A Comparison of Some Properties of Elm Mosaic and Tomato Ringspot Viruses

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Accepted for publication 13 August 1969.

ABSTRACT

Although a unilateral protection can be demonstrated between tomato ringspot virus (TmRSV) and elm mosaic virus (EMV), and the two viruses are strikingly similar in physical properties, host range, and symptoms, a study of serological and vector relationships indicates that the two are distinct. Serological comparisons of EMV and several isolates of TmRSV revealed no cross reactions. All isolates of TmRSV were transmitted by *Xiphinema americanum,* but EMV was not. Phytopathology 60:114-115.

Elm mosaic has been observed on elms in midwestern United States for many years (13). Varney & Moore (14) mechanically transmitted a virus from mosaic-affected elms to herbaceous hosts, and suggested that the virus was closely related to tomato ringspot virus (TmRSV). In addition to similarities in host range and physical properties, they demonstrated unilateral protection with TmRSV. TmRSV protected against elm mosaic virus (EMV) but EMV did not protect against TmRSV. Recent studies on nematode transmission to be described here suggest that EMV differs from TmRSV. For this reason, the serological relationship of EMV of TmRSV was investigated.

MATERIALS AND METHODS.—Our isolate of EMV was obtained from an American elm (*Ulmus americana* L.) in Madison, Wisconsin. Its characteristics were similar to those described by Varney & Moore (14) for EMV. Isolates of TmRSV included a type isolate (ATCC No. 13), grape yellow vein virus (5), and peach yellow bud virus (2, 6) (supplied by R. G. Grogan), a birdsfoot trefoil isolate (8) (supplied by S. A. Ostazeski), and a raspberry isolate (11) (supplied by R. Stace-Smith).

EMV and TmRSV were purified from infected cucumber (*Cucumis sativus* L. 'Model') by the method of Stace-Smith (12). Antiserum to each virus was obtained from rabbits that received intramuscular injections of virus emulsified in Freund's complete adjuvant. Rabbits were bled several times, beginning 2 weeks after the third weekly injection, and all serum from a rabbit was combined. On agar double-diffusion plates, each antiserum reacted with its homologous virus at dilutions of 1:1024 in saline, but not beyond.

Cross-protection tests were conducted with tobacco (*Nicotiana tabacum* L. 'Havana 38'). To insure that both viruses became systemic, very small plants with two or three leaves less than 2.5 cm long were inoculated and illuminated 18 hr/day with artificial light. Symptomless leaves were produced after systemic symptoms appeared, and cross-protection tests were made on these. Because the viruses produced more severe necrosis at shorter day lengths, plants were incubated at 12-hr day lengths after the challenge inoculation.

Methods for nematode transmission trials were essentially as have been described (7). *Xiphinema americanum* Cobb were obtained from a soil-bed planted with Sudan grass (*Sorghum vulgare* var. *sudanense* [Piper] Hitchc.) in the greenhouse. The culture of *X. diversicaudatum* (Micoletzky) (supplied by R. Reidel, Cornell) was increased in the greenhouse in pots planted with multiflora rose (*Rosa multiflora* Thunb.). Cucumber (*Cucumis sativus* L. 'Model') was used as a host for virus acquisition by the nematodes, and as a bait plant for evaluation of transmission. In one trial with *X. diversicaudatum, Pisum sativum* L. 'Alaska' was used as an acquisition and bait plant.

Groups of nematodes were allowed acquisition access periods of 7 to 10 days on infected plants. Nematodes, either singly or in groups, were transferred from the acquisition plants to bait plants. After 30 to 40 days, roots and tops of bait plants were indexed by mechanical inoculation to cucumbers and cowpeas (*Vigna sinensis* [Torner] Savi 'Monarch'). In all cases of positive transmission, virus was identified by testing sap of infected plants with antisera to either TmRSV, EMV, or tobacco ringspot virus (TRSV) on agar double diffusion plates.

RESULTS.—*Serology.*—Using the agar gel double-diffusion test, the antiserum prepared against TmRSV reacted with all isolates of TmRSV, but not with EMV. The antiserum prepared against EMV reacted with EMV, but with none of the isolates of TmRSV.

Cross-protection.—Cross-protection tests confirmed the results of Varney & Moore (14). Tobacco infected by TmRSV did not become infected when inoculated with EMV. Tobacco infected by EMV on the other hand, did become infected when inoculated with TmRSV. The complete invasion of the leaves of EMV-infected plants by EMV was apparent from the absence of local symptoms when they were reinoculated with EMV. Lesions caused by TmRSV or EMV-infected tobacco were not as large as on plants infected only with TmRSV, but were as numerous.

Nematode transmission.—All isolates of TmRSV were transmitted by *X. americanum,* both by single nematodes and by groups of nematodes. The amount of transmission varied in each trial, and was somewhat more erratic than transmission of TRSV by *X. americanum,* as has been reported (4). No transmission of

EMV by *X. americanum* was obtained in numerous trials with single nematodes or with groups of nematodes. In some trials the acquisition plants were infected with both EMV and TmRSV on TRSV. In such cases only TmRSV or TRSV was transmitted. No transmission of EMV, TmRSV, or TRSV occurred in two trials with *X. diversicaudatum*.

DISCUSSION.—EMV is similar to TmRSV in physical properties and host range (14). In greenhouse culture, the similarity of symptoms produced by the two viruses under varying environmental conditions is impressive. In their serological reactions and vector relationships, however, the viruses are distinct. Their behavior in reciprocal cross-protection tests resembles the interaction reported between severe etch virus and potato virus Y (1), in which etch virus can infect plants already infected with Y virus, and eventually replaced Y virus. Potato virus Y apparently did not infect etch virus-infected plants. However, Schmelzer et al. (10) reported that Y virus strains did superinfect etch virus-infected plants, and usually caused additional symptoms. We did not attempt to reisolate EMV after inoculating TmRSV-infected plants, but no symptoms of EMV developed. It seems important to differentiate these reactions from true cross-protection.

The characteristics of EMV suggest that it is nematode-transmitted, although results of this study have failed to demonstrate a nematode vector. The limited trials with *X. diversicaudatum* were not extensive enough to eliminate this nematode as a possible vector, but the trials with *X. americanum* indicate that it is not a vector under conditions favorable for the transmission of TRSV and TmRSV. EMV is readily transmitted by pollen (3), and this may account for its wide distribution.

A virus with some properties similar to EMV was isolated from elms and lilac in northern Europe by Schmelzer (9). As indicated in his paper, our antiserum to EMV was supplied to him, and no relationship between EMV and elm mottle virus was demonstrated.

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