EVALUATION OF *DITYLENCHUS PHYLLOBIUS* (TYLENCHIDA: ANGUINIDAE) AS A POTENTIAL BIOLOGICAL CONTROL AGENT FOR *SOLANUM VIARUM* AND *SOLANUM TAMPICENSE* (SOLANACEAE)†

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RESUMEN

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La sosa tropical común, *Solanum viarum* Dunal, y la sosa tropical de areas bajas humedas, *S. tampicense* Dunal, son plantas exóticas que recientemente han invadido pastos y areas naturales en Florida. Estas solanáceas representan una seria amenaza para la vegetación nativa de las zonas infestadas y han sido objeto de control biológico. Se aplicó el enfoque de "nueva asociación" de control biológico con el fin de determinar si el nematodo de las agallas foliares y de los tallos *Ditylenchus phyllobius* (Thorne) Filip'jev, el cual ataca a la 'silverleaf nightshade' (*S. elaeagnifolium* Cav.) era capaz de infectar a la sosa tropical común y a la sosa tropical de areas bajas húmedas. Ninguna de las plantas evaluadas desarrolló agallas características de *D. phyllobius* en hojas o tallos. Consecuentemente, el 'silverleaf nightshade' nematodo *D. phyllobius* no parece tener valor como agente para el control biológico de la sosa tropical común ni de la sosa tropical de areas bajas humedas.

Palabras claves: control biológico, *Ditylenchus phyllobius*, maleza, *Nothanguina phyllobia*, *Solanum tampicense*, *Solanum viarum*.

Tropical soda apple (TSA), *Solanum viarum* Dunal, and wetland nightshade (WLN), *S. tampicense* Dunal, are exotic, perennial plants that have invaded pastures and natural areas in Florida (Coile, 1993; Wunderlin *et al.*, 1993). TSA infests an estimated 303 000 ha of pasture statewide (Mullahey, 1996) and has since spread to Alabama, Georgia, Mississippi, Pennsylvania, North and South Carolina, and Puerto Rico (Cooke, 1997). In contrast to TSA, which dominates upland sites, regularly flooded wetlands are particularly vulnerable to invasion by WLN (Fox and Wigginton, 1996a, b; Wunderlin *et al.*, 1993). The most severe infestations of WLN (approximately 60 ha) are localized in southwest Florida in the vicinity of Highlands County (Fox and Wigginton, 1996a, b). WLN is more restricted in its distribution than TSA due its unique habitat requirements. TSA and WLN not only have the potential to displace the native vegetation in their respective habitats, but TSA also serves as a reservoir for diseases and insect pests of solanaceous crops grown in Florida (McGovern *et al.*, 1994).

Because TSA and WLN were introduced into Florida from South and Central America, respectively, without their normal complement of natural enemies, their success may be attributed to lack of host-specific insects and diseases in Florida (the introduced range), which affords these plants a competitive advantage over native species. The foreign origin of TSA

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and WLN makes them good candidates for classical biological control (Habeck *et al.*, 1996). However, these weeds belong to the plant family Solanaceae, which includes numerous economically important and native species (Bailey, 1971; Soil Conservation Service, 1982). Natural enemies introduced from the native ranges of TSA and WLN must utilize only the target weeds and perhaps a few other introduced non-economic solanums as host plants to protect solanaceous crops and to minimize the risk of environmental spillover (Louda *et al.*, 1997; Strong, 1997; Tisdell *et al.*, 1984). Such a high degree of host specificity, however, may be difficult to demonstrate for natural enemies introduced from foreign countries.

Silverleaf nightshade (SLN), *S. elaeagnifolium* Cav., is an endemic North American weed (Boyd *et al.*, 1983) that is a close relative of TSA and WLN and occurs sporadically in Florida (Wunderlin, 1982). SLN's center of distribution is isolated from Florida by the Gulf of Mexico and includes some areas of south Texas and northern Mexico that are climatically similar to many sites in peninsular Florida infested with TSA and WLN (Sutherst and Maywald, 1985). Furthermore, SLN is attacked by a complex of natural enemies (Goeden, 1971; Orr, 1980) that may be able to use TSA and WLN as host plants, but are unable to reproduce on potato, tomato, tobacco, pepper, or other non-target solanaceous plants in Florida with the possible exception of horsenettle (*S. carolinense* L.) and eggplant (*S. melongena* L.) (Olkers *et al.*, 1995; Orr, 1980).

One of the SLN natural enemies that may have potential as a biocontrol agent for TSA and WLN is the foliar and stem-galling nematode *Ditylenchus phyllobius* (Thorne) Filipjev (= *Nothanguina phyllobia* Thorne) (Orr, 1980; Parker, 1991). This nematode severely damages its host by causing distortion and swelling of palisade tissues in the leaves, petioles, and axillary buds. SLN plants infected by *D. phyllobius* exhibit a stunted growth pattern, reduced flowering, and premature leaf and fruit abscission. Seedlings and tender vegetatively-produced shoots of SLN attacked by the nematode are often killed (Orr, 1980).

The likelihood that *D. phyllobius* will have a similar or greater impact on TSA and WLN is based upon the "new association" hypothesis for biological control (Hokkanen and Pimentel, 1984). In this scenario, TSA and WLN may be highly susceptible to infection by *D. phyllobius* because both species are from different geographical regions where they have not coevolved with the nematode and therefore lack the defense mechanisms to resist attack. Our objective in this study was to assess the biocontrol potential of *D. phyllobius* against TSA and WLN.

Screening of the nematode was conducted from July 1995 to April 1997. Bioassays were performed under quarantine conditions because *D. phyllobius* had not been reported previously from Florida (Esser and Orr, 1979). Nematode infected SLN plants were collected in Edinburg, Hidalgo County, Texas, between March 1995 and September 1996, and processed in the laboratory at Mission, Texas. The plants were dried under forced air at 37°C for 36 h and the stems and fruits removed by hand before the galled leaf tissue was shipped to the Florida Biological Control Laboratory quarantine facility, Division of Plant Industry, Florida Department of Agriculture and Consumer Services, Gainesville. Dried leaf tissue containing infective juveniles of *D. phyllobius* (>30 000 juveniles/g) (Parker, 1991) was applied to shadehouse-grown TSA and WLN plants that were germinated from seeds and transplanted into 15-cm-diam. pots. The age of the plants at inoculation ranged from 6 to 12 months for TSA and over 12 months for WLN. To facilitate the infection process, the plants were cut back to the soil surface and allowed to develop preemergent shoots before applying the nematode-infected SLN leaf tissue. After the leaf tissue was applied to the soil surface, it was covered with a 2 cm layer of moist sand to rehydrate the gall material and revive the infective juveniles. For each plant species, five rates of dried SLN leaf tissue (3.2, 1.6, 0.8, 0.4, 0.2, and 0.0 g/plant) were tested with six replicates per treatment. The controls (0.0 g/plant) were processed in a similar manner except the SLN leaf tissue was excluded. The plants were placed in a rearing room under Gro-Lux® fluorescent lights programmed for a 14 h photophase and a temperature of 26 ± 2°C. Each test plant was maintained for 2 months post-treatment and then examined for leaf or stem galls. We also extracted the nematodes from two additional 3.2 g samples of dried SLN leaf tissue (Rodriguez-Kabana and Pope, 1981) to confirm the viability of *D. phyllobius* and to quantify the density of the infective juveniles extracted from the SLN leaf tissue. Nematode density was determined in the following manner. A 1-ml aliquot of water was withdrawn with a syringe from the container where the juveniles migrated during the extraction process (three subsamples), and the number of nematodes/ml ($\bar{x}$ ± SD) in each subsample was counted under a dissecting microscope. Voucher specimens of the infective juveniles of *D. phyllobius* were deposited in the Florida State Collection of Arthropods and Nematodes, Gainesville.

Extraction of the SLN leaf tissue confirmed the presence of the infective juveniles of *D. phyllobius* in the leaf galls. The density of the motile juveniles extracted from the two 3.2 g samples was 1240 ± 208 and 1193 ± 110 nematodes /ml. The SLN nematode failed to induce leaf or stem gall formation in either TSA or WLN even at the highest treatment rates (approximately 100 000 infective juveniles/g of SLN leaf tissue). Under these conditions, we always achieve high rates of infection of SLN. We interpret the absence of any leaf or stem galls on TSA and WLN to indicate they are unsuitable host plants for *D. phyllobius.*

The results obtained in this study thus indicate that *D. phyllobius* probably has no value as a biological control agent for TSA or WLN. However, related studies support the validity of the "new association" approach for biological control of TSA (Charudattan and DeValerio, 1995, 1996). Specifically, two strains of the soilborne plant pathogen *Pseudomonas solanacearum* (Smith 1896) Smith 1914 originally isolated from tomato were found to be highly virulent to TSA and may be developed as bioherbicides (Charudattan and DeValerio, 1996). Since the economic and ecological risks associated with introducing natural enemies of TSA and WLN from their native ranges may be difficult to resolve by state and federal regulatory agencies, the screening of additional natural enemies of SLN that exhibit some evidence of host specialization should be given high priority. The environmental risks associated with natural enemies of SLN or other native solanums that can reproduce on TSA or WLN would be low because these organisms are already components of the North American fauna and their environmental impacts in Florida would be more predictable. The utilization of these "new associates" may be a safer alternative to classical biological control of such high risk target weeds as TSA, WLN, and even turkey berry, *S. torvum* Swartz, a federally-listed noxious weed in Florida (Westbrooks and Eplee, 1989) that is also increasing in abundance.

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