

A leaf spot disease of brassicas caused by *Xanthomonas campestris* pv. *raphani*

J. G. Vicente, B. Everett

Warwick HRI, The University of Warwick, Wellesbourne, Warwick CV35 9EF, UK

and S. J. Roberts

Current address: Plant Health Solutions, 20 Beauchamp Road, Warwick CV34 5NU, UK



Leaf-spot disease of *Brassicaceae* crops and other hosts

- Attributed to either *X. campestris* pv. *armoraciae* (McCulloch) Dye or *X. campestris* pv. *raphani* (White) Dye
- Other pathovars of *X. campestris* including *X. campestris* pv. *campestris*, the cause of black rot, can produce leaf spots, but the host range of this disease is narrower and the symptoms are distinct
- *X. campestris* leaf-spot isolates are sometimes obtained from commercial brassica seed
- The aim of this study was to clarify the nomenclature of *X. campestris* leaf spot isolates

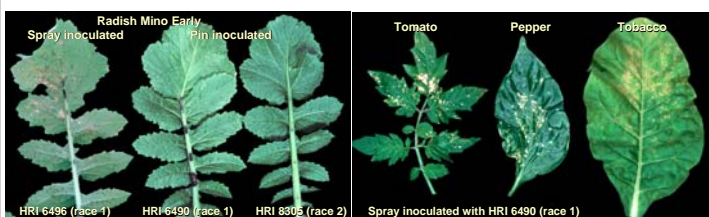
Pathogenicity

- Inoculation methods:
 1. spray inoculation of bacterial suspension followed by 24-48h high humidity
 2. pin inoculation with entomological pin charged with bacterial growth
- Results recorded after one and two weeks
- Isolates received as either *X. campestris* pv. *raphani* and pv. *armoraciae* that caused leaf spots and dark sunken lesions in the middle vein, petiole and/or stem when spray and pin inoculated into a susceptible *B. oleracea* cultivar (Wirosa F₁) were selected
- Twenty-five leaf-spot isolates were inoculated into a range of hosts

Reaction	Hosts	Cultivar/line
Very susceptible to all races	Savoy cabbage (<i>B. oleracea</i> var. <i>sabauda</i>) Ethiopian mustard (<i>B. carinata</i>) Radish (<i>Raphanus sativus</i>) Tomato (<i>Lycopersicon esculentum</i>)	Wirosa F ₁ Selection of PI 199947 French Breakfast 3 Moneymaker
Susceptible	Pumpkin (<i>Cucurbita maxima</i>) Cucumber (<i>Cucumis sativus</i>) Tobacco (<i>Nicotiana tabacum</i>)	F ₁ Becky Telegraph Improved White Burley
Weakly susceptible	Horseradish (<i>Armoracia rusticana</i>)	
Resistant to race 1 (and susceptible to 2 and 3)	Oilseed rape (<i>B. napus</i> var. <i>oleifera</i>) Mustard (<i>B. juncea</i>) Turnip (<i>B. rapa</i> var. <i>rapifera</i>) Wallflower (<i>Cheiranthus cheiri</i>)	Cobra line 14R Florida Broad Leaf Just Right Hybrid Cloth of Gold
Resistant to race 2 (and susceptible to 1 and 3)	Cauliflower (<i>B. oleracea</i> var. <i>botrytis</i>) Radish (<i>R. sativus</i>) Pepper (<i>Capsicum annuum</i>)	Miracle F ₁ Mino Early Wordbeater
Variable	Candytuft (<i>Iberis</i> sp.)	White Empress
Resistant to all races	Stock (<i>Matthiola incana</i>)	Brompton mixed colours



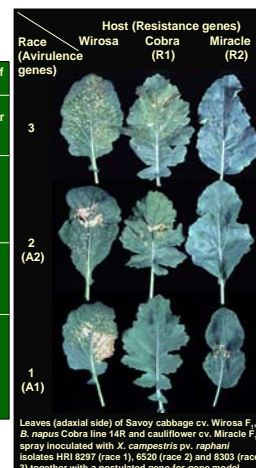
Radish French Breakfast 3 spray inoculated with HRI 8298 (race 1)



Identification of races

Frequency of occurrence, host of origin and geographical distribution of *Xanthomonas campestris* pv. *raphani* races amongst 25 isolates

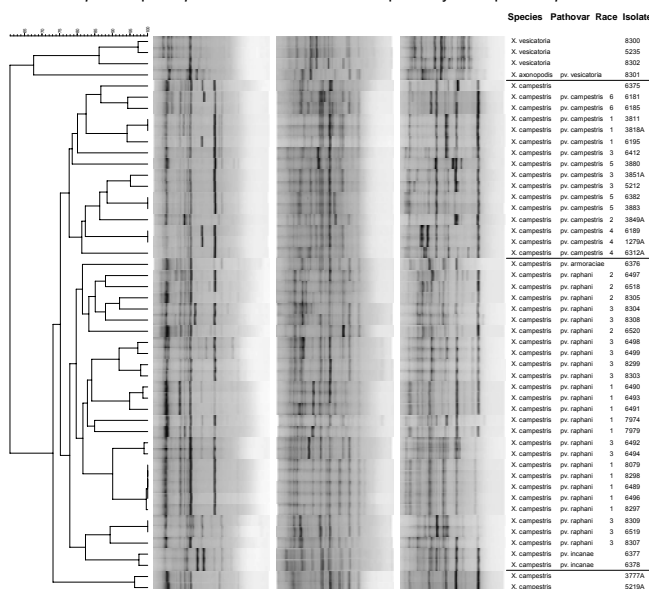
Race type	Host of origin (number of isolates)	Geographical origin (number of isolates)	Total number of isolates
1	<i>Brassica oleracea</i> (5) <i>Raphanus sativus</i> (2) Unknown (3)	France (3) Southern Hemisphere (2) US (2) Unknown (3)	10
2	<i>Brassica rapa</i> (3) Unknown (1)	Japan (2) USA (1) Unknown (1)	4
3	<i>Brassica oleracea</i> (4) <i>Brassica rapa</i> (2) <i>Raphanus sativus</i> (1) <i>Lycopersicon esculentum</i> (1) Unknown (3)	France (2) Japan (1) Canada (1) USA (4) E. Asia (1) Unknown (2)	11



Leaves (adaxial side) of Savoy cabbage cv. Wirosas F₁, *B. napus* Cobra line 14R and cauliflower cv. Miracle F₁ spray inoculated with *X. campestris* pv. *raphani* isolates HRI 8297 (race 1), 6500 (Race 2) and 8303 (race 3) together with a postulated gene-for-gene model.

rep-PCR fingerprinting

- High variability between *X. campestris* pv. *raphani* isolates even within the same race
- But *X. campestris* pv. *raphani* isolates clustered separately from pv. *campestris*



Dendrogram of genetic similarity of *Xanthomonas campestris* pv. *raphani* and other *Xanthomonas* isolates. Similarities were calculated from the combined data of REP, ERIC and BOX primer sets using Dice's coefficient. The dendrogram was obtained using the UPGMA method.
* The isolate HRI 6375 from candytuft (*Iberis* sp.) and the isolates HRI 3777A and HRI 5219A from wallflower (*Cheiranthus cheiri*) should be included in new *X. campestris* pathovars.

Comparison with other pathovars

- Causes a non-vascular disease
- Has a wide host range including most brassicas, ornamental crucifers, radish and tomato
- Causes leaf spots and dark sunken lesions as described by White (1930)
- *X. campestris* pv. *campestris*, *X. axonopodis* pv. *vesicatoria* and *X. vesicatoria* (syn. *X. campestris* pv. *vesicatoria*) have narrower host ranges
- *X. campestris* pv. *armoraciae* symptoms include leaf spots, but no sunken lesions and is strongly pathogenic on horseradish and only weakly pathogenic on some brassicas (McCulloch, 1929)

References:

McCulloch L. (1929) J. Agric. Res. 38: 269-287 White H.E. (1930) Phytopathology 20: 653-662

Conclusions

The *X. campestris* leaf-spot isolates studied here were identified as pv. *raphani* and not pv. *armoraciae*
A new type-strain (HRI 6519) and race-type-strains (HRI 6490, 8305, 6519) were assigned for *X. campestris* pv. *raphani*

Acknowledgements

This work was funded by the UK Defra.

We thank the following researchers for supplying some of their isolates: Margreet Asma, Hacène Bouzar, Diane A. Cuppels, John P. Damicone and Katsunori Tamura. We also thank Bio-Rad Laboratories Ltd for the use of Fingerprinting™ II.

