Differential Sets

Xanthomonas spp. (X. euvesicatoria, X. vesicatoria, X. perforans and *X. gardneri*)– **Pepper**

Pepper bacterial leaf spot symptoms include small, irregular, water-soaked, greasy- appearing lesions on leaf undersurfaces. Lesions develop rapidly in size, and become tan to reddish-brown. Often lesions are more numerous at leaf tips and margins where moisture accumulates. Symptoms are usually more severe and lesions reach a greater size following periods of prolonged leaf wetness. Defoliation occurs under heavy disease pressure. When conditions are dry, leaves become tattered as lesion centers and leaf margins dry and disintegrate. Stem lesions occur as narrow, light-brown, longitudinally raised cankers. Fruit spots begin as water-soaked areas that later become necrotic. These spots are rough in appearance and crack as they develop.

Until the early 1990's, bacterial leaf spot of pepper and tomato was thought to be caused by a single bacterial species, *Xanthomonas campestris* pv. *vesicatoria*. In the early 1990's, two distinct genetic groups were shown to exist within strains of *X. campestris* pv. *vesicatoria*. In 1995, Vauterin et al. restructured the species within the genus *Xanthomonas* and proposed *X. vesicatoria* and *X. axonopodis* pv. *vesicatoria*. Subsequently, four taxonomically distinct xanthomonads were identified and placed into four groups, designated A, B, C, and D. Jones et al. showed these four groups to be distinct enough to deserve species status: *X. euvesicatoria* = *X. campestris* (*axonopodis*) pv. *vesicatoria* (group A), *X. vesicatoria* = *X. vesicatoria* (group B), *X. perforans* (group C), and *X. gardneri* (group D). Pepper races found within *X. euvesicatoria* are the most widely distributed and cause the greatest economic loss in pepper. *Xanthomonas vesicatoria* and *X. gardneri* are also known to cause bacterial leaf spot on pepper and can have a significant impact in regions where they are found. *Xanthomonas perforans* strains are occasionally found to cause disease on pepper. Strains from all four species have been isolated from tomato. These four species (*X. euvesicatoria, X. vesicatoria, X. perforans and X. gardneri*) cannot be differentiated by pathogenicity as they all cause very similar symptoms. As resistance in tomato and pepper to bacterial spot is based on races that go across these species, it was agreed to use the name *Xanthomonas* spp with its acronym X. spp.

Five resistance genes have been identified within pepper. All induce a hypersensitive response and are effective against all four species of *Xanthomonas*. These genes were identified from the following plant introductions: PI 163192 (*Bs1* gene); PI 260435 (*Bs2* gene); PI 271322 (*Bs3* gene); PI 235047 (*Bs4* gene); *Capsicum baccatum* var. *pendulum* 1556 (Bs7 gene). A hypersensitive response is observed as a confluent necrosis when leaves are infiltrated with a concentrated bacterial suspension. Growth of the bacterial population is arrested during the development of a hypersensitive response and disease symptoms are not observed. The hypersensitive response is controlled according to the gene-for-gene model of resistance in that resistance is controlled by an avirulence gene in the pathogen and a resistance gene in the host.

A non hypersensitive response was identified in the breeding line Pep 13 and the accession PI 271322 and is controlled by *bs5* and *bs6*, two recessive genes with additive action. Sometimes with *bs5* and often with *bs6,* resistance is observed as yellowing and necrosis of the infiltrated area of the leaf. Growth of the bacteria is reduced during the development of the lesions and no symptoms are observed in resistant plants. In the differential table this type of resistance is observed with races 6 and 10 in combination with the differential host ECW12346R.

Differentiating Hosts	Gene	Races of *Xanthomonas* spp.										
		X spp: 0	X spp: 1	X spp: 2	X spp: 3	X spp: 4	X spp: 5	X spp: 6	X spp: 7	X spp: 8	X spp: 9	X spp: 10
Early Cal Wonder (ECW)*	None	S	S	S	S	S	S	S	S	S	S	S
ECW 10R*	*Bs1*	HR	S	HR	S	S	HR	S	S	S	S	S
ECW 20R*	*Bs2*	HR	HR	HR	HR	S	S	S	HR	HR	S	S
ECW 30R*	*Bs3*	HR	HR	S	S	HR	S	S	HR	S	HR	S
PI235047	*Bs4*	HR	HR	S	HR	HR	S	HR	S	S	S	S
ECW 12346R*	*Bs1, Bs2, Bs3, bs5, bs6*	HR	HR	HR	HR	HR	HR	HR**	HR	HR	HR	HR**

S = susceptible
* = In use by the vegetable seed industry
HR** = highly resistant without a hypersensitive reaction
HR = highly resistant with a hypersensitive reaction

Protocol

See CPVO and www.cppsi.org for protocols on disease resistance testing.

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