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EVALUATION OF CITRUS, HYBRIDS, AND RELATIVES AS HOSTS OF *PRATYLENCHUS COFFEAE*, WITH COMMENTS ON OTHER HOSTS

by

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Pratylenchus coffeae (Zimmermann, 1898) Filipjev *et* Schuur. Stekh., 1941, is a serious pest of many crops in tropical and subtropical areas of the world. Its geographic range includes Australia (Colbran, 1955); Barbados, Congo, Jamaica, Java, Martinique (Whitehead, 1969); Belgium (D'Herde *et al.*, 1969); Brazil, Brunei, El Salvador, India, Indonesia, Thailand, Hawaii, Venezuela (Siddiqi, 1972); Canary Islands (deGuiran and Vilardebo, 1963); Ceylon (Hutchinson, 1960); Colombia, Dominican Republic (Wehunt and Holdeman, 1959); Costa Rica, Honduras, Panama, Philippines (Taylor and Loegering, 1953); Cuba (Decker, 1968); Dominica (Edmunds, 1969); French West Indies, Guadeloupe (Kermarrec and Scotto La Massese, 1972); Granada B. W. I. (Cobb, 1919); Guatemala (Chitwood and Berger, 1960); Japan (Yokoo and Kukoda, 1966); Madagascar (Williams, 1969); Mexico (Knobloch and Laughlin, 1973); The Netherlands (Oostenbrink, 1961); Peru (Krusberg and Hirschmann, 1958); Puerto Rico (Ayala and Acosta, 1971); South Africa (Heyns, 1971); Sumatra (Loof, 1960); United States: Arkansas (Riggs *et al.*, 1956); California (Ayoub, 1960); Florida (Feldmesser and Hannon, 1969); Iowa (Norton *et al.*, 1964); Kansas (Orr, 1967); Kentucky (Chapman, 1958); North Carolina (Barker and Clayton, 1969); and South Dakota (Norton, 1968). More than 130 species and varieties of plants have been reported as hosts

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for this nematode (Edwards and Wehunt, 1973) including many major agricultural crops. Unreported hosts and hosts not listed in Edwards and Wehunt (1973) include *Aglaonema simplex* Blume (new host) reported by the Division of Plant Industry, Florida Department of Agriculture and Consumer Services, *Bambusa* sp. (Elmiligy and Geraert, 1971); *Bromus catharticus* Vahl. (Cobb, 1919); *Cardamine* sp., and *Cephalotaxus harringtonia* (Forbes) K. Koch. (Colbran, 1964); *Coffeae arabica* L., var. *arabica*, and *C. arabica* 'Pache' (Schieber and Sosa, 1960); *C. arabica* 'Bourbon' (Chitwood and Berger 1960 a); *C. arabica* 'Ugandi' (Chitwood and Berger, 1960); *Dioscorea alata* L. (Ayala and Acosta, 1971); *D. cayenensis* Lam. (Acosta, 1974); *Hedera canariensis* Wild. (new host), *Indigofera endecaphylla* Jacq., and *Nitella* sp. (Loof, 1960); *Ipomoea batatas* (L.) Lam., and *Oryza sativa* L. (Yokoo and Kukoda, 1966); *Leucaena* glauca Benth., *Ligularia kaempferi* Sieb. *et* Zucc., and *Potamogeton* sp. (Siddiqi, 1964); *Musa nana* Lour. (Decker, 1968); *M. sapientum* L. (Ayoub, 1960); *Narcissus* sp. (Norton, 1968); *Quercus laurifolia* Michx. (new host), *Saccharum officinarum* L. (Williams, 1969); and *Vetiveria zizanioides* (L.) Nash (Goodey, *et al.*, 1965). *Pratylenchus coffeae* has been reported as a pest of citrus in several citrus growing areas of the world (Feldmesser and Hannon, 1969; Siddiqi, 1964; Yokoo and Ikegemi, 1966), and has recently been shown to cause severe damage to citrus in field trials in Florida (O'Bannon and Tomerlin, 1973).

This nematode species is not widespread in Florida citrus. It was not known what effects it might have on citrus varieties or relatives, since no citrus host list had been compiled for this nematode. Therefore, a number of cultivars and hybrids of *Citrus* and *Poncirus trifoliata* (L.) Raf., *Microcitrus* hybrids and *Severinia buxifolia* (Poir.) Ten. were evaluated to determine their reaction to *P. coffeae* under controlled conditions.

Materials and Methods

A series of host studies were conducted over a 2-year period on open-pollinated seeds from trees in Florida, California, and Japan. Seeds of each selection were planted in flats containing a 1:1 peat-vermiculite planting mix. Four to six months after germination, seedlings were removed from flats and transplanted into large above-ground growth tanks. The soil in the tanks was an Astatula fine

sand uniformly infested with *P. coffeae.* To maintain a uniform nematode infestation, susceptible rough lemon seedlings were grown in tanks. At intervals, the plant tops were removed and the infected roots were turned back into the soil for nematode release. Four to ten seedlings of each test selection were planted at random in rows in each tank. Selections were grown in tanks for 6 to 9 months and received routine cultural care. Soil temperature ranged from 15 to 27°C during the growing period.

At harvest, roots were dug and rinsed in water to remove soil and debris. The root system of each selection was closely examined and nonattached roots were discarded. About 2 grams of feeder roots were removed from the tap root, washed in water and placed moist in 50 cc glass jars for root incubation (Young, 1954). Lids were applied loosely to the jars to allow air exchange. After 3 and 5 days, 50 cc of water was added to each jar; the contents were stirred and the liquid was decanted immediately into 50 cc vials. A 5-cc aliquot of nematode suspension was pipetted into a counting dish and all stages of *P. coffeae* found were counted with the aid of a dissecting microscope. After the second reading, the moist roots were weighed and the number of nematodes per gram of root was calculated.

Results and Discussion

All 125 selections used in these studies were classified as hosts of *P. coffeae.* Most selections were considered highly susceptible, supporting populations > 1,000/g root. Only four selections of a *Microcitrus australis* (Planch.) Swing. x *M. australasica* (F. Muell.) Swing. hybrid and Rubidoux 70-A5 trifoliate orange (*Poncirus trifoliata*) had nematode populations of less than 100/g root. They were considered to show some resistance to *P. coffeae* because of low numbers (Table I). All other selections were considered susceptible.

Root size and growth habits vary considerably among genera. *Citrus* spp. generally have coarser, larger root systems than the finer, smaller roots of *Poncirus* sp.. Numbers of *P. coffeae* per gram of root, however, were high with all selections even though root sizes varied.

Five citrus rootstocks: Carrizo citrange, Algerian navel, Ridge

Table I - *Reaction of various citrus and noncitrus selections to the root lesion nematode,* Pratylenchus coffeae.

Selection	I. D. No.	Mean no. of *P. coffeae*/ g root
Citrus aurantium L.		
Brazil sour orange	IF-71-225	1,067
Presumed sour orange hybrid	IF-71-197	353
Presumed sour orange hybrid	FF-1-101-2	2,117
Presumed sour orange hybrid	FF-1-101-10	2,373
Presumed sour orange hybrid	HF-2-2-14	591
C. aurantium x *C. reticulata* Blanco		
(Sauvage sour x Cleopatra mandarin)	FF-5-12-19	3,200
(Sauvage sour x Cleopatra mandarin)	FF-5-12-42	2,257
C. grandis (L.) Osb.		
Siamese pummelo	HF-2-8-1-9	410
Tahiti pummelo	HF-2-8-7-5	603
C. grandis x *C. sinensis* (L.) Osb.		
(China pummelo x Ridge Pineapple orange)	FF-1-59-61	3,083
C. junos Sieb. ex Tan.		
Yuzu		1,093
C. limon (L.) Burm. f.		
Batabi Shikan lemon	HF-2-11-10	398
Bernia lemon	HF-2-8-13	1,058
Cuban shaddock	IF-71-219	170
Estes rough lemon		1,892
Heyman red rough lemon	FF-9-1-60	7,950
Milam lemon		1,542
Red rough lemon	H-205	4,340
Red rough lemon	IF-71-198	1,344
Red rough lemon	IF-71-216	1,920
Red rough lemon	IF-71-217	1,220
Red rough lemon	IF-71-218	812
Rough lemon	H-181	1,097
Rough lemon	H-293	1,800
Rough lemon	H-299	6,000
Rough lemon	H-300	1,207
Rough lemon	H-309	2,976
Rough lemon	IF-71-207	966
Rough lemon	IF-71-208	1,924
Schaub rough lemon	IF-71-204	905
Soh Jahlia	IF-71-210	711
Soh Jahlia	IF-71-211	607
Stow red rough lemon	IF-71-228	1,253
C. macrophylla Wester	IF-71-199	1,075
C. macrophylla	IF-71-201	272
C. paradisi Macf.		
Leonardy grapefruit	HF-7-12-9	690
C. reticulata var. *austera* Sw. hybrid ?		
Rangpur lime	H-303	3,703
Rangpur lime	H-308	983

Table I *(continued)*

Selection	I. D. No.	Mean no. of *P. coffeae*/ g root
Rangpur lime	H-310	3,226
Rangpur lime	H-312	2,539
Rangpur lime	IF-71-194	858
Rangpur lime, tetraploid	C-61-93-1	1,533
C. reticulata Blanco x *C. aurantium*		
(Sunki mandarin x Sauvage sour)	IF-71-203 (m)	483
(Sunki mandarin x Sauvage sour)	IF-71-203 (u)	1,436
(*C. reticulata* x *C. sinensis*) hybrid ?		
Ortanique	HF-2-26-3	2,933
C. sinensis (L.) Osb.		
Algerian navel orange	HF-2-11-3	1,203
Barao sweet orange	HF-2-27-4	1,708
Carlton sweet orange	HF-2-22-3	3,633
Koethen sweet orange	IF-71-223	632
Lab sweet orange	HF-7-11-10	249
Madam Vinous sweet orange	IF-71-221	2,171
Natal sweet orange	HF-2-27-9	2,656
Ridge Pineapple sweet orange	HF-7-12-4	1,371
Torregrossa sweet orange	HF-2-18-4	6,190
C. volkameriana Ten. *et* Pasq.		
Volkamer lemon	IF-71-212	1,452
Volkamer lemon	IF-71-220	876
[*Microcitrus australis* (Planch.) Swing. x *M. australasica* (F. Muell.) Swing.] hybrid	26-1	13
(*Microcitrus australis* x *M. australasica*) hybrid	26-2	32
(*Microcitrus australis* x *M. australasica*) hybrid	26-3	23
(*Microcitrus australis* x *M. australasica*) hybrid	26-4	68
(*Microcitrus australis* x *M. australasica*) hybrid	26-5	3,543
(*Microcitrus australis* x *M. australasica*) hybrid	26-6	155
Poncirus trifoliata (L.) Raf. (trifoliate orange)		
Argentina	FF-1-53-95	1,130
Christiansen	FF-1-53-99	4,491
Davis-B	FF-1-53-97	3,289
Kryder 15-3	FF-9-20-3	2,800
Kryder 15-3	FF-9-20-4	2,667
Large flower	HF-7-3-16	739
Okitsu	70-A2	756
Pomeroy	FF-9-20-2	1,167
Rubidoux	CRC-838	1,483
Rubidoux	HF-7-20-13	2,300
Rubidoux	IF-71-222	1,109
Rubidoux	70-A5	18
Small flower	HF-7-4-16	912
Tetraploid	HF-7-9-13	1,741
Texas	70-A6	423
P. trifoliata hybrids		
C. limon x *P. trifoliata* (Citremon-46216)	HF-2-3-13-9	423
C. paradisi x *P. trifoliata*		
Citrumelo-4551	HF-7-14-4-4	2,489

Table I *(continued)*

Selection	I. D. No.	Mean no. of *P. coffeae*/ g. root
Citrumelo-4475	HF-7-20-7	3,539
Citrumelo-4475	IF-71-195	2,638
Citrumelo-4475	IF-71-196	1,600
Sacaton citrumelo	IF-71-200	1,079
Sacaton citrumelo	IF-71-202	1,735
Sacaton citrumelo	IF-71-227	2,508
Tucson citrumelo	IF-71-205	1,000
Tucson citrumelo	IF-71-206	771
(*C. reticulata* hybrid ? x *P. trifoliata*) x *C. sinensis*		
(Temple x Large flower) x Valencia orange	FF-1-29-25	2,154
(Temple x Large flower) x Valencia orange	FF-1-29-40	5,689
(Temple x Large flower) x Valencia orange	FF-1-29-40 (m)	4,160
(Temple x Large flower) x Valencia orange	FF-1-29-66	1,138
C. reticulata x *P. trifoliata*		
Changsha mandarin x English large	FF-1-131-3	5,333
Changsha mandarin x English large	FF-1-131-8	2,676
Changsha mandarin x English large	FF-1-131-9	963
Changsha mandarin x English large	FF-1-131-10	5,053
Changsha mandarin x English large	FF-1-131-14	229
Changsha mandarin x English large	FF-1-131-15	4,667
Changsha mandarin x English large	FF-1-131-30	8,080
Changsha mandarin x English large	FF-1-131-32	3,756
Changsha mandarin x English large	FF-1-131-34	5,867
Changsha mandarin x English large	FF-1-131-36	8,481
Changsha mandarin x English large	FF-1-131-39	4,267
Changsha mandarin x English large	FF-1-131-40	1,450
Changsha mandarin x English large	FF-1-131-42	4,000
Changsha mandarin x English small	FF-1-132-25	825
Changsha mandarin x English small	FF-1-132-27	3,267
Changsha mandarin x English small	FF-1-132-32	2,233
Cleopatra mandarin x Swingle	IF-71-214	1,190
Cleopatra mandarin x Swingle	IF-71-215	750
C. sinensis x *P. trifoliata*		
Carrizo citrange	HF-7-18-17	3,883
Carrizo citrange	IF-71-213	1,858
Nafertile orange x *P. trifoliata*	CRC-15-16	1,706
Ruby orange x Webber-Fawcett	CRC 13-7	518
Ruby orange x Webber-Fawcett	CRC 14-7	1,393
Ruby orange x Webber-Fawcett	CRC 15-7	1,706
Troyer citrange	CRC-1459	351
Troyer citrange	HF-7-16-17	1,006
Troyer citrange	IF-71-226	1,801
Yuma citrange	IF-71-224	1,193
Yuma citrange	FF-1-10-5	9,145
P. trifoliata x (*C. sinensis* x *P. trifoliata*)		
Rubidoux x Carrizo citrange	FF-3-5-76	2,000
Rubidoux x Carrizo citrange	FF-3-5-80	1,737
Rubidoux x Carrizo citrange	FF-3-5-83	1,850
Rubidoux x Carrizo citrange	FF-3-6-8	943
Severina buxifolia (Poir.) Ten.	HF-2-23-4	2,076

Pineapple, Milam lemon, and Estes rough lemon, known to be resistant or tolerant to the burrowing nematode, *Radopholus similis* (Cobb) Thorne (O'Bannon and Tomerlin, 1971) were susceptible to *P. coffeae*. Certain cultivars and hybrids of *P. trifoliata* have been reported as resistant to the citrus nematode, *Tylenchulus semipenetrans* Cobb (Baines *et al.*, 1960; Cameron *et al.*, 1954; Feder, 1968). All trifoliate orange selections and hybrids, except one accession from Japan, Rubidoux 70-A5 trifoliate orange, were susceptible to *P. coffeae*.

The results of these studies show that most *Citrus* spp., hybrids and certain relatives are good hosts of *P. coffeae*. Kumar *et al.* (1971) reported that a race of *P. coffeae* did not multiply on three citrus species, *C. aurantifolia*, *C. jambhiri* and *C. reticulata*. More recently, Kumar and Kasiviswanathan (1972) established the existence of at least two physiological races of *P. coffeae*. Citrus varieties resistant to other nematodes were susceptible to *P. coffeae*, except for *Microcitrus*. In controlled greenhouse studies, a *Microcitrus* hybrid exhibited immunity to *Radopholus similis*. Four of the six selections of this hybrid tested indicated a high degree of resistance to *P. coffeae*. However, as has been shown with other segregating types, large populations must be examined in the search for resistance.

SUMMARY

Distribution and hosts of *Pratylenchus coffeae* (Zimmermann) Filipjev *et* Schuur. Stekh. are reported from the literature. Three new noncitrus hosts are reported. One-hundred-twenty-five *Citrus* spp., hybrids and certain relatives were shown to be hosts of *P. coffeae*. Four of six *Microcitrus* hybrid selections and one *Poncirus trifoliata* (L.) Raf. selection indicated a high degree of resistance to *P. coffeae*.

RIASSUNTO

Valutazione di Agrumi, Ibridi e Parenti, come ospiti di Pratylenchus coffeae, *con commenti su altri ospiti.*

Sono riportati la distribuzione geografica e gli ospiti di *Pratylenchus coffeae* (Zimmermann) Filipjev *et* Schuur. Stekh. Vengono segnalati tre nuovi ospiti non appartenenti ad agrumi e viene dimostrato che 125 selezioni di agrumi, ibridi e parenti, sono ospiti di questo nematode. Quattro ibridi di *Microcitrus*, delle sei selezioni saggiate, ed una selezione di *Poncirus trifoliata* (L.) Raf. hanno mostrato un alto grado di resistenza nei confronti di *P. coffeae*.

RESUMÉ

Aptitude des Citrus, hybrides et parents, comme hôtes de Pratylenchus coffeae *et commentaires concernant d'autres hôtes.*

La distribution et les hôtes de *Pratylenchus coffeae* (Zimmermann) Filipjev *et* Schuur. Stekh. sont indiqués. Trois nouveaux hôtes non Citrus sont signalés. Il est precisé que 125 sélections d'agrumes, hybrides et parents sont des hôtes de ce nématode. Quatre hybrides de six sélections de *Microcitrus* essayées et une de celles de *Poncirus trifoliata* (L.) Raf. ont montré un haut degré de résistance à *P. coffeae.*

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