Physalis angulata as a Local Lesion Host for Postharvest Indexing of Potato Virus A

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ABSTRACT

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Physalis angulata was the best local lesion host for potato virus A (PVA) of three *Physalis* species tested. It grows rapidly, has long, smooth leaves, produces few branches, and remains susceptible to PVA up to flowering and beyond. Local lesions developed in 7–10 days on intact leaves and in 4–5 days on detached leaves. Potato viruses X, Y, and M did not cause local necrotic lesions in *P. angulata.* However, potato virus X caused systemic mottling, and potato virus Y caused mild to severe mosaic and leaf drop. The local lesions produced by inoculation with PVA singly and in combination with each of the other viruses (M, X, Y) were very distinct and unaffected by the presence of the other viruses. Local lesions were produced at a temperature range of 15 to 25 C and at a light intensity range of 4 to 10 klux. Crude extract in glycine-phosphate buffer from various parts of the PVA-infected tubers caused lesions in *P. angulata.* PVA was detected in field-grown tubers either freshly harvested or stored for 1–3 mo at 10 or 25 C. The use of *P. angulata* as a local lesion host was as effective as enzyme-linked immunosorbent assay in detecting PVA in mixed infections.

It was previously reported (2) that *Physalis floridana* develops local lesions when inoculated mechanically with crude sap from potato plants infected with potato virus A (PVA). Later (3), it was shown that *P. angulata* and *P. pubescens* also develop local lesions when inoculated with sap containing PVA. Because potato virus Y (PVY) and PVA cause similar local lesions on intact leaves of *P. floridana,* the use of detached leaves was recommended for the detection of PVA from mixed infections. The detached leaves technique successfully eliminates expression of PVY; it is cumbersome, however, and intact leaves are preferred by most researchers.

Recent tests have shown that intact leaves of *P. angulata* can be used to detect PVA in mixed infections of potato viruses. A preliminary report has appeared elsewhere (5).

MATERIALS AND METHODS

The isolate of PVA used in previous studies (3,4) and maintained in potato cultivar Russet Burbank was mainly used as a source of virus from foliage. Various isolates from experimental plots were used in tuber testing. Potato foliar extracts containing PVA were used in initial studies, but later tests also involved potato sprout or tuber extracts. Unless stated otherwise, test plant seedlings were grown in a mix of soil, peat, and sand (4:1:1) in 12.5-cm clay pots in a greenhouse at 18–25 C with a light intensity of 3–5 klux. Further details of specific test conditions are described later in the paper. Inoculum prepared in glycine-phosphate buffer, pH 9.2 (0.05 M glycine, 0.03 M K_2HPO_4) was rubbed onto leaves dusted with Carborundum (600 mesh). Five or six leaves were inoculated on each plant, and eight to 10 plants were used in each test. Each test, except that on storage of tubers, was repeated at least three times.

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RESULTS

In general, seeds of *P. angulata, P. floridana,* and *P. pubescens* germinated readily, and seedlings grew normally throughout the year. Five to 7 wk were required for plants to grow five or six fully developed leaves. There was no difference in susceptibility to PVA between winter- and summer-grown plants, providing postinoculation conditions of low light (3–4 klux) and temperature (15–18 C) were maintained. In comparative tests using PVA in foliar sap, *P. angulata* leaves consistently showed a higher number of lesions than the other species; eg, in a typical test, average numbers of lesions were: *P. angulata,* 205 ± 4.5; *P. floridana,* 126 ± 7.8; *P. pubescens,* 151 ± 7.2. In addition, *P. angulata* leaves were generally larger and smoother than those of the other two species, and local lesions were much more distinct.

Once *P. angulata* was identified as the preferred local lesion host, studies were initiated on its susceptibility to other potato viruses and its response to various environmental conditions.

Reactions to potato viruses X, Y, and M. Necrotic local lesions were never observed on *P. angulata* plants inoculated with several isolates of PVX and PVY and with one isolate of PVM. However, some isolates of PVY occasionally caused water-soaked spots on inoculated leaves. The majority of PVX isolates caused only mottle in leaves of *P. angulata,* but certain ring spot isolates caused mosaic and severe leaf distortion. Vein-clearing, severe mosaic, and leaf drop were regularly observed in plants inoculated with PVY isolates. No symptoms were observed in plants inoculated with PVM, and the virus was not recovered from inoculated plants.

When *P. angulata* was inoculated with PVA and equal parts of PVM, PVX, and PVY, the only local lesions that developed were those typical of PVA. They were characterized by a light center and a darker periphery (3). There was no effect on the number of local lesions when these viruses were present in infected tissues.

Plant growth stage. *P. angulata* plants were highly susceptible up to 18 wk of age, as long as leaves from the main stems were used. Average numbers of local lesions from 57 or 58 leaves from various plant stages were: 6–8 wk, 187 ± 12.6; 11–14 wk, 246.3 ± 17.8; and 16–18 wk, 259 ± 17.4. Leaves from branches showed erratic lesion development and fewer lesions. Older plants appeared to be more susceptible to PVA.

Light intensity. Larger numbers of local lesions developed on plants kept at light intensities of 4–6 klux (average of 46 ± 3.2 lesions from 92–102 leaves) than at 8 and 10 klux (average of 16 ± 1 lesions from 83 leaves). However, even at 10 klux, distinct local lesions were produced consistently on all inoculated leaves.

Temperature. Generally, greatest numbers of PVA local lesions developed at 15–25 C; average numbers of lesions on 75–79 leaves at 15 C were 37.2 ± 3.5; at 20 C, 31.5 ± 2.8; at 25 C, 30.4 ± 2.9; at 33 C, 0.6 ± 0.2. Local lesions that developed at 15 C were small and light gray, whereas those at 25 C were more distinct, larger, and darker (Fig. 1).

Intact leaves vs detached leaves. Both intact and detached leaves of *P. angulata* were inoculated with sap containing PVA from upper leaves, lower leaves, stem pieces, sprouts, and tubers of potatoes. Lesions appeared in 4–5 days on detached leaves that were maintained under humid conditions and in 7–10 days on intact leaves; otherwise, there was no difference in results using detached or intact leaves.

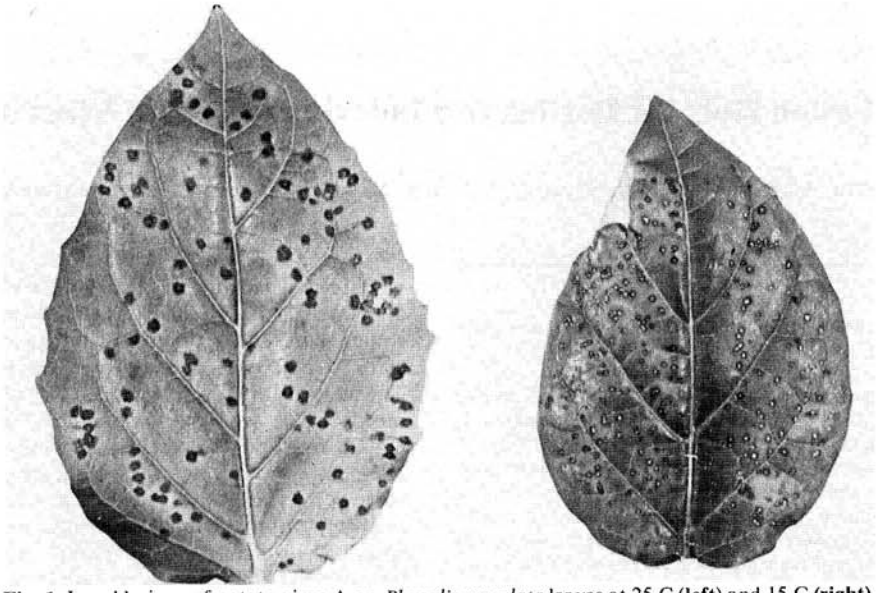

Fig. 1. Local lesions of potato virus A on *Physalis angulata* leaves at 25 C **(left)** and 15 C **(right).**

Table 1. Suitability of potato tuber parts for indexing of potato virus A on *Physalis angulata*

Tuber part[a]	Lesions[b]
Sprouts	26.5 ± 2.4
Bud end	8.5 ± 0.9
Midtuber	4.5 ± 0.4
Stem end	4.5 ± 0.5

[a] One gram of tissue was ground in 2 ml of glycine-phosphate buffer and inoculated onto leaves of *P. angulata*.
[b] Data are averages from 60 leaves in three experiments.

Table 2. Indexing of tubers for potato virus A (PVA) with *Physalis angulata*

Storage	No. infected/ total tubers tested[a]
Within 1 wk of harvest	60/66
6 wk at 25 C, dark	20/22
12 wk at 25 C, dark	21/22
6 wk at 25 C, light	22/22
12 wk at 25 C, light	22/22
6 wk at 10 C	22/22
12 wk at 10 C	21/22

[a] One gram of tissue was ground in 2 ml of glycine-phosphate buffer and inoculated onto five leaves of *P. angulata*, one plant per tuber.

Suitability of tuber parts. Tubers were obtained from potato plants infected with 15 PVA isolates in an experimental plot, and four *P. angulata* leaves were inoculated with sap from each tuber sample. The greatest number of lesions was obtained with inoculum from tuber sprouts, and inoculum from the bud end developed twice as many lesions as that from the stem end or the midtuber (Table 1).

In another test, 60 of 66 *P. angulata* plants inoculated with sap from bud-end tissues from freshly harvested tubers developed local lesions resulting from PVA (Table 2). After storage for 6 and 12 wk under various conditions, almost all tubers gave a positive assay for PVA. The PVA detection increased in tubers that were stored 6–12 wk at 25 C under light.

Field surveys. During the summer of 1981, 116 samples of potato foliage showing various degrees of mottle or mosaic were collected from commercial fields in New Brunswick, Canada. Buffered extract from each sample was inoculated onto *P. angulata* plants, and part of each sample was also tested for PVA and PVY by enzyme-linked immunosorbent assay (4). Fifty of the samples were infected with PVY alone, based on systemic symptoms; 25 were infected with PVA, based on local lesions; and 7 contained both PVA and PVY. These results were in full agreement with those of the enzyme-linked immunosorbent assay tests.

DISCUSSION

Although *P. floridana, P. angulata,* and *P. pubescens* have been reported as not susceptible to PVA (1), our tests consistently demonstrated local lesions in these species from various seed sources when they were inoculated with PVA. Furthermore, *P. angulata* has particular advantages as a host for PVA in that intact leaves can be used to detect PVA in mixed infections of PVX or PVY, and it remains susceptible beyond the flowering period and under wider light and temperature conditions than *P. floridana* (3). It is also an excellent host for postharvest indexing because *P. angulata* is equally susceptible to PVA in extracts from freshly harvested or stored tubers.

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