Orchard Weeds as Hosts of Tomato Ringspot and Tobacco Ringspot Viruses

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ABSTRACT

Powell, C. A., Forer, L. B., Stouffer, R. F., Cummins, J. N., Gonsalves, D., Rosenberger, D. A., Hoffman, J., and Lister, R. M. 1984. Orchard weeds as hosts of tomato ringspot and tobacco ringspot viruses. Plant Disease 68:242-244.

Forty-two species of weeds from 22 families were collected from apple or peach orchards where tomato ringspot virus (TmRSV)-induced diseases were found in Indiana, New York, and Pennsylvania and analyzed for TmRSV and tobacco ringspot virus (TbRSV) by the enzyme-linked immunosorbent assay (ELISA). Plants from 21 species representing 12 families were found infected with TmRSV. In addition, eight species representing six families were found infected with TbRSV. The species with the highest frequency of infection with TmRSV were *Taraxacum officinale* (dandelion), *Rumex acetosella* (sheep sorrel), and *Stellaria* spp. (common chickweed). These results are discussed with regard to the epidemiology of TmRSV-induced orchard diseases and the importance of weed control as a component of integrated orchard management programs.

Additional key word: nepoviruses

Tomato ringspot virus (TmRSV) is a member of the nepovirus group (7). It is transmitted by the nematodes *Xiphinema americanum* Cobb (18) and *X. rivesi* Dalmasso (5).

TmRSV is associated with diseases of many commercial fruit crops, including peach (1,14), grape (4,6,19), raspberry (15), sweet cherry (10), prune (9), blueberry (8), apple (16), and strawberry (3). Two of these diseases, prunus stem-pitting (PSP) of stone fruits and apple union necrosis and decline (AUND), are of prime importance in the northeastern United States. These diseases are of major concern because 1) they can cause significant economic loss in affected orchards, 2) their incidence has increased dramatically in the last 20 yr, and 3) they have not been controlled at the orchard level by implementation of "virus-free" nursery-stock programs.

Recently, it was shown that common orchard weeds may be reservoirs of TmRSV (12). This prompted an extensive, cooperative survey in Pennsylvania, New York, and Indiana to determine the prevalence of TmRSV in weeds in orchards with TmRSV-induced diseases. The results of this survey are presented in this report.

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MATERIALS AND METHODS

Pennsylvania. Two apple orchards and two peach orchards with TmRSV-induced disease were selected as sites for the survey. A 1-m^2 sample area was randomly selected at each site. Each sample area was divided into four equal sections. All broadleaf weeds present in each section, up to a maximum of five plants per species per section, were sampled and analyzed for virus by mechanical inoculation to *Chenopodium quinoa* Willd. and *Nicotiana tabacum* L. 'Samsun' (1 g weed root and leaf tissue triturated in 2 ml 0.01 M potassium phosphate, pH 7.0). The virus isolates obtained were assayed for TmRSV and TbRSV by enzyme-linked immunosorbent assay (ELISA) (2), using antisera to local virus isolates. Weeds were sampled and assayed in the fall and again the following spring.

New York. Weeds from apple orchards showing AUND were sampled and tested for TmRSV and TbRSV by ELISA as described previously (13) using antisera to local virus isolates.

Indiana. Weed plants were randomly collected from orchard sites known to contain TmRSV- and TbRSV-transmitting *Xiphinema* spp. The weeds were triturated in potassium phosphate buffer, pH 7.0, and the extracts were stored frozen at 20 C. After sampling was complete, the extracts were thawed and tested directly for TmRSV and TbRSV by ELISA, using antisera to local virus isolates.

RESULTS

Twenty-one weed species representing 12 families were found infected with tomato ringspot virus in one or more locations (Table 1), attesting to the wide natural host range of this virus. Many of these same weed species were also infected with TbRSV. None of the infected weeds showed virus symptoms. Some dandelions were infected with both TmRSV and TbRSV.

In Pennsylvania, where weeds were indexed by mechanical inoculation before ELISA, five dandelions and one of all three species of plantain were found to contain an unknown virus(es) that produced nepoviruslike symptoms in *C. quinoa* and tobacco but did not react with either TmRSV or TbRSV antiserum. This result points out the need for serological confirmation of virus isolates recovered in surveys of this type.

There were 20 weed species representing 14 families in which neither TmRSV nor TbRSV was detected. They are as follows (the number after the Latin binomial indicates the combined number of each species analyzed from all three states represented in the survey: *Asclepias syriaca* 3 (common milkweed), *Campsis radicans* 1 (trumpet creeper), *Sambucus canadensis* 1 (elderberry), *Cerastium* spp. 10 (mouse-ear chickweed), *Ambrosia artemisiifolia* 3 (common ragweed), *Convolvulus spithameus* 12 (shade bindweed), *Arabidopsis thaliana* 27 (mouse-eared cress), *Capsella bursa-pastoris* 5 (shepherd's purse), *Lamium amplexicaule* 4 (henbit), *Morus* spp. 1 (mulberry), *Oenothera biennis* 1 (evening primrose), *Oxalis dillenii* 31 (yellow wood sorrel), *Potentilla canadensis* 19 (common cinquefoil), *Rosa* spp. 3 (wild rose), *Rubus allegheniensis* 14 (Allegheny blackberry), *Veronica* spp. 46 (speedwell), *Solanum carolinense* 8 (horse nettle), *Solanum dulcamara* 2 (bitter nightshade), *Parthenocissus cinquefolia* 1 (Virginia creeper), and *Vitis* spp. 3 (wild grape).

DISCUSSION

Although both TmRSV and TbRSV were detected frequently in orchard weeds, TmRSV is the virus of primary concern. TmRSV is the causal agent of PSP (14) and is the putative causal agent of AUND (13,17). TbRSV was reported

to cause a disease in cherry (20) and was detected in peach (21), but it has not been detected in apple. TbRSV is probably not a serious pathogen in tree fruit, but critical experiments to evaluate this hypothesis are not complete.

For a weed species to be an economically important reservoir of TmRSV, it must meet the following four criteria. First, the virus must be able to infect and multiply in the particular species of plant identified. Second, the reservoir species should be present in high density. The nematode vectors of TmRSV are endemic in most eastern fruit-growing areas of the United States (*unpublished*) but are not very mobile; therefore, a high density of the weed reservoir would favor efficient transmission of the virus from weed to fruit tree, fruit tree to weed, and weed to weed. We might have detected TmRSV in some of the weed species that indexed negative in our survey if we had sampled more plants. However, these weeds are relatively rare in most orchards and do not meet the second criterion for economically important TmRSV reservoirs. Third, an important TmRSV reservoir should have a perennial growth habit to provide a continuous source of virus for the nematode vector and a means for the virus to overwinter. Annual weed hosts would not fulfill either of these requirements unless the virus were efficiently seed-transmitted. The fourth criterion for important weed reservoirs of TmRSV is that the weed must be able to serve as an efficient virus donor for the nematode vector.

Of the species surveyed in these studies, the only weed known to fulfill these four criteria is common dandelion. In addition, TmRSV is transmitted in dandelion seed (11). Sheep (red) sorrel probably also fulfills the criteria, but nematode transmission experiments with this weed have not been performed. Wild strawberry is also probably an important reservoir in individual orchards where it is prevalent. Common chickweed is frequently infected with TmRSV; however, it is an annual. The three plantain species were found to be infected with TmRSV in Pennsylvania; one species was infected in New York but none were infected in Indiana. Wild carrot appears to be a good host for TmRSV, but this plant is not commonly found in maintained orchards; it could be important in fields that are left fallow before orchard establishment because wild carrot is often prevalent in such fields.

Table 1. Analysis of common orchard weeds for tomato ringspot virus and tobacco ringspot virus infection

Latin name	Common name	Type of plant[a]	IN		NY		PA[b]	
			Tm	Tb	Tm	Tb	Tm	Tb
Caryophyllaceae *Stellaria* spp.	Common chickweed	HA	3/10	1/10	···	···	3/18	0/18
Chenopodiaceae *Chenopodium album*	Lamb's-quarters	HA	1/18	0/18	···	···	···	···
Compositae *Aster pilosus*	White-head aster	HP	···	···	···	···	2/21	0/21
Compositae *Chrysanthemum leucanthemum*	Oxeye daisy	HP	···	···	···	···	1/1	0/1
Compositae *Cirsium vulgare*	Common thistle	HB	···	···	···	···	1/9	0/9
Compositae *Taraxacum officinale*	Common dandelion	HP	16/34	28/34	189/337[c]	11/32[c]	80/136	22/136
Cruciferae *Brassica kaber*	Wild mustard	HB	···	···	···	···	1/2	1/2
Cruciferae *Coronopus didymus*	Swine cress	HA,HB	···	···	···	···	1/1	1/1
Cruciferae *Lepidium densiflorum*	Pennycress	HA,HB	···	···	···	···	8/8	2/8
Euphorbiaceae *Euphorbia esula*	Leafy spurge	HP	···	···	1/1	0/1	···	···
Euphorbiaceae *Euphorbia supina*	Prostrate spurge	HA	···	···	···	···	1/1	0/1
Leguminosae *Trifolium pratense*	Red clover	HB	···	···	0/3	0/3	9/21[d]	···
Leguminosae *Trifolium repens*	White clover	HP	···	···	···	···	15/40[d]	···
Phytolaccaceae *Phytolacca americana*	Common pokeweed	HP	0/1	0/1	1/1	0/1	···	···
Plantaginaceae *Plantago lanceolata*	Buckhorn plantain	HP	0/5	0/5	0/11[c]	1/4[c]	5/41	5/41
Plantaginaceae *Plantago major*	Broadleaf plantain	HP	0/12	0/12	2/9[c]	0/9[c]	2/17	0/17
Plantaginaceae *Plantago rugelii*	Common plantain	HP	···	···	···	···	3/6	0/6
Polygonaceae *Rumex acetosella*	Sheep sorrel (red)	HP	1/4	0/4	5/35	0/35	3/6	0/6
Polygonaceae *Rumex crispus*	Curly dock	HP	0/2	1/2	0/4	0/4	···	···
Rosaceae *Fragaria vesca*	Wild strawberry	HP	1/3	0/3	5/25	0/25	···	···
Scrophulariaceae *Verbascum thapsus*	Common mullein	HB	···	···	4/10	0/10	···	···
Umbelliferae *Daucus carota*	Wild carrot	HB	···	···	···	···	8/8	2/8

[a] WP = woody perennial, HP = herbaceous perennial, WA = woody annual, HA = herbaceous annual, and HB = herbaceous biennial.
[b] IN = data from Indiana, NY = data from New York state, PA = data from Pennsylvania, Tm = number of plants infected with TmRSV per number tested, Tb = number of plants infected with TbRSV per number tested, and ··· = test was not conducted.
[c] Number of three plant composite samples.
[d] Results from a separate experiment in which clover samples were randomly collected from eight orchards.

In order for susceptible tree fruit crops to become infected with TmRSV, three components must be present: a source of the virus, the dagger nematode vector, and conditions favorable for the nematode to vector the virus. Control of PSP and AUND diseases requires inclusion of procedures to reduce these components in the integrated orchard management program. Our data suggest that orchard weeds are a critical factor in the epidemiology of TmRSV-induced diseases in fruit crops. They probably serve as a primary source of TmRSV, and their presence could greatly increase the probability that dagger nematodes feeding on the fruit crop will be viruliferous. Therefore, we recommend that rigorous broadleaf weed control be a primary component of integrated orchard management programs.

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