RADOPHOLUS SIMILIS DAMAGE TO *ANTHURIUM ANDRAEANUM*[†]

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RESUMEN

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Se estudió el daño causado por *Radopholus similis* en *Anthurium andraeanum* cv. Marian Seefurth. Plantas de anthurium de ocho cm de altura se transplantaron en microparcelas que se fumigaron con 1,3-dicloropropano. Las plantas se incocularon con una mezcla de 0, 10, 100 ó 1000 estados diferentes de vida de *R. similis*/planta. Se registró altura de planta y número de hojas por planta durante nueve meses, y las plantas completas se cosecharon a los 16 meses. Diferencias en el crecimeinto de las plantas con diferentes niveles de inoculum se observaron al tercer mes. ($P < 0.01$). La tasa de incremento de altura de planta y número de hojas fue diferente entre todos los niveles de inoculum. La extrapolación de producción de flores a partir de los datos de crecimiento de hojas demostraron efectos acumulativos de la declinación de anthurium. Poblaciones iniciales de *R. similis* tan bajas como 10 nematodos/planta causan daño a plantas de anthurium, siendo crítico el control de nematodos para alcanzar la rentabilidad de la producción de flores de anthurium.

Palabras claves: Anthurium andraeanum, Radopholus similis, patogenicidad, reproducción de nematodo.

Radopholus similis (Cobb) Thorne is a damaging endoparasitic nematode often associated with decline-type diseases in perennial crops in which plants gradually loose vigor. In "toppling disease" of banana, severe nematode infections damage roots to the extent that plant anchorage is impaired. Lower levels of infection reduce the banana plant's ability to acquire water and nutrients, thus reducing fruit yield (Gowen and Quénéhervé, 1990). Leaves turn yellow, droop, and may even be shed in "yellows" or "slow-wilt" of pepper caused *R. similis* but the pepper plants usually do not die until 3 to 5 years after initial nematode infection (Koshy and Bridge, 1990). Citrus foliage becomes sparse and branches die in "spreading decline" (Duncan and Cohn, 1990). Citrus damaged by *R. similis* are more susceptible to wilt under water stress compared to healthy trees (DuCharme, 1968). In "anthurium decline," *R. similis* causes leaves of *Anthurium andraeanum* Linden ex André to turn yellow and plants to be stunted (Aragaki and Apt, 1984). The anthurium plants live for several years but flower yield can be decreased by as much as 50 percent (Aragaki and Apt, 1984).

The relationship between plant damage and initial plant-parasitic nematode population densities is well-documented in annual crops but less so in perennial tropical ornamentals. Yield in potato and bean is inversely related to initial nematode population densities of *Pratylenchus penetrans* (Cobb) Filipjev & Schuurmanns Stekhoven, an endoparasitic nematode closely related to *R. similis* (Elliot and Bird, 1985; Olthof, 1987). A similar type of relationship

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probably exists between *R. similis* and the perennial *A. andraeanum* as that which occurs between alfalfa and different population densities of root-knot nematode (Noling and Ferris, 1987). However, the chronic nature of the declines makes this relationship difficult to predict. The objective of this experiment was to determine the relationship between initial population densities of *R. similis* and growth of *A. andraeanum.*

Sixteen 1-m long × 0.5 m wide × 0.3 m deep microplots were established in a greenhouse with 80% saran shade at the Waiakea Research Station, Hilo, HI. The microplots were lined with a 0.2-mm thick black plastic and filled with volcanic cinder (grade #3, 9.5-19 mm diam). The microplots were fumigated with 1,3-dichloropropene at 339 kg a.i./ha and covered with plastic for 3 weeks, after which three 8-cm tall *A. andraeanum* cv. Marian Seefurth plants were transplanted into each microplot. One week later, each plant was inoculated with 0, 10, 100, or 1000 mixed life stages of *R. similis* in 20 ml aliquots. The four inoculum levels were replicated four times with three plants per replication. Treatments were arranged in a randomized block design. All plants in a microplot received the same level of nematode inoculum. The inoculum was pipetted at the plant stem and cinder media interface. *Radopholus similis* used in the inoculum was from cultures grown on sterile alfalfa callus tissue (Ko *et al.*, 1995).

Plants received standard cultivation practices for fertilization, irrigation, and insect control. Plant height and leaf numbers were determined for each plant at 1, 3, 4, 7, and 9 months after transplanting. The experiment was terminated 16 months after planting and plant shoot and root fresh weights recorded. A 100 cm^3 media sample from each microplot was assayed for nematodes in a mist chamber (Barker, 1985). Shoots and roots were separated from each plant and 20-g subsamples of the shoots and roots were assayed separately in a mist chamber to extract *R. similis.*

Plant heights and numbers of leaves were subjected to linear regression on time to determine growth rates at different initial population densities (P_i). The same data were examined using a repeated measures analysis and LSDs calculated for each P_i and date. P_f (final population density) and final plant fresh weight data were analyzed for variance and where appropriate, means separated with a Waller-Duncan k ratio t-test.

During the first 9 months, anthurium plant growth could be represented by linear equations (Fig. 1). Growth in the first month after transplanting was greater than the rates in subsequent months however. Regression models for plant height over time for each P_i are:

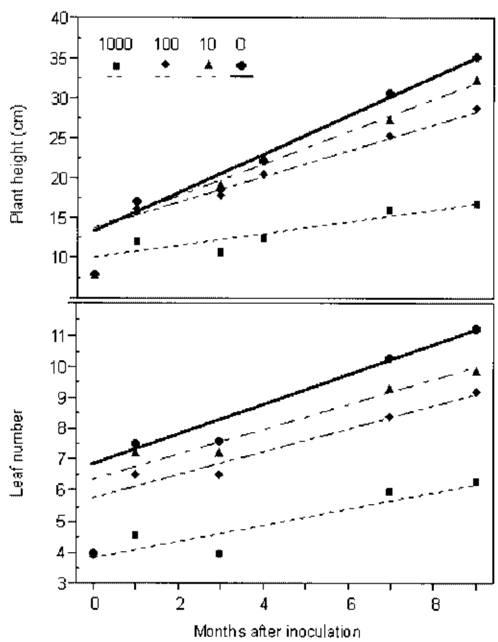

Fig. 1. Regression lines of height and leaf number of *Anthurium andraeanum* as influenced by initial population densities of *Radopholus similis.* Means of the data are shown as ■ = 1000, = 100, ▲ = 10, or = 0 nematodes/plant.

P_0 Height = 13.12 + 2.44(Month); $r^2 = 0.85$, P = 0.01,

P_{10} Height = 13.76 + 2.03(Month); $r^2 = 0.73$, P = 0.01,

P_{100} Height = 13.86 + 1.64(Month); $r^2 = 0.49$, P = 0.01,

P_{1000} Height = 10.04 + 0.77(Month); $r^2 = 0.17$, P = 0.01.

As nematode P_i increased, the slope of the regression line was smaller reflecting slower rates of growth. Within 1 month, P_{1000} plants were shorter than all other plants (Table 1). By 4 months after inoculation, the P_{100} plants were shorter than the P_0 and P_{10} plants. Burrowing nematodes did not measurably affect P_{10} plants until 7 months after inoculation.

Radopholus similis retarded leaf development as well as height of anthurium plants (Fig. 1). Since flowers subtend each new leaf in anthurium, fewer leaves result in less flower production. Flowers emerge about 4 weeks after a new leaf and are followed by new leaves a few weeks later (Dai and Paull, 1990; Kamemoto and Kuehnle, 1996). The P_{1000} level reduced leaf production by 75%. This nematode-induced growth reduction is likely to continue for as long as the nematodes are not controlled. Six flowers per main stem are considered an acceptable annual yield (Kamemoto and Kuehnle, 1996) and are usually attained by the cultivar Marian Seefurth (Dai and Paull, 1990). The estimated rate of leaf production is 0.5, 0.38, 0.36, and 0.27 leaves/month for P_0, P_{10}, P_{100}, and P_{1000}, respectively (Table 2). Given these rates of new leaf formation and the fact that flowers subtend leaves, only the P_0

Table 1. Least Square Means probability of differences in anthurium plant height between plants inoculated with 0, 10, 100, or 1000 *Radopholus similis* at different months after inoculation.

	Nematode level	P_0	P_{10}	P_{100}	P_{1000}
Month 1	P_0		ns	ns	0.01
	P_{10}	ns		ns	0.01
	P_{100}	ns	ns		0.01
	P_{1000}	0.01	0.01	0.01	
Month 3	P_0		ns	ns	0.01
	P_{10}	ns		ns	0.01
	P_{100}	ns	ns		0.01
	P_{1000}	0.01	0.01	0.01	
Month 4	P_0	ns	ns	ns	0.01
	P_{10}	ns		ns	0.01
	P_{100}	0.01	ns		0.01
	P_{1000}	0.01	0.01	0.01	0.01
Month 7	P_0		0.03	0.01	0.01
	P_{10}	0.03		ns	0.01
	P_{100}	0.01	ns		0.01
	P_{1000}	0.01	0.01	0.01	
Month 9	P_0		ns	0.01	0.01
	P_{10}	ns		0.02	0.01
	P_{100}	0.01	0.02		0.01
	P_{1000}	0.01	0.01	0.01	

Table 2. Estimated flower production of *Anthurium andraeanum* infected with different initial levels of *Radopholus similis.* Flower production is based upon flowers subtending each new leaf in mature *A. andraeanum.*

Initial nematode number	Leaf number equation	Estimated cumulative flower harvest			
		12 months	24 months	36 months	48 months
P_0	6.63 + 0.5 (month) $r^2 = 0.47$, $P = 0.01$	6	12	18	24
P_{10}	6.48 + 0.38 (month) $r^2 = 0.33$, $P = 0.01$	4	9	14	18
P_{100}	5.83 + 0.36 (month) $r^2 = 0.42$, $P = 0.01$	4	8	13	17
P_{1000}	3.85 + 0.27 (month) $r^2 = 0.21$, $P = 0.01$	3	6	10	13

level was likely to achieve an acceptable level of flower production.

At 16 months, total root and shoot weight mimicked projected flower number (Table 2). The uninfected plants were 365% larger than the P_{1000} plants. Fresh root weight was 61, 47, 42, and 20 g for lowest to highest P_is, respectively (minimum significant difference (msd) 15, k ratio = 100). Shoot fresh weight decreased with increasing P_i at the termination of the experiment (85, 69, 52, and 20 g, respectively; msd 18, k ratio = 100).

Final nematode population densities differed among the P_is in the root tissue but not in the stem or media. Final population densities were 611, 99, 214, and 0 nematodes/g root in P_{1000}, P_{100}, P_{10}, and P_0 plants, respectively (msd 462, k ratio = 100). These population densities reflect the plant damage caused by previous nematode generations. Initial nematode populations may retard plant growth thus limiting food sources for subsequent nematode populations. Nematode numbers ranged from 0-109/100 cm^3 of media and from 0-2/g stem tissue but did not differ among the P_is ($P > 0.05$).

Radopholus similis is insidious in anthurium. Damage to anthurium is a function of P_i and length of exposure. At high initial population densities, the nematodes incite obvious reductions in plant growth. The effects of low and moderate initial population densities become more pronounced and serious over time resulting in the chronic disease called anthurium decline.

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LITERATURE CITED

ARAGAKI, M., and W. J. APT. 1984. Nature and control of anthurium decline. Plant Disease 68:509-511.

BARKER, K. R. 1985. Nematode extraction and bioassay. Pp. 19-35 *in* K. R. Barker, C. C. Carter, and J. N. Sasser, eds. An Advanced Treatise on *Meloidogyne.* Vol. II: Methodology. North Carolina State University Graphics, Raleigh, NC, U.S.A.

DAI, J., and R. E. PAULL. 1990. The role of leaf development on anthurium flower growth. Journal of the American Society of Horticultural Science 115:901-905.

DuCHARME, E. P. 1968. Burrowing nematode decline of citrus: a review. Pp. 20-37 *in* G. C. Smart, Jr., and V. G. Perry, eds. Tropical Nematology. University of Florida Press, Gainesville, FL, U.S.A.

DUNCAN, L. W., and E. COHN. 1990. Nematode parasites of citrus. Pp. 321-346 in M. Luc, R. A. Sikora, and J. Bridge, eds. Plant Parasitic Nematodes in Subtropical and Tropical Agriculture. CAB International, Wallingford, U.K.

ELLIOT, A. P., and G. W. BIRD. 1985. Pathogenicity of *Pratylenchus penetrans* to navy bean (*Phaseolus vulgaris* L.). Journal of Nematology 17:81-85.

GOWEN, S., and P. QUÉNÉHERVÉ. 1990. Nematode parasites of bananas, plantains and abaca. Pp. 431-460 *in* M. Luc, R. A. Sikora, and J. Bridge, eds. Plant Parasitic Nematodes in Subtropical and Tropical Agriculture. CAB International, Wallingford, U.K.
KAMEMOTO, H., and A. R. KUEHNLE. 1996. Breeding anthuriums in Hawaii. University of Hawaii Press, Honolulu, HI, U.S.A.
KO, M. P., D. P. SCHMITT, and B. S. SIPES. 1996. Axenizing and culturing endomigatory plant-parasitic nematodes using Pluronic® F127, including its effects on population dynamics of *Pratylenchus penetrans.* Journal of Nematology 28:115-123.
KOSHY, P. K., and J. BRIDGE. 1990. Nematode parasites of spices. Pp. 557-582 *in* M. Luc, R. A. Sikora, and J. Bridge, eds. Plant Parasitic Nematodes in Subtropical and Tropical Agriculture. CAB International, Wallingford, U.K.
NOLING, J. W., and H. FERRIS. 1987. Nematode-degree days, a density-time model for relating epidemiology and crop losses in perennials. Journal of Nematology 19:108-118.
OLTHOF, T. H. 1987. Effects of fumigants and systemic pesticides on *Pratylenchus penetrans* and potato yield. Journal of Nematology 19:424-430.

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