Pepper Veinal Mottle Virus in the Weed *Physalis angulata* in the Ivory Coast

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ABSTRACT

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Pepper veinal mottle virus was isolated from *Physalis angulata* showing vein yellowing and mosaic of infected leaves. The virus was identified on the basis of host range and physical and serological properties. Symptoms were reproduced in healthy *P. angulata* by mechanical inoculation with purified virus or with crude sap from infected *P. angulata*. No other viruses were associated with the disease. Natural infection of *P. angulata* by pepper veinal mottle virus has not been reported previously.

Physalis angulata L. is a common weed in tomato, pepper, eggplant, and other vegetable crops in the southern region of the Ivory Coast. Vein yellowing and mosaic, symptoms that resemble those of pepper veinal mottle virus (PVMV) infection in *P. floridana* L., are often seen in *P. angulata*. From this plant, I isolated a virus with filamentous particles that was transmissible by aphid and by mechanical inoculation of sap and that induced the same symptoms in *P. angulata* under screenhouse conditions as seen in the field. The virus appeared to be identical to PVMV. The following study was done to confirm this identification.

MATERIALS AND METHODS

Virus propagation and properties. The source of virus was a *P. angulata* plant growing in a tomato and pepper crop. The virus was isolated from infected *P. angulata* by grinding leaf tissue in cold 0.05 M phosphate buffer, pH 7, containing 1% sodium sulfite and rubbing the tissue onto Carborundum-dusted leaves of *P. floridana* and *Nicotiana megalosiphon* Heurck Müll. The virus was maintained on *P. floridana* and *N. megalosiphon*.

For host range studies, 15–20 plants of each species tested were used. Back-inoculation tests were done by inoculation of sap from all species tested (with or without symptoms) on six plants of *P. floridana* or *N. megalosiphon*. For insect transmission tests, *P. floridana* served as virus source; *P. angulata*, *Nicotiana* × *edwardsonii* Christie & D. W. Hall, and *N. clevelandii* Gray served as test species. Nonviruliferous aphids (*Aphis gossypii* Glover) starved for 2–4 hr were placed on the plants for acquisition and inoculation feeding periods of 2 min. Twenty aphids per plant were used for *P. angulata* and five per plant for *Nicotiana*×*edwardsonii* and *N. clevelandii*. All test plants were grown in screenhouses where temperatures varied from 28 to 35 C during the day and relative humidity was always 90–100%.

Properties in crude sap. Undiluted sap from young leaves of systemically infected *N. megalosiphon* and *P. floridana* was used to determine the thermal inactivation point, dilution endpoint, and longevity in vitro of the virus using the methods of Bos et al (1). Six plants of *P. floridana* or *N. megalosiphon* were used to assay each treatment.

Purification and electron microscopy. The virus was purified according to the method of Thouvenel et al (11) with few modifications. Leaves of *N. megalosiphon* infected for 15 days were homogenized in 0.5 M sodium borate buffer, pH 8.2, containing 1 M urea and 1% mercapto-ethanol. After the first centrifugation (7,000 *g*, 20 min) and prior to the Triton X-100 treatment, the extract was clarified by adding $CHCl_3$ (25%) followed by slow-speed centrifugation. Preparations were stained with 0.5% uranyl acetate and examined in a Siemens Elmiskop 102.

Serology. The microprecipitin reaction under paraffin oil (12) was used for serological tests. It was performed either with purified virus or with crude sap of diseased leaves of *N. megalosiphon*. For the latter, plant sap was clarified with an equal volume of $CHCl_3$ prior to testing. No antiserum was prepared against the virus of *P. angulata*. Antisera against PVMV isolate from Ghana (PVMV-Gh) (4) with a homologous titer of 1/4,096 and PVMV isolate from the Ivory Coast (PVMV-CI) (6) with a homologous titer of 1/4,096 were used.

RESULTS AND DISCUSSION

Host range and properties. *P. angulata* reacted with vein yellowing, mosaic, leaf malformation, and reduction of leaf and plant size. These symptoms were also observed in *Capsicum annuum* L. 'Carré doux d'Amérique,' *C. frutescens*, *P. floridana*, and *N. megalosiphon;* they were very similar to these produced by PVMV-CI. *C. annuum*, *C. frutescens*, *Hyoscyamus niger* L., *Lycopersicon esculentum* Mill. 'Money Maker,' *N. clevelandii*, *N. glutinosa* L., *N. megalosiphon*, *Physalis alkekengi*, *P. floridana*, and *P. peruviana* L. developed systemic symptoms. *H. niger* and *N. megalosiphon* reacted with necrotic and chlorotic local lesions. *Gomphrena globosa* L. was a symptomless host. The following species were not infected: *Celosia argentea* L., *Cucumis melo* L., *Chenopodium ambrosioides* L., *Passiflora edulis* Sims, *Brassica pekinensis* Rupr. 'Petsai,' and *Pisum sativum* L. 'Onward.'

In undiluted sap from *P. floridana* (one test), the virus had a dilution end point between 10^{-2} and 10^{-3}; in undiluted sap from *N. clevelandii*, the dilution end point was between 10^{-3} and 10^{-4}, the thermal inactivation point was between 55 and 60 C, and longevity in vitro was between 8 and 9 days at 24–26 C.

A. gossypii transmitted the virus in a nonpersistent manner, with transmission rates of 81, 50, and 73% when *P. angulata*, *N. clevelandii*, and *Nicotiana* × *edwardsonii*, respectively, were used as test plants.

Electron microscopy. Grids prepared from infectious crude sap (dipping method) (2) or purified virus showed filamentous, flexuous particles very similar to these of PVMV-CI.

Serology. Antiserum against PVMV-CI had a titer of 1/4,096 either with purified PVMV-CI antigen or with the virus from *P. angulata*. Antiserum against PVMV-Gh had a titer of 1/4,096 with the virus from *P. angulata*. No serological difference between PVMV-CI, PVMV-Gh, and the virus isolated from *P. angulata* could be demonstrated. These results confirmed those obtained by J. J. de Wijs (6).

Results indicate that the virus isolated from *P. angulata* is identical to PVMV-CI. The common weed *P. angulata* is a new host for PVMV-CI and can be a good reservoir of the virus. *A. gossypii*, the potential vector, is very common in the Ivory Coast, where PVMV has already been isolated from pepper (*Capsicum frutescens*), sweet pepper (*C.*

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annuum), *Datura metel* (6), tomato, and eggplant (7). Therefore, because the vector and the virus sources are often present, PVMV can spread either in one or another crop or in the weed *P. angulata*. PVMV has been reported from pepper, sweet pepper, and *Petunia hybrida* in Ghana (4); from tomato and pepper in Nigeria (3,8–10); and from tobacco and *Solanum nigrum* in Kenya, *D. stramonium* in the Republic of South Africa, and eggplant and scarlet (*S. integrifolium*) in Ghana (5). This is the first report of PVMV in *P. angulata*.

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