathogen's survival in the field in association with crop debris or in the absence of *Allium* spp. and weeds is not precisely known. Overhead irrigation should be avoided (Roumagnac *et al.*, 2004b) and furrow or drip irrigation should be considered as alternative irrigation modes. No *Allium* cultivars have been consistently characterized as resistant to *X. axonopodis* pv. *allii* and no sources of resistance have been identified to date.

Phytosanitary risk

Xanthomonas axonopodis pv. *allii* can cause significant yield losses and high costs for chemical control (approximately 200 EUR per ha) (Lang *et al.*, 2007) when conditions are suitable. This pest presents a risk for *Allium* spp. grown outdoors in the Mediterranean parts of the EPPO region and to a lesser extent the temperate parts of the EPPO region.

Phytosanitary measures

EPPO recommends that seeds and seedlings of host plants should be produced in areas free from or places of production free from *Xanthomonas axonopodis* pv. *allii*.

Acknowledgement

This datasheet was prepared by O. Pruvost, CIRAD, UMR PVBMT (FR).

References

Alvarez AM, Buddenhagen IW, Buddenhagen ES & Domen HY (1978) Bacterial blight of onion, a new disease caused by *Xanthomonas* sp. *Phytopathology* **68**, 1132–1136.

Bowen P, Gibbs HAA & O' GLW (1998) Garlic, chives, challot and leek are alternative hosts to *Xanthomonas campestris*, the pathogen of leaf blight of onion *Allium cepa* L. In 7th Int. Cong. Plant Pathol., pp. 6-96. ISPP, Edinburgh, Scotland.

Gent DH, Al-Saadi A, Gabriel DW, Louws FJ, Ishimaru CA & Schwartz HF (2005a) Pathogenic and genetic relatedness among *Xanthomonas axonopodis* pv. *allii* and other pathovars of *X. axonopodis*. *Phytopathology* **95**, 918–925.

Gent DH, Lang JM, Bartolo ME & Schwartz HR (2005b) Inoculum sources and survival of *Xanthomonas axonopodis* pv. *allii* in Colorado. *Plant Disease* **89**, 507–514.

Gent DH, Lang JM & Schwartz HF (2005c) Epiphytic survival of *Xanthomonas axonopodis* pv. *allii* and *X. axonopodis* pv. *phaseoli* on leguminous hosts and onion. *Plant Disease* **89**, 558–564.

Gent DH & Schwartz HF (2005a) Management of *Xanthomonas* leaf blight of onion with a plant activator, biological control agents, and copper bactericides. *Plant Disease* **89**, 631–639.

Gent DH & Schwartz HF (2005b) Effect of nitrogen fertilization and seed contamination on epiphytic populations of *Xanthomonas axonopodis* pv. *allii* and development of *Xanthomonas* leaf blight of onion. *Plant Health Progress*, p 105–121.

Gent DH, Schwartz HF, Ishimaru CA, Louws FJ, Cramer RA & Lawrence CB (2004) Polyphasic characterization of *Xanthomonas* strains from onion. *Phytopathology* **94**, 184–195.

Humeau L, Roumagnac P, Picard Y, Robène-Soustrade I, Chiroleu F, Gagnevin L *et al.* (2006) Quantitative and molecular epidemiology of bacterial blight of onion in seed production fields. *Phytopathology* **96**, 1345–1354.

Isakeit T, Miller ME, Barnes LW, Dickstein ER & Jones JB (2000) First report of leaf blight of onion caused by *Xanthomonas campestris* in the Continental United States. *Plant Disease* **84**, 201.

Kadota I, Uehara K, Shinohara H & Nishiyama K (2000) Bacterial blight of Welsh onion, A new disease caused by *Xanthomonas campestris* pv. *allii* pv. nov. *Journal of General Plant Pathology* **66**, 310–315.

Lang JM, Gent DH & Schwartz HF (2007) Management of *Xanthomonas* leaf blight of onion with bacteriophages and a plant activator. *Plant Summa Phytopathologia* **91**, 871–878.

Moore ERB, Kruger AS, Hauben L, Seal SE, De Baere R, De Wachter R *et al.* (1997) 16S rRNA gene sequence analyses and inter- and intrageneric relationships of *Xanthomonas* species and *Stenotrophomonas maltophilia*. *FEMS Microbiology Letters* **151**, 145–153.

Neto JR, Malavolta VA Jr, Cardelli MA & Sinigaglia C (1987) Ocorrencia de uma nova doença bacteriana em cebola, no estado de Sao Paulo. *Summa Phytopathologica* **13**, 10.

Nunez JJ, Gilbertson RL, Meng X & Davis RM (2002) First report of *Xanthomonas* leaf blight of onion in California. *Plant Disease* **86**, 330.

O'Garro LW & Paulraj LP, (1997) Onion leaf blight caused by Xanthomonas campestris: Alternative hosts & resistant onion genotypes. *Plant Disease* **81**, 978–982.

Paulraj L & O'Garro LW (1993) Leaf blight of onions in Barbados caused by *Xanthomonas campestris*. *Plant Disease* **77**, 198–201.

Picard Y, Roumagnac P, Legrand D, Humeau L, Robène-Soustrade I, Chiroleu F *et al.* (2008) Polyphasic characterization of *Xanthomonas axonopodis* pv. *allii* associated with outbreaks of bacterial blight on three *Allium* species in the Mascarene archipelago. *Phytopathology* **98**, 919–925.

Robene I, Perret M, Jouen E, Escalon A, Maillot MV, Chabirand A *et al.* (2015) Development and validation of a real-time quantitative PCR assay to detect Xanthomonas axonopodis pv. allii from onion seed. *Journal of Microbiological Methods* **114**, 78–86.

Robene-Soustrade I, Legrand D, Couteau A, Humeau L, Roux-Cuvelier M, Roumagnac P *et al.* (2005) A nested PCR-multiplex to detect *Xanthomonas axonopodis* pv. *allii* in onion seeds. In: 5th ISTA-SHC Seed Health Symposium, International Seed Testing Association, Angers, France.

Roumagnac P, Gagnevin L, Gardan L, Sutra L, Manceau C, Dickstein ER *et al.* (2004a) Polyphasic characterization of xanthomonads isolated from onion, garlic and Welsh onion (*Allium* spp.) and their relatedness to different *Xanthomonas* species. *International Journal of Systematic and Evolutionary Microbiology* **54**, 15–24.

Roumagnac P, Gagnevin L & Pruvost O (2000) Detection of *Xanthomonas* sp., the causal agent of onion bacterial blight, in onion seeds using a newly developed semi-selective isolation medium. *European Journal of Plant Pathology* **106**, 867–877.

Roumagnac P, Pruvost O, Chiroleu F & Hughes G (2004b) Spatial and temporal analyses of bacterial blight of onion caused by *Xanthomonas axonopodis* pv. *allii*. *Phytopathology* **94**, 138–146.

Sanders FH, Langston DB Jr, Brock JH, Gitaitis RD, Curry DE & Torrance RL (2003) First report of a leaf blight of onion caused by *Xanthomonas* spp. in Georgia. *Plant Disease* **87**, 749.

Schaad NW (ed.) (1988) *Laboratory Guide for Identification of Plant Pathogenic Bacteria*, St Paul, USA, APS Press.

Schwartz HF & Otto K (2000) First report of leaf blight of onion caused by *Xanthomonas campestris* in Colorado. *Plant Disease* **84**, 922.

Schwartz HF, Otto KL & Gent DH (2003) Relation of temperature and rainfall to development of *Xanthomonas* and *Pantoea* leaf blights of onion in Colorado. *Plant Disease* **87**, 11–14.

Serfontein JJ (2001) *Xanthomonas* blight of onion in South Africa. *Plant Disease* **85**, 442.

Trujillo G & Hernandez Y (1999) Identificacion de bacterias fitopatogenas en semillas de plantas cultivadas. In: XVI Congreso Venezolano de Fitopatologia Barquisimeto, Venezuela, Sociedad Venezolano de Fitopatologia.