

## A Ten-year Assessment of Benefits to the Citrus Nursery and Soil Pit Industries in Florida from Regulatory Research on *Tylenchulus* Species.<sup>1</sup>

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**INTRODUCTION:** Nematode exclusion through site and pit certification programs is one of the best options that growers have to effectively manage nematode pests of citrus. For the past 40 years, the citrus nursery site approval and premovement certification program has ensured that citrus seedlings sold to Florida growers are free of damaging nematode pests, thus preventing their spread into newly planted groves. This certification program was especially important after the freezes in the 1980s, when much of the acreage of the state shifted from North Central into areas in South Florida where citrus had never been grown. In addition, the pit approval certification program has prevented the spread of these nematodes because it ensures that in Florida the peat used in the media to grow citrus seedlings and the materials used to construct roads in or near citrus groves are free of the principal nematode pests of citrus.

**RESEARCH ON *TYLENCHULUS* SPECIES:** *Tylenchulus semipenetrans* Cobb., the citrus nematode, is one of the important parasites of citrus roots that is excluded from citrus nurseries in Florida through certification programs. For many years, it has been known that there are populations of *Tylenchulus* in Florida that parasitize certain plants in native areas where citrus had not been grown previously. The host status of these populations relative to citrus and their taxonomic relation to the citrus nematode has been clarified through regulatory research.

In 1957, when what appeared to be the citrus nematode, *Tylenchulus semipenetrans*, was found on the roots of a native plant, climbing hempweed, *Mikania scandens* (L.) Willd. (= *M. batatifolia* DC.) (Fig. 1), growers were warned that the citrus nematode is apparently native to Florida and that it may be advisable to fumigate before planting citrus in new areas (Chitwood and Birchfield 1957). Greenhouse studies, however, showed that climbing hempweed was not a host of *T. semipenetrans* from citrus roots (Hannon *et al.* 1963). A few years later, a *Tylenchulus* population was found on an indigenous Florida grass, *Schizachyrium rhizomatum* (Swallen) Gould, but under greenhouse conditions it did not infect citrus (Stokes and Langdon 1966; Stokes 1969). At that time, it was assumed that these populations of *Tylenchulus* in native areas were strains or races of the citrus nematode. From the early 1970s to the mid-1980s, many proposed pit sites and citrus nursery sites in uncultivated areas with no history of citrus production could not be certified due to the presence of these "wild" strains of the citrus nematode occurring on native plants. Suspicion arose that these "wild" citrus nematode populations occurring in native areas might not need to be subjected to regulatory restrictions; however, more information was needed on the distribution, host preference, and morphological characteristics of these populations to justify any change in regulatory policy.



**Fig. 1.** Climbing hempweed, *Mikania scandens* (L.) Willd., a plant found in native areas of Florida and originally reported to be a host of the citrus nematode; however, subsequent research indicated that *Tylenchulus semipenetrans* from citrus does not infect this plant, but that another species, *Tylenchulus palustris*, infects this vine.

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In the mid-1980s, the citrus industry supported research by Division of Plant Industry nematologists who studied *Tylenchulus* populations from areas that had no previous history of citrus cultivation. These scientists found that *Tylenchulus* populations from native areas actually consist of two distinct types, and that each type has its own distinct group of hosts. They also confirmed that neither type was able to infect citrus (Inserra *et al.* 1989; Dow *et al.* 1990), and that it was possible to distinguish morphologically these two types of the "wild" populations from each other and from the *Tylenchulus* species that damages citrus, i.e., *T. semipenetrans*. The "wild" populations that parasitize climbing hempweed and several other dicot hosts were described as *T. palustris*. The populations that were first found on *S. rhizomatum* and other grasses were described as *T. graminis* (Inserra *et al.* 1988). Because these two new nematode species are not subject to regulatory restrictions, this has resulted in fewer site and pit certification failures.

**BENEFITS FROM REGULATORY RESEARCH:** Ten years have elapsed since this research was conducted, but the impact of this research on pit and site approval failures has not been analyzed or published to date. Records from the Division of Plant Industry files were examined to provide this information. From 1977 to 1986, before the two new species of *Tylenchulus* were described there were 2027 locations sampled for site and pit approval. A total of 154, or one of every 13 locations failed because the citrus nematode or its "wild" race was detected in samples taken at these locations. To determine how many of these failures occurred in native areas with no known history of citrus production, plant product specialists examined their sampling maps pertaining to the 154 locations that failed certification during the ten-year period. About one half of these failures, 74 locations, were in native areas. The other 80 certification failures were locations where citrus had previously been grown at the location or nearby in the environs. Because the newly described *Tylenchulus* species occurring in native uncultivated areas are no longer subject to the regulatory restrictions, there have been no certification failures in these areas after 1986 (Table 1). This was primarily due to the regulatory research on *Tylenchulus* species which provided regulatory scientists with reliable morphological criteria to distinguish *Tylenchulus* species occurring in native areas from the species that damages citrus, *T. semipenetrans*.

TABLE 1. Total number of sites and pits approved and the number of failures due to *Tylenchulus* species in native areas where citrus was never known to occur.

Year	Sites and pits	<u>Failures in native areas</u>	
	Approved	Number	Total acres
<u>Prior to New Species Descriptions</u>			
1977-78	227	11	75
1979-80	336	10	66
1981-82	443	12	63
1983-84	423	21	282
1985-86	444	20	175
<u>After New Species Descriptions</u>			
1987-88	244	0	0
1989-90	195	0	0
1991-92	140	0	0
1993-94	140	0	0
1995	81	0	0

At the time when this regulatory research was conducted, there was a critical need for new approved citrus nursery sites that would meet nematode certification standards. From 1978 to 1985, 22 million trees were planted in Florida's citrus groves, but from 1986 to 1993, three times this number, 66 million citrus seedlings were set (Table 2). This increased demand for citrus seedlings was primarily due to two factors. In the 1980s, there was a series of severe freezes, resulting

TABLE 2. Number of trees set in commercial citrus groves in Florida and average price per budded tree.

Year	Number of trees set <sup>1</sup>	Avg. Price per tree <sup>2</sup>
1978	1,424,300	2.08
1979	2,379,000	2.81
1980	2,180,000	2.95
1981	3,270,100	3.30
1982	2,698,200	3.39
1983	4,656,500	3.52
1984	2,767,700	3.46
1985	2,801,700	3.72
1986	5,742,000	3.62
1987	9,634,300	3.44
1988	6,804,600	3.35
1989	9,429,800	3.20
1990	8,643,000	3.06
1991	10,809,800	2.91
1992	9,221,700	2.88
1993	5,653,300	2.70

<sup>1</sup>Data on number of tree set from Florida Commercial Citrus Inventory (1978-1993).

<sup>2</sup>Average price per budded tree from 1989-1993 is based data from 9 citrus nurseries surveyed by W.W. Smith in 1996, and data from 1978-1988 is based on data from 29 nurseries surveyed by Dr. Ron Muraro, IFAS, UF.

## SHIFT IN FLORIDA CITRUS PRODUCTION

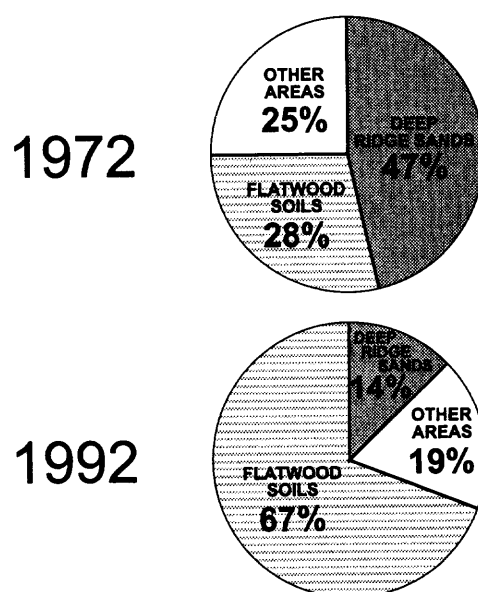


Fig. 2. Regional shift in Florida citrus production from the freeze-prone areas further north where citrus was grown in the Central Ridge area in deep sandy soils to regions further south with flatwood soils.

in total gross losses of more than one half of the citrus acreage in Florida (Table 3). This resulted in a regional shift in production. For example, 47 percent of the state's citrus production was in the deep sands of the ridge in 1972, primarily in Lake, Orange, and Polk Counties which were on the northern edge of the Florida citrus area, but by 1992 this region had only 14 percent of the state's production. During this time period, large new areas of the frost-free southern flatwood region were planted to citrus. By 1992, 67 percent of Florida's citrus production was provided by this region compared to 28 percent in 1972 (Fig. 2). Much of this citrus planted after the freezes was set at a high density per acre. This also contributed to the increased demand for citrus seedlings from 1986 to 1992. In 1958, the average tree density was 60 trees per acre, but through the years there has been a trend toward planting higher numbers of trees per acre, and by 1993, the average number of trees set per acre had reached a density of 141 trees (Fig.3). Some new plantings have up to 225 trees per acre.

The market value of a budded citrus tree has averaged around \$3.00 for the past 20 years (Table 2), so in a given commercial citrus nursery, one acre with 33,000 citrus seedlings has a market value around 100,000 dollars. During the eight-year period from 1986 to 1993 when the demand for citrus seedlings reached an all-time high, the market value of the trees planted was \$206 million compared to \$72 million for the eight-year period prior to this time, 1978 to 1985. Thus, the regulatory research on *Tylenchulus* species, which increased the availability of approved sites, made a positive contribution to the citrus industry. Florida's multimillion dollar soil pit and tropical peat industries also have benefited from this regulatory research which increased the availability of pit sites. These pit sites are also subject to the same citrus nematode certification requirements because the products from these industries are used in citrus groves and nurseries.

In conclusion, although it may be difficult to access the precise cost-benefits, 10 years after the regulatory research on *Tylenchulus* species it is clear that the \$80,000 research grant investment for this regulatory research has been returned manyfold to Florida's agricultural industries and the general economy. Information this research provided on the biology and taxonomy of *Tylenchulus* species in native uncultivated areas increased the availability of approved sites without compromising the need to exclude sites infested with the nematodes that damage citrus. This research occurred at a

crucial time when the demand for certified citrus nursery sites greatly increased after the freezes in the 1980s, and as citrus expanded into new areas in South Florida. The citrus and soil pit industries will continue to benefit from this research because it has increased the availability of approved pit and citrus nursery sites in native uncultivated areas of Florida.

TABLE 3. Total acres of citrus in Florida (1980-1994), gross loss and new planted acres during the previous biennium.

Census year	Total acres	Two year change		New acres planted
		Gross loss	%	
1980	845,283	25,925	3.1	39,973
1982 <sup>1</sup>	847,856	51,942	6.1	54,515
1984 <sup>1</sup>	761,365	159,719	18.8	73,228
1986 <sup>1</sup>	624,492	185,598	24.4	48,725
1988	697,929	52,240	8.4	125,677
1990 <sup>1</sup>	732,767	85,858	12.3	120,696
1992	791,290	74,704	10.2	133,227
1994	853,742	45,214	5.7	107,666

<sup>1</sup>January freezes in 1981, 1982, 1985, and 1986. December freezes in 1983, 1985, and 1989. Data from the 1994 Commercial Citrus Inventory.

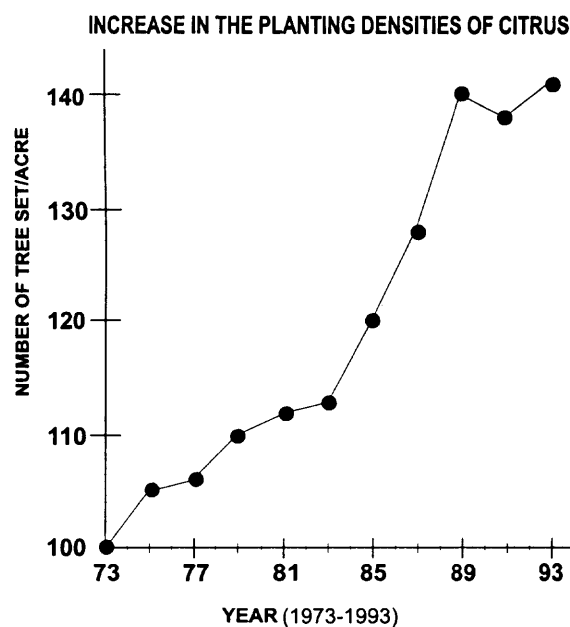


Fig. 3. Change in the average number of trees set per acre from 1973 to 1993. Data from Florida Commercial Inventory and based on the number of trees set divided by the acres set.

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