# ALTERNATE HOSTS OF THE FLORIDA TOMATO GEMINIVIRUS

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## Introduction

Since its first appearance in the fall of 1989, a new disease of tomato caused by the Florida tomato geminivirus (FTGV) has become an important limiting factor for tomato production in the southern half of the state. Common symptoms of FTGV in tomato includes mosaic, stunting, distortion of shoots and leaves and reduced yields. The virus is vectored (spread) by *Bemisia tabaci*, the sweetpotato whitefly (SPWF) (3).

Alternate hosts including both weeds and cultivated plants often play key roles in the epidemiology of plant viruses by providing reservoirs for the virus itself and/or its vectors. A number of important weed hosts have been identified for aphid-vectored viruses in Florida (1). Our goal is to gain fundamental knowledge concerning the host range of FTGV so that effective management strategies may be developed.

## Methods

**Field Surveys** - Samples of symptomatic and nonsymptomatic weeds were collected, for the most part, from within and around tomato fields in southwest Florida exhibiting a high incidence of geminivirus. Weed surveys were conducted both during and after the spring, 1991 cropping season. Over 590 samples representing 39 species in 14 families (Caprifoliaceae, Commelinaceae, Compositae, Convolvulaceae, Cruciferae, Cucurbitaceae, Euphorbiaceae, Leguminosae, Malvaceae, Myrtaceae, Onagraceae, Rubiaceae, Solanaceae, Urticaceae) were tested for the presence of FTGV. Virus detection was accomplished by means of nucleic acid hybridization assays (dot-blots) which utilized nucleic acid probes complementary to FTGV. Two probes were used; one (A-probe) is general in scope and detects SPWF-transmitted geminiviruses, while the other (B-probe) is highly specific for FTGV. Sweetpotato whiteflies collected from certain weeds in the field were also assayed in the same manner.

**Transmission Studies** - Virus inoculum was originally obtained from cuttings of an infected, field-grown tomato plant (*Lycopersicum esculentum* (L). Karst. ex Farw. 'Sunny') which exhibited typical FTGV symptoms. Two different methods were utilized for virus acquisition by SPWF. In one method infected tomato plants were used to rear colonies of viruliferous SPWF while nonviruliferous colonies of SPWF were maintained on tomatoes free of FTGV. Alternatively, SPWF from an nonviruliferous colony were allowed an acquisition time of 48-72 hours on FTGV-infected tomatoes before being transferred to test plants.

Three controls were used for each experiment: (1) test plant species exposed to nonviruliferous SPWF, (2) tomatoes exposed to nonviruliferous SPWF, and (3) tomatoes exposed to viruliferous SPWF. The fourth treatment consisted of the weeds and cultivated plants exposed to viruliferous SPWF. Each treatment consisted of 4-12 seedlings which were maintained in screened cages in transfer rooms under fluorescent lights at 23-25C/73-77C or in a greenhouse at 21-37C/70-100F. Approximately 250 SPWF (~20 SPWF/plant) were introduced into the cages and allowed to feed for 48-72 before being killed with insecticide. In a number of cases transmission to 'Sunny' tomatoes from certain field collected weeds exhibiting geminivirus-like symptoms was also attempted via SPWF and mechanical means. Approximately 250 SPWF were introduced into cages containing symptomatic weed plants and allowed to feed for 24 hours. Eight tomato plants were then placed in the cages. Whiteflies were augmented on a weekly basis for 3-4 weeks.

Attempts to mechanically transmit virus to tomato from symptomatic weeds used pulverized tissue (1:10, W/V) in a buffer containing 0.1 M $KH_2PO_4$ containing 0.2% mercaptoethanol at a Ph of 7.4. Virus inoculum was rubbed on the leaves of test plants coated with carborundum (320 grit) using cotton tip applicators. Positive controls were inoculated with either macerates from FTGV-infected tomatoes and negative controls received buffer alone. Mechanically inoculated plants were maintained as above.

Over 240 plants representing 23 species in 8 families (Compositae, Cruciferae, Cucurbitaceae, Euphorbiaceae, Leguminosae, Malvaceae, Onagraceae, Solanaceae) were inoculated via SPWF or mechanical means. All experimental plants were monitored for virus symptom expression for 3-4 weeks. In the case of the mechanical transmission attempts test plants were cut back and symptom expression was monitored for an additional 3-4 weeks. Detection of FTGV in test plants also utilized dot-blot assays. Individual SPWF from positive and negative colonies were probed for FTGV in the same manner.

## Results and Discussion

Whitefly transmission of FTGV from tomato to tomato (positive controls), based on expression of typical symptoms and dot-blot assays averaged above 75%. Mechanical transmission from tomato to tomato ranged from 25-30%. Three of 8 SPWF from the FTGV-infected colony gave a strong positive reaction, 5 gave a weak positive and all of the whiteflies from the FTGV-free colony tested negative by means of dot-blots. None of the test plants exposed to SPWF from the FTGV-free colony developed symptoms or tested positive for FTGV.

Three symptomatic field-collected weed species, *Sida acuta* Burm. f. (Teaweed), *Sida* *hombifolia* (Indian Hemp) and *Macroptilium lathyroides* (Benth.) Urban (Phasibean) and one symptomatic cultivated species, *Euphorbia millii* Desmoul. (Crown of Thorns) tested positive only with the A-probe indicating infection with a geminivirus distinct from FTGV. Five nonsymptomatic weed species, *Ludwigia erecta* (L.) Hara., *L. decurrens* Walt., (Water primrose) *Chamaesyce hypericifolia* (L.) (Spurge), *C. hirta* (L.) Millsp. (Hairy Spurge) and *Sesbania* sp. (Sesban) tested positive with both A and B probes indicating probable infection with FTGV. It is interesting to note that individual SPWF collected from weeds (*Ludwigia bonariensis*, *M. lathyroides*) during the summer fallow season in a field near Immokalee also tested positive in dot blot assays with both probes. The results of field surveys are listed in Table 1.

Thus far transmission attempts from FTGV-infected tomatoes to two species of *Ludwigia* (*L. bonariensis* and *L. octovalvis*) and to a great number of other weeds and cultivated plants have been unsuccessful (Table 2). We have likewise failed to transmit virus from symptomatic *Sida* spp. and *M. lathyroides* to tomato either mechanically or via SPWF providing confirmation of their distinctness from FTGV. On the other hand FTGV was transmitted via whitefly to the weed *Solanum viarum* Dun. (Tropical Soda Apple) and to *Physalis ixocarpa* (tomatillo) and *Phaseolus vulgaris* L. (bean Top Crop'). Transmission was based on symptom expression (stunting, mosaic and leaf curl in Tropical Soda Apple and tomatillo and very mild mosaic in bean) and positive dot-blot assays with both A and B probes. Back-transmission experiments using SPWF to infect tomato are currently underway. Mechanical transmission of FTGV to two species of tobacco, *Nicotiana edwardsonii* and *N. benthamiana* was previously demonstrated (D. Purcifull, personnel communication).

Unlike those geminiviruses spread by leafhoppers, it is not unusual for whitefly-vectored geminiviruses to have very narrow host ranges (2). At present the role played, if any, by *S. viarum* and *P. vulgaris* in FTGV epidemiology is not known. Thus far no samples of *S. viarum* from the field have tested postive. However, *S. viarum* is an extremely thorny and noxious weed in its own right and is rapidly becoming a problem in southwest Florida. While of great interest, the results with field-collected weeds and whiteflies are preliminary. The potential of certain weeds to serve as reservoirs for FTGV must be confirmed through further surveys involving large numbers of samples and transmission experiments consisting of whitefly transmission to and from tomato.

## References

1. Adlerz, W.C. 1981. Weed Hosts of Aphid-borne Viruses of Vegetable Crops in Florida. Pages 467-478 In J. M. Thresh Ed. Pests,Pathogens and Vegetation. Pittman Publishing Inc., Marshfield, Massachusetts.

2. Bock, K.R. 1982. Gemini Diseases of Tropical Crops. Plant Disease. 66:266-270.

3. Kring, J.B., Schuster, D.J., Price, J.F. and Simone, G.W. 1990. Sweetpotato Whitefly Transmission Studies of Florida Tomato Disorders. Florida Experiment Station Journal Series No. A-00073. 5 pp.

## TABLE 1. TOMATO GEMINIVIRUS FIELD SURVEY

| PLANT | COMMON NAME | VIRUS SYMPTOMS | # SAMPLED | # POSITIVE (DOT-BLOT ASSAY) |
|---|---|---|---|---|
| CAPRIFOLIACEAE | | | | |
| *Lonicera japonica* | Japanese Honeysuckle | Yellow netting | 4 | 0 |
| COMMELINACEAE | | | | |
| *Commelina* sp. | Spiderwort | - | 7 | 0 |
| COMPOSITAE | | | | |
| *Ambrosia artemisiifolia* L. | Common Ragweed | +/- Mosaic, Distortion, Stunting | 23 | 0 |
| *Bidens* sp. | Spanish Needles | +/- Mosaic | 24 | 0 |
| *Eclipta alba* L. | Eclipta | - | 7 | 0 |
| *Sonchus oleraceus* L. | Common Sow Thistle | - | 5 | 0 |
| CONVOLVULACEAE | | | | |
| *Ipomea* sp. | Morning Glory | Leaf curl | 2 | 0 |
| CRUCIFERAE | | | | |
| *Brassica oleracea* var. *capitata* L. | Cabbage | Mosaic | 1 | 0 |
| *B. oleracea* var. *Tronchuda* L. | Kale | Mosaic, Distortion | 1 | 0 |
| CUCURBITACEAE | | | | |
| *Cucurbita pepo* L. | Zucchini | Silver Leaf | 1 | 0 |
| *Momordica pendula* L. | Wild Balsam Apple | - | 4 | 0 |
| EUPHORBIACEAE | | | | |
| *Chamaesyce hirta* (L.) Millsp. | Hairy Spurge | - | 4 | 1/1* |
| *C. hypericifolia* (L.) Millsp. | Spurge | - | 10 | 3/3 |

TABLE 1 (con.)

| PLANT | COMMON NAME | VIRUS SYMPTOMS | # SAMPLED | # POSITIVE (DOT-BLOT ASSAY) |
|---|---|---|---|---|
| EUPHORBIACEAE (con.) | | | | |
| *Euphorbia millii* (L.) Millsp. Desmoul. | Crown of Thorns | Mosaic, Distortion, Yellow-netting | 29 | 8/0** |
| *Euphorbia cyathophora* (Murr.) Kl. & Gke. | Painted Leaf, Wild Poinsettia | - | 5 | 0 |
| LEGUMINOSAE | | | | |
| *Crotalaria rotundifolia* L. | Rabbit Bells | - | 5 | 0 |
| *Crotalaria* sp. | - | - | 20 | 0 |
| *Desmodium* sp. | Beggar's Lice | Mosaic | 2 | 0 |
| *Galactia* sp. | Milk Pea | - | 2 | 0 |
| *Indigofera hirsuta* Harv. | Hairy Indigo | - | 9 | 0 |
| *Macroptilium lathyroides* (Benth.) Urb. | Phasibean | Bright mosaic | 48 | 10/0 |
| *Sesbania* sp. | Sesban | - | 12 | 2/2 |
| MALVACEAE | | | | |
| *Sida* spp. | Broomweed, Teaweed | Bright mosaic | 66 | 20/0 |
| *S. acuta* Burm. f. | Teaweed | " | 3 | 3/0 |
| *S. rhombifolia* L. | Indian Hemp | " | 2 | 1/0 |
| *Urena lobata* L. | Caesarweed | - | 29 | 0 |
| *Hibiscus rosa-sinensis* L. | Hibiscus | Mosaic | 47 | 0 |
| MYRTACEAE | | | | |
| *Myrica cerifera* L. | Southern Wax Myrtle | Leaf distortion | 3 | 0 |
| ONAGRACEAE | | | | |
| *Ludwigia bonariensis* (Micheli) Hara. | Water primrose | - | 34 | 12/0 |

TABLE 1. (con.)

| PLANT | COMMON NAME | VIRUS SYMPTOMS | # SAMPLED | # POSITIVE (DOT-BLOT ASSAY) |
|---|---|---|---|---|
| ONAGRACEA (con.) | | | | |
| *L. erecta* (L.) Hara. | ▪ | - | 20 | 5/5 |
| *L. octovalvis* (Jacq.) Raven | ▪ | - | 33 | 0 |
| *L. decurrens* Walt. | ▪ | - | 9 | 3/3 |
| RUBIACEAE | | | | |
| *Diodia teres* Walt. | Poor Joe | - | 6 | 0 |
| *D. virginiana* L. | Buttonweed | Vein-clearing | 1 | 0 |
| SOLANACEAE | | | | |
| *Capsicum annuum* L. | Bell Pepper | Chlorosis, Mosaic | 10 | 0 |
| *Physalis angustifolia* Nutt. | Narrow Leaf Ground Cherry | - | 4 | 0 |
| *Physalis* sp. | Ground Cherry | - | 13 | 0 |
| *Solanum viarum* | Tropical Soda Apple | Chlorosis | 22 | 0 |
| *Solanum* sp. | Nightshade | +/- Mosaic, Distortion | 58 | 0 |
| URTICACAE | | | | |
| *Boehmeria cylidrica* Jacq. | False Nettle | Mosaic | 1 | 0 |

| INSECT | HOST PLANT | VIRUS SYMPTOMS | # SAMPLED | POSITIVE (DOT-BLOT ASSAY) |
|---|---|---|---|---|
| *Bemisia tabaci* (Sweet potato whitefly) | *Ludwigia* sp. | - | 7 | 2/2 |
| ▪ | *Macroptilium lathyroides* (Benth.) Urb. | Bright Mosaic | 2 | 1/1 |

*Positive with both A and B probes
**Positive with A-probe only

TABLE 2. TOMATO GEMINIVIRUS - EXPERIMENTAL TRANSMISSION VIA SWEETPOTATO WHITEFLY

| PLANT | COMMON NAME | NO. INOCULATED | SYMPTOMS | # POSITIVE (DOT-BLOT ASSAY) |
|---|---|---|---|---|
| COMPOSITAE | | | | |
| *Bidens bipinnata* L. | Spanish Needles | 12 | - | 0 |
| *Carthamus tinctorius* (L.) | Safflower | 4 | - | 0 |
| *Helianthus annuus* L. | Sunflower 'Teddy Bear' | 6 | - | 0 |
| CRUCIFERAE | | | | |
| *Brassica oleracea* var. *capitata* L. | Cabbage | 8 | Vein-clearing | 0 |
| CUCURBITACEAE | | | | |
| *Cucurbita pepo* L. | Acorn Squash 'Table Ace' | 6 | - | 0 |
| *Melothria pendula* L. | Creeping Cucumber | 8 | - | 0 |
| EUPHORBIACEAE | | | | |
| *Poinsettia cyathophora* (Murr.) Kl. & Gke. | Fiddler's Spurge | 12 | - | 0 |
| LEGUMINOSAE | | | | |
| *Macroptilium lathyroides* (Benth.) Urb. | Phasibean | 14 | - | 0 |
| *Phaseolus vulgaris* L. | Bean 'Top Crop' | 15 | Mild Mosaic | 5/5* |
| | 'Blue Lake' | 12 | - | N.D. |
| *Phaseolus limensis* Macfady | Lima Bean | 4 | - | 0 |
| *Rhyncosia minima* (L.) DC. | - | 13 | - | 0 |
| MALVACEAE | | | | |
| *Abelmoshus esculentus* (L.) Moench | Okra 'Annie Oakley' | 4 | - | 0 |
| *Gossypium hirsutum* L. | Cotton | 4 | - | 0 |
| *Sida acuta* Burm. f. | Teaweed | 18 | - | 0 |

**TABLE 2. (Con.)**

| PLANT | COMMON NAME | NO. INOCULATED | SYMPTOMS | # POSITIVE (DOT-BLOT ASSAY) |
|---|---|---|---|---|
| ONAGRACEAE | | | | |
| *Ludwigia bonariensis* (Micheli) Hara. | Water primrose | 26 | - | 0 |
| *L. octovalvis* (Jacq.) Raven | * | 12 | - | 0 |
| SOLANACEAE | | | | |
| *Capsicum annuum* L. | Bell Pepper | 12 | - | 0 |
| *Physalis angustifolia* Nutt. | Narrow Leaf Ground Cherry | 12 | Chlorosis | 0 |
| *P. ixocarpa* Brot. | Tomatillo | 8 | Stunting, Leaf curl | 3/3 |
| *S. americanum* L. | Common Nightshade | 10 | - | 0 |
| *S. tuberosum* L. | Potato | 4 | - | 0 |
| *S. melongena* var. *esculentum* Nees. | Eggplant | 9 | - | 0 |
| *Solanum viarum* | Tropical Soda Apple | 8 | Stunting, Mosaic | 1/1 |

*Positive with both A and B probes