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Host range comparison of the causal agents of pepper yellow vein and lettuce big vein

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Abstract

A number of solanaceous and composite plant species were tested as hosts for the causal agents of pepper yellow vein (PYVA) and lettuce big vein (LBVA), transmitted by a pepper and a lettuce isolate of *Olpidium brassicae*, respectively. The agents had the following artificial hosts in common: *Lycopersicon esculentum, Solanum melongena, Physalis floridana, Nicandra physaloides, Lactuca sativa, Sonchus oleraceus* and *L. virosa*. *Capsicum annuum, S. villosum, S. nigrum, Crepis vesicaria* and *Senecio vulgaris* were infected by PYVA, but not by LBVA. *Cichorium endivia* and *Taraxacum officinalis* were not infected by any of the two agents. *N. physaloides*, although not colonized by the pepper isolate of *Olpidium*, still became infected by PYVA.

Additional keywords: soil transmission, chytrid fungus, *Olpidium brassicae*.

The exact nature of the causal agent of pepper yellow vein (PYVA), a viruslike disease of sweet pepper (*Capsicum annuum*), is still unknown. Like the agent causing lettuce big vein (LBVA) it is transmitted by the chytrid fungus, *Olpidium brassicae* (Fletcher et al., 1987). The natural hosts of LBVA are found among *Lactuca* spp. and a few other Compositae (Tomlinson and Garrett, 1964; Campbell, 1965). PYVA infects a number of Solanaceae and is particularly adapted to *Capsicum* spp., as is evident from typical yellow-vein symptoms produced after infection (Fletcher et al., 1987; Rast, 1988). However, this agent also caused a systemic, symptomless infection in lettuce (Rast, 1991a). This prompted a further comparison of the host range of PYVA and LBVA among both solanaceous and composite species.

Seeds of the test plants were germinated in moist, sterilized sand at 18 and 23 °C night and day temperatures respectively. Single seedlings were transplanted directly after emergence into 6.5-cm plastic pots filled with a sterilized mixture of two parts of a light sandy soil and one part of coarse sand. For each test, a batch of ten seedlings was used and placed in a plastic bowl to prevent cross contamination between tests. Tests with PYVA and LBVA were conducted in separate glasshouse compartments under natural light conditions at 18–20 °C for PYVA, and at 15–18 °C for LBVA. In winter, additional light was given to provide a daylength of 12 hours. The test plants were watered alternately with tap water and a nutrient solution throughout the observation period. The pepper and lettuce isolates of *O. brassicae*, used as inoculum for

the transmission of PYVA and LBVA, were propagated in sweet pepper 'Tisana' or lettuce 'Soraya' plants, respectively, and stored in dried root material as resting spores. Two methods of inoculation were used. In the 'wet' inoculation method the seedling roots together with the root system of a living, infected plant, previously checked for release of zoospores, were immersed in an aerated nutrient solution in a glass or plastic container for 1–6 days. Alternatively, the root system of an infected plant was immersed in tap water for one hour and removed prior to immersion of the seedling roots for 4–6 hours. In the 'dry' inoculation method about 0.01 g of powdered dry root material containing resting spores was placed in the hole before transplanting each seedling. Inoculated test plants were observed for symptom development and colonization of their roots by *O. brassicae* for a period of 10 weeks. Uninoculated plants served as controls and were similarly examined.

Starting about 4 weeks after inoculation, 3–5 root pieces of 2–3 cm each for each test plant were examined for the presence of *O. brassicae* using a microscope. Those plants where colonization was found were checked 2 weeks later. One of the plants with mature zoosporangia and resting spores in the roots was selected to determine whether the roots contained either PYVA or LBVA. This was done by back-inoculation to sweet pepper or lettuce using ten plants treated by the 'wet' method. When colonization by *O. brassicae* was unsuccessful another ten plants were treated using the 'dry' method. Regardless of whether symptoms were observed or not, the plants were also investigated for the agents in the aerial parts. This was done by growing rooted cuttings in coarse sand, which were transplanted in sterilized soil following 'dry' inoculation with PYVA- and LBVA-free *O. brassicae* isolates. When the fungus was established, one of the cuttings was used for back-inoculation. Systemic invasion of solanaceous plants inoculated with PYVA was sometimes tested by grafting onto sweet pepper.

In *L. esculentum, P. floridana, S. melongena, L. sativa, L. virosa* and *S. oleraceus* a moderate to dense colonization by *O. brassicae* was associated with the presence of PYVA and LBVA in the roots (Table 1). In *P. floridana* the aerial parts were symptomless although PYVA was shown to be present, and similarly in *L. esculentum* for LBVA. *S. oleraceus* produced systemic symptoms after inoculation with both agents.

There were minor differences between the three accessions of *S. oleraceus*, especially in the incubation time and intensity of the symptoms. When the plants were still in the rosette stage of growth, one accession reacted with veinal chlorosis with PYVA, while another accession showed similar symptoms with LBVA. In the flowering stage, the plants of all three accessions showed chlorotic vein banding with both agents in the leaves of the peduncle. The two accessions of *L. virosa* were also systemically infected by both agents, showing irregular patches of veinal chlorosis in senescent leaves. However, since the plants did not form flower it was not possible to test cuttings for systemic infection. Although a moderate to dense colonization by *O. brassicae* was found in *S. nigrum, S. villosum, C. vesicaria* and *S. vulgaris*, infection occurred with PYVA, but not with LBVA. As *S. nigrum* and *S. vulgaris* were not colonized by the lettuce isolate of *O. brassicae*, they could not be investigated for LBVA. Systemic infection of *S. villosum* by PYVA consistently caused mild vein clearing symptoms and irregular yellow spots. For *N. physaloides*, which did not show any colonization by the pepper isolate of *O. brassicae*, a systemic infection by PYVA was demonstrated by grafting. When ten plants of *C. annuum* 'Tisana' were each grafted with the top of

Table 1. Results of transmission tests with PYVA and LBVA by isolates of *Olpidium brassicae* from pepper and lettuce to solanaceous and composite plant species.

Plant species tested	Colonization by pepper isolate of *O. brassicae*	Infection by PYVA	Colonization by lettuce isolate of *O. brassicae*	Infection by LBVA
Solanaceae				
Capsicum annuum	++	++s	++	−
Lycopersicon esculentum	++	++	++	++
Nicandra physaloides	−	++ [a]	+	+
Physalis floridana	+	++ [a]	+	+
Solanum melongena	++	+	++	+
Solanum nigrum	++	++ [a]	−	.
Solanum villosum	++	++s	++	−
Compositae				
Cichorium endivia	±	−	−	−
Crepis vesicaria	+	+	+	−
Lactuca sativa	++	++	++	++s
Lactuca virosa	+	+	+	+
Senecio vulgaris	+	+	−	−
Sonchus oleraceus	++	++s	++	++s
Taraxacum officinalis	−	−	−	−

Colonization: ++ = dense, + = moderate, ± = poor, − = none.
Infection: ++s = systemic with symptoms, ++ = systemic without symptoms, + = root infection only, − = no infection, . = not tested.
[a] Systemic infection established by grafting.

a plant of *N. physaloides*, nine developed yellow-vein symptoms. In *N. physaloides* a moderate colonization by the vector of LBVA resulted in the recovery of the agent from the roots only.

Except for *S. villosum* and *L. esculentum*, none of the solanaceous plant species tested were shown to be susceptible to LBVA. *S. villosum* was already known as a passage host to free lettuce isolates of *O. brassicae* from LBVA (Van Dorst and Peters, 1988). The dense colonization of *L. esculentum* does not agree with the results reported by Tomlinson and Garrett (1964), but may be explained by the use of either different tomato cultivars or *O. brassicae* isolates (Temmink, 1971). Further results with LBVA, pertaining to the failure of its vector to colonize *C. endivia* and *T. officinalis* and to the symptoms observed in *L. virosa*, are consistent with those reported by Campbell (1965).

It has now been shown that the two agents have several hosts in common, but that PYVA infects a larger proportion of the plant species tested than LBVA. The question remains whether the species experimentally infected by PYVA could play a role as natural hosts of the agent. With LBVA Campbell (1965) postulated that a natural host should either show symptoms or should be capable of maintaining an infective *Olpidium* population for a period considerably longer than 12 weeks. When this criterion is applied to PYVA, only *C. annuum* (and other *Capsicum* spp.), *S. villosum* and *S.*

oleraceus would satisfy these conditions, as they showed symptoms. With the other plant species conclusions cannot be made as the plants were discarded after 10 weeks without examining the roots for the presence of *Olpidium*.

The pepper and lettuce isolates of *O. brassicae* showed clear differences in compatibility with *S. nigrum* and *N. physaloides*. *S. nigrum* was not colonized by the lettuce isolate of *O. brassicae* and it was impossible to detect LBVA, either by back-inoculation from roots or rooted cuttings, or by grafting. *S. nigrum* might have become infected if a compatible pepper isolate had been used as a vector. Work in progress indicates that the pepper isolate may acquire and transmit LBVA as effectively as the lettuce isolate (Rast, 1991b).

N. physaloides, on the other hand, while apparently not colonized by the pepper isolate of *O. brassicae*, was nevertheless found to become infected by PYVA. This plant species seems to permit the fungus only to penetrate root cells and release PYVA, but to inhibit further development of the fungus. Clearly, host/vector relations should be considered apart from host/agent relations.

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