

## Previously Unreported Stem-pitting Symptoms of Florida Citrus

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This paper reports stem-pitting symptoms observed on 19 species, hybrids, and cultivars of citrus grown commercially in Florida. Pitting symptoms are

described and illustrated, survey data and initial virus indexing are summarized. Symptoms are discussed in relation to known virus diseases.

### MATERIALS AND METHODS

**Survey.** The Florida Department of Agriculture and Consumer Services (FDACS) and grower participants in the Citrus Budwood Registration Program maintain registered bud- and seed-source (scion) groves to supply true-to-type, virus-indexed propagating material. When planted, most trees in scion groves carry no known virus, although natural tristeza infection is common in many areas (4). Standard indexing methods establish freedom from tristeza, vein enation, psorosis, cachexia (xyloporosis), and exocortis viruses.

Annual inspections are made in scion

groves for the leaf or bark symptoms of psorosis, and to obtain information on other diseases, clonal performance, and bud variation. The stem-pitting symptoms reported in this paper were discovered by FDACS personnel during an inspection of this type.

As pitting of the type discovered was previously unknown in Florida and as the distribution pattern of pitted trees at this one location suggested localized natural spread, field surveys were undertaken to determine whether this severe type of pitting was present in other areas. These initial surveys were con-

TABLE 1  
DISTRIBUTION AND SUSCEPTIBILITY TO STEM PITTING OF 10 CITRUS VARIETIES IN FLORIDA\*

Variety	Number of trees examined	Number of trees affected	Percentage of trees affected	Number of locations with pitted trees	Severity of symptoms†
Milam.....	1,441	432	30	16	SV
Page.....	184	77	42	6	SV
Nova.....	139	29	21	1	MOD
Robinson.....	77	7	9	1	SV
Osceola.....	68	8	12	1	MOD
Minneola tangelo.....	72	40	55	4	SV
Orlando tangelo.....	80	None	—	—	—
Sour orange.....	46	7	15	1	SL
Sweet lime.....	43	34	79	1	MOD
Grapefruit.....	86	3	3	1	SL

\* Nineteen species, hybrids, and cultivars of citrus were found expressing symptoms. Host varieties were omitted when not enough trees were examined to establish valid distribution figures.

† SV = Severe pitting with wood distortion; MOD = Moderate pitting of wood under the bark with occasional inconspicuous external depressions. SL = Slight pits in wood under bark, no external symptoms.

ducted in registered scion plantings, which are widely distributed throughout citrus areas, and which provide accurate information as to the clonal identity and virus status of any pitted trees found.

Tree trunks and limbs were carefully examined for pitting symptoms. Bark windows averaging  $4 \times 10$  cm were made frequently to confirm ratings, check suspicious areas, and to obtain data for all the mild symptoms reported. Trees with symptoms were rated as either slightly, moderately, or severely pitted with wood distortion. Pitting was observed on 682 of the 2,417 trees examined. Survey data are summarized in table 1.

**Indexing.** Convincing circumstantial evidence that a transmissible disease agent is involved, and possibly being spread naturally, led to the indexing work summarized below. Four inoculum sources, all with severe pitting symptoms, were selected for comprehensive virus testing. Source A is a 12-year-old, unbudded cutting of Milam originally removed from the top of one seedling among 100 grown from the first seeds ever obtained. This tree now grows in a seed-source planting with 110 similar trees near Winter Haven. Source B is a six-year-old, budded Milam on Carrizo citrange growing in a validated seed-source planting east of Haines City. At the state's Budwood Foundation Grove, the tree that supplied the bud for this inoculum is healthy. Sources C and D, Page and Robinson, respectively,

are in validated bud-source plantings, both budded on Rough lemon budwood of the official releases made in 1964 and 1966 by the United States Department of Agriculture.

Greenhouse and field virus indexing was initiated, with buds from each of the four disease sources described. The number of plants inoculated from each disease source is shown after the indicator variety in the following list. In the greenhouse, inoculations were made on: Key lime, 6 (series repeated after four weeks with four plants per test); Eureka lemon, 4; Milam, 5; Orlando tangelo, 5; Rusk citrange, 5; sour orange, 6; *Citrus excelsa*, 4; Madam Vinous sweet orange, 4; Dweet tangor, 4; and Etrog citron, 10. For field indexing, three plants each of Pineapple sweet orange, Orlando tangelo, *Poncirus trifoliata* and Etrog citron were inoculated. Composite plants, Valencia sweet orange on sour orange and Milam rootstocks, are being prepared for further studies. As the incidence of tristeza is known to be high in several localities surveyed (4), additional tests for this virus and for exocortis were begun in a greenhouse to see if a correlation existed between pitting and either virus. Budwood was collected for this work from 10 horticultural varieties in eight locations. Several test series make up the 134-test total. Each series represents a single clonal bud source, and pitting was found on some but not all trees in each series.

## RESULTS AND DISCUSSION

**Symptoms.** The pitting observed (fig. 1) consisted of abrupt, elongated depressions in the xylem, arranged longitudinally with the plant axis, and with corresponding projections on the inner bark surface. No gum deposits were seen in bark or xylem tissue, although a thin brown stain was occasionally noted on the surface of freshly exposed wood.

Pits appeared singly or as a series, and

often coalesced on severely affected trees to form grooves in the wood. Viewed externally, these grooves gave a ropy, distorted appearance to the trunk or limb. Pitting was not found below ground level nor on wood smaller than 4 cm in diameter.

Pits described as "slight" in table 1 range upward to 2 mm deep and 4 mm long. The term "moderate" was used to characterize depressions up to 5 mm

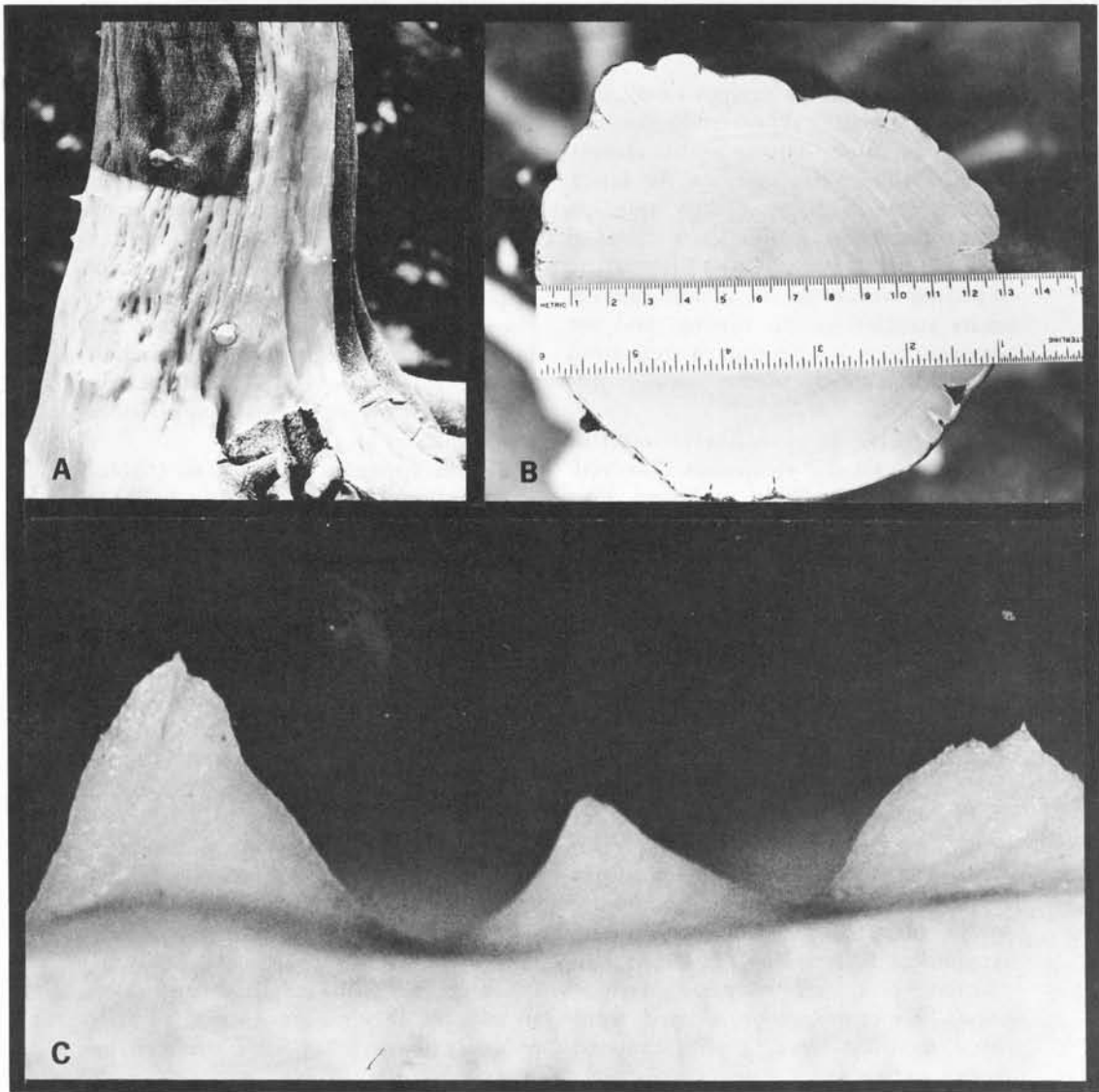


Fig. 1. *A*, eight-year-old Milam cutting showing severe pitting and distortion. Canopies and root systems appear normal at present; *B*, cross-section of trunk from eight-year-old Milam cutting illustrating depth of wood pits; *C*, magnification of bark projections to show sharp serrated crests.

deep and 8 mm long. Depressions called "severe" were found as large as  $3 \times 10$  cm on Minneola tangelo and up to  $1.5 \times 3$  cm on Page and Milam.

Typical bark projections rise to a sharp crest or series of crests, often finely serrated or topped with minute, thorn-like, projecting tissue (fig. 1C). On Page

trees, crests of bark projections were more rounded and pits more elongated.

The pitting found on Minneola tangelo trees is thought to be unrelated to that observed on other varieties. Depressions are not so numerous, and closely resemble symptoms associated with blind pocket psoriasis (9). However,

these symptoms occur on nucellar clones of *Minneola tangelo* indexed negatively for psorosis.

**Psorosis, cachexia (xyloporosis), exocortis.** The pitting reported does not appear to be caused by the agents responsible for these three diseases. All observations were made on seedling trees, or on propagations from clones indexed negative for these viruses. The nature of pitting symptoms, the lack of gum deposits associated with pitting, and the apparent partial infection of trees from a single bud source further support this hypothesis.

**Cristacortis.** It is unlikely that this disease caused the symptoms observed. Orlando tangelo is a preferred host variety for *cristacortis* (8). Absence of pitting on 80 Orlando tangelo trunks examined, coupled with clear symptoms seen on eight of their sweet lime rootstocks, indicates a different causal agent. The gum deposits and underground pitting associated with *cristacortis* were not found in this survey (8).

**Tristeza.** Several strains of this disease are known to be spread naturally in Florida (6), and the incidence of naturally infected field trees has risen sharply since 1961 (4, 7). In this survey the apparent partial infection among groups of seedling trees and among virus-indexed clones in 21 widely distributed plantings suggests natural spread. Bark specimens secured from pitted seedling trees of the standard *tristeza* indicator varieties, *Citrus mac-*

*rophylla* and Key lime, closely resembled the projections on bark specimens from other varieties obtained in this survey and those associated with *tristeza* infection in other areas (1, 2).

Key lime plants inoculated from sources A, B, C, and D showed strong epinasty and "blurred" leaf patterns on young leaves 12 days after budding. Typical *tristeza* vein clearing was not apparent, and distorted leaves fell from these plants a few days later. Uninoculated check plants appeared normal. A similar shock reaction is produced on Key lime by Grant's T<sub>3</sub> (strong) *tristeza* strain (6).

Milam appeared tolerant to *tristeza* in greenhouse tests (5), but in a field experiment conducted at Orlando from 1965 to 1969, clearly defined pits developed on Milam rootstocks of sweet orange trees inoculated with a severe (T<sub>3a</sub>) isolate of *tristeza* (S. M. Garnsey, personal communication). In the Orlando experiment, no significant differences were found in the growth rate or canopy appearance of plants with or without pitting. These data suggest several possibilities: (1) A previously unrecognized disease or disease complex may be producing the pitting symptoms reported; (2) the disease reactions of such recently developed varieties as Milam, Robinson, Page, Osceola, Lee, and Nova are not fully apparent; and (3) a strong, possibly mutant, strain of *tristeza* may be spreading in Florida's citrus groves.

## CONCLUSIONS

Pitting is evident in 21 virus-indexed citrus plantings widely distributed in counties containing 63 per cent (3) of Florida's commercial citrus acreage. Trunks of severely affected 6- to 12-year-old trees of Milam (possible hybrid *Citrus jambhiri* Lush. × unknown), and the mandarin hybrids cvs. Robinson and Page are heavily pitted, furrowed, and distorted (fig. 1). While some trees of the same variety and identical bud

source may be healthy, others display definite but less severe symptoms, suggesting natural spread. Only inconspicuous pitting was observed on Pineapple and navel sweet oranges, Marsh and Duncan grapefruit, and the rootstock varieties Rangpur lime, sour orange, Estes Rough lemon, and Carrizo citrange. Pitting found on sweet lime, Morton citrange, calamondin, Cleopatra mandarin, and the mandarin hy-

brids cvs. Osceola, Lee, and Nova was moderate. A severe but different type of pitting affects many old-line and seedling-line Minneola tangelo trees. Of the 80 Orlando tangelo trunks examined,

none showed pits, although well developed symptoms appeared on the rootstocks for 8 of 10 trees budded on sweet lime. Tops and root systems of trees with pitting appear healthy and normal.

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#### LITERATURE CITED

1. BITTERS, W. P.  
1972. Reaction of some new citrus hybrids and citrus introductions as rootstocks to inoculations with tristeza virus in California. *In: Proc. 5th Conf. Intern. Organ Citrus Virol.* (W. C. Price, ed.) Gainesville: Univ. of Florida Press, pp. 112-20.
2. DUCHARME, E. P., AND L. C. KNORR  
1954. Vascular pits and pegs associated with diseases in citrus. *Plant Dis. Reprtr.* 38: 127-42.
3. FLORIDA AGRICULTURAL STATISTICS 1970 CITRUS SUMMARY  
1970. Tallahassee: Florida Dept. of Agriculture, p. 33.
4. FLORIDA DEPARTMENT OF AGRICULTURE AND CONSUMER SERVICE  
1972. Unpublished data.
5. FORD, H. W., AND W. A. FEDER  
1964. Three citrus rootstocks recommended for trial in spreading decline areas. *Univ. Florida Exp. Sta. Cir.* 5-151.
6. GRANT, T. J., AND R. P. HIGGINS  
1957. Occurrence of mixtures of tristeza virus strains in citrus. *Phytopathology* 47: 272-76.
7. NORMAN, G., W. C. PRICE, T. J. GRANT, AND H. BURNETT  
1961. Ten years of tristeza in Florida. *Proc. Florida State Hort. Soc.* 74: 107-11.
8. VOGEL, R., AND J. M. BOVÉ  
1968. Cristacortis, a virus disease inducing stem pitting on sour orange and other citrus species. *In: Proc. 4th Conf. Intern. Organ. Citrus Virol.* (J. F. L. Childs, ed.) Gainesville: Univ. Florida Press, pp. 221-28.
9. WALLACE, J. M.  
1959. A half century of research on psorosis. *In: Citrus virus diseases.* (J. M. Wallace, ed.) Berkeley: University of California Division of Agricultural Sciences, pp. 5-21.