HOST STATUS OF EIGHTEEN VEGETABLE CROPS FOR *PRATYLENCHUS BRACHYURUS*

Andressa C. Z. Machado,[1,2] and M. M. Inomoto[1]

Departamento de Entomologia, Fitopatologia e Zoologia Agrícola, Escola Superior de Agricultura "Luiz de Queiroz", Universidade de São Paulo, Caixa Postal 9, 13418-900 Piracicaba, SP, Brazil;[1] Fellow of CNPq.[2]

ABSTRACT

Machado, A. C. Z., and M. M. Inomoto. 2001. Host status of eighteen vegetable crops for *Pratylenchus brachyurus*. Nematropica. 31:259-265.

Eighteen vegetable crops species were tested as hosts for *Pratylenchus brachyurus* under greenhouse conditions: cabbage, cantaloupe, carrot, cauliflower, Chinese kale, cucumber, eggplant, gherkin, green onion, kale, lettuce, okra, onion, pea, squash, sweet pepper, tomato, and watermelon. Corn and French marigold were included as standard resistant and susceptible hosts, respectively. Under onion, cabbage, sweet pepper, carrot, lettuce and the French marigold control the nematode population declined. Cucumber, okra, tomato and cantaloupe were very susceptible to *P. brachyurus*. Reproduction of *P. brachyurus* on these plants was equal to or even higher than on corn.

Key words: Abelmoschus esculentus, Allium cepa, Allium fistulosum, Brassica oleracea var. *acephala, Brassica oleracea* var. *botrytis, Brassica oleracea* var. *capitata, Brassica chinensis, Capsicum annuum, Citrullus vulgaris, Cucumis anguria, Cucumis melo, Cucumis sativus, Cucurbita pepo, Daucus carota*, host range, *Lactuca sativa*, lesion nematodes, *Lycopersicon esculentum, Pisum sativum, Pratylenchus brachyurus, Solanum melongena.*

RESUMEN

Machado, A. C. Z., y M. M. Inomoto. 2001. Reacción de dieciocho hortalizas a *Pratylenchus brachyurus*. Nematrópica. 31:259-265.

Dieciocho especies de hortalizas se evaluaron con relación a sus reacciones a *Pratylenchus brachyurus* en condiciones de invernadero. Las hortalizas seleccionadas fueron: berenjena, calabaza, cebolla, cebolla verde, col, col china, coliflor, guisante, lechuga, melón, pimentón, pepino, pepinillo, okra, repollo, sandía, tomate y zanahoria. Se incluyeron maíz y tagete enano como patrón susceptible y resistente, respectivamente. En cebolla, repollo, pimentón, zanahoria, lechuga, así como en el tagete, la población del nematodo se redujo. Pepino, okra, tomate y melón probaron ser hospederos muy susceptibles de *P. brachyurus*. La reproducción de *P. brachyurus* en estas especies fue similar o mayor que en maíz.

Palabras claves: Abelmoschus esculentus, Allium cepa, Allium fistulosum, Brassica oleracea var. *acephala, Brassica oleracea* var. *botrytis, Brassica oleracea* var. *capitata, Brassica chinensis, Capsicum annuum, Citrullus vulgaris, Cucumis anguria, Cucumis melo, Cucumis sativus, Cucurbita pepo, Daucus carota, Lactuca sativa, Lycopersicon esculentum*, nematodos lesionadores, *Pisum sativum, Pratylenchus brachyurus, Solanum melongena.*

INTRODUCTION

Nematodes are major pests of vegetable and tuber crops, mainly under intensive production systems. The lesion nematode, *Pratylenchus brachyurus* (Godfrey) Filipjev, is widespread in vegetable production areas of Brazil (Lordello *et al.*, 1954; Lordello and Mello-Filho, 1971; Sharma and Loof, 1977; Sharma and Ekhardt, 1979; Ferraz, 1980; Campos and Sturhan, 1987; Café-Filho and Huang, 1988). Unfortunately, the widespread occurrence and damage caused by species of root-knot

nematodes (*Meloidogyne* spp.) often masks the importance of other nematodes, including lesion nematodes (Jatala and Bridge, 1990; Netscher and Sikora, 1990).

Pratylenchus brachyurus produces small lesions on the surface of potato tubers, and reduces potato quality in São Paulo State (Lordello *et al.*, 1954). This nematode also provokes extensive lesions in roots of okra, resulting in plant growth reduction in Rio de Janeiro State (J. P. Pimentel, pers. comm.). However, its importance to other vegetable crops in Brazil is unknown. Although *P. brachyurus* is a polyphagous parasite, its host range has not been conclusively determined, so crop rotation recommendations for nematode management are not available. Among the thirty-four plant genotypes tested for host-suitability to *P. brachyurus* by Endo (1959), only four were vegetable or tuber crops: cucumber, lettuce, potato and watermelon. Charchar and Huang (1981) studied the host status of nineteen vegetable and tuber crops for *P. brachyurus* under greenhouse conditions. Eleven of those plants tested maintained or increased population densities of *P. brachyurus*, with multiplication factors (Pf/Pi: final population density at the end of the experiment/initial population density) ranging from 1.0 to 55. Only eight of these crops may be useful in a crop rotation practice for *P. brachyurus* management. However, contradictory results were reported by Khan (1992), who studied the reproduction of *P. brachyurus* on local cultivars of 30 vegetable crops in northern Nigeria. Complementary studies are needed to clarify host status of the plants studied by Endo (1959), Charchar and Huang (1981), and Khan (1992) to *P. brachyurus*.

The objective of our research was to determine the host status to *P. brachyurus* of eighteen commonly cultivated vegetable and tuber crops in Brazil. This will provide information for further studies on crop rotation for *P. brachyurus* management.

MATERIALS AND METHODS

General procedures: *Pratylenchus brachyurus* (Pb) was isolated from okra roots in Seropédica, RJ, Brazil. One single female was used to produce a monoxenic culture of Pb (Pb20) on alfalfa callus *in vitro* (Riedel *et al.*, 1973). This isolate had been maintained *in vitro* for 3-4 years. Specimens of Pb were heat killed, mounted on glass slides with 2% formaldeyde, and identified by light microscopy (Loof, 1978; Handoo, 1989). Juvenile and adult Pb, obtained from alfalfa callus by a Baermann method modified for flat recipient (Southey, 1986), were used as inoculum. Corn (*Zea mays* L.) cv. IAPAR 26 was selected as a standard susceptible host for Pb. French marigold (*Tagetes patula* L.) was chosen as a standard resistant host (Winoto-Suatmadji, 1969). Experiments were done in a greenhouse in Piracicaba, SP, Brazil.

Experiment 1: Eight vegetable crops were tested in experiment 1: lettuce cv. Grandes Lagos (*Lactuca sativa* L.), eggplant cv. Embu (*Solanum melongena* L.), onion cv. Baia Periforme (*Allium cepa* L.), carrot cv. Nantes (*Daucus carota* L.), pea cv. Marina A-034 (*Pisum sativum* L.), cucumber Vista Alegre AG-213 hybrid (*Cucumis sativus* L.), okra cv. Santa Cruz 47 (*Abelmoschus esculentus* (L.) Moench), and tomato cv. Super Marmande (*Lycopersicon esculentus* Mill.). Lettuce, eggplant, onion, pea, tomato and the French marigold were sown in a tray, and transplanted into 500 ml plastic pots (two seedlings per pot), each containing 400 ml of soil sterilized with methyl bromide (150 ml/1 000 L soil). Nematodes were inoculated ten days after transplanting. Carrot was sown directly in 500 ml plastic pots, thinned to two plants per pot ten days after germination, and Pb was inoculated twenty

days after thinning. Cucumber, okra and corn were also sown directly and thinned to two plants per pot ten days after germinating, and Pb was inoculated ten days after thinning. These procedures were done because the plants demand different times to reach consistent root biomass. For inoculations, 2 ml of an aqueous suspension containing approximately 500 Pb per ml, were added to two small holes in the soil, 2 cm deep, near the plants.

Experiment 2: In this experiment, ten other vegetable crops were tested: squash cv. Menina Brasileira (*Cucurbita moschata* Duch.), green onion cv. Todo ano (*Allium fistulosum* L.), Chinese kale cv. Comum (*Brassica chinensis* L.), cauliflower Sol de Verão AG-180 hybrid (*Brassica oleracea* L. var. *botrytis*), kale cv. Manteiga (*Brassica oleracea* L. var. *acephala* DC), gherkin cv. Do Norte (*Cucumis anguria* L.), watermelon cv. Rajada (*Citrullus vulgaris* Schrad.), cantaloupe cv. Valenciano (*Cucumis melo* L.), sweet pepper cv. Cascadura Ikeda (*Capsicum annuum* L.), and cabbage cv. Chato de Brunswich (*Brassica oleracea* L. var. *capitata*). Green onion, Chinese kale, cauliflower, kale, sweet pepper and cabbage were sown in a tray and later transplanted into 500 ml plastic pots, containing approximately 400 ml of sterilized soil. Squash, gherkin, watermelon and cantaloupe were obtained by direct sowing in recipients similar to those used for the transplanted plants. Fifteen days after transplanting green onion, Chinese kale, cauliflower, kale, sweet pepper and cabbage, and three days after germination of squash, gherkin, watermelon and cantaloupe, the nematodes were inoculated, using a procedure similar to that described in experiment 1.

Experiment 3 and 4: The most resistant Pb hosts determined in experiments 1 and 2 (pea, onion, carrot, lettuce, cabbage, watermelon, green onion, and sweet pepper) were retested in these experiments. This was done in the same manner way as described before, except for a lower inoculum density in experiment 4 (400 Pb per pot).

Experimental design and data analysis: All experiments were set up in a completely randomized design, with five (experiments 1 and 2) or six replicates (experiments 3 and 4) per treatment. Each replicate was a plastic pot containing two plants. Sixty-five days after inoculation in experiment 1, and 60 days in experiments 2, 3 and 4, nematodes were extracted from roots and soil according to the methods of Coolen and D'Herde (1972) and Jenkins (1964), respectively. Final population density of Pb was determined by counting juveniles and adults extracted from roots and soil, using Peters counting slides and light microscopy. Multiplication factors (Pf/Pi) were calculated and normalized using a logarithmic transformation ($\log [x + 1]$) prior to analysis. Computer software (SANEST, CIAGRI, Piracicaba, SP) was used for analysis of variance, and Tukey's Honestly Significant Difference Test ($P \leq 0.05$) was used for mean separation. Susceptible hosts were those with Pf/Pi higher than or equal to corn, and resistant hosts those with Pf/Pi lower than or equal to French marigold.

Nematodes extracted at the ends of experiments were prepared as vouchers. Vials containing females and juveniles of Pb in 2% formaldeyde were labeled Pb20/ESALQ/1998, and deposited to Nematology collection of Departamento de Entomologia, Fitopatologia e Zoologia Agrícola, ESALQ/USP, Piracicaba, Brazil. This isolate is being maintained *in vitro* (alfalfa callus) and on corn plants in the greenhouse.

RESULTS AND DISCUSSION

Experiment 1: The multiplication factors of Pb on onion, carrot and lettuce were not different from that of the standard resistant host, French marigold ($P < 0.05$;

Table 1). This result confirmed the report by Charchar and Huang (1981). Endo (1959) and Khan (1992) also obtained low multiplication of Pb on lettuce (Pf/Pi = 0.02) and on onion (0.6), respectively (Table 1). However, Lordello and Mello-Filho (1981) reported root damage caused by Pb on onion in Brazil, and Khan (1992) reported carrot and lettuce to be susceptible hosts (Pf/Pi = 4.1 and 4.6, respectively).

Populations increased strongly (Pf/Pi ≥ 7) on cucumber, okra, and tomato, as reported earlier (Charchar and Huang, 1981; Khan, 1992), although the level of increase varied between these studies. In contrast, Endo (1959) observed a decline in Pb on cucumber, and Osseni (1985) reported that Pb numbers in roots of pineapple planted intercropped with okra were lower than those observed in monoculture, suggesting that okra suppressed Pb. Such discrepancies may be due to the preference of Pb for okra roots, maintaining pineapple roots temporarily free of nematodes, and to the difference among isolates of Pb and cultivars of cucumber and okra used in the reports. The Pb20 was a vigorous isolate, which had caused extensive root necrosis on okra under field conditions (J. P. Pimentel, pers. comm.). Cucumber cultivars used by Endo (1959), Charchar and Huang (1981) and in our study were Model, Aodai and Vista Alegre AG-213 hybrid, respectively. Osseni (1985) used okra cv. Long Perking Pod in his experiment and we tested Santa Cruz 47. Khan (1992) did not indicate the okra cultivars used.

Intermediate populations occurred after eggplant and pea, confirming the report by Charchar and Huang (1981), but in

Table 1. Multiplication factors (Pf/Pi) of *Pratylenchus brachyurus* in eight vegetable crops and standard hosts in experiment 1, and in previous reports.

Treatments	Experiment 1 (65 dai[v])	Endo, 1959 (60 dai)	Charchar and Huang, 1981 (90 dai)	Khan, 1992 (75 dai)
Cucumber	16.69 a[w]	0.22[x]	2.48 bc[y]	—
Okra	15.06 ab	—[z]	3.23 bc	30.5[x]
Tomato	8.18 bc	—	54.53 a	26.5
Corn	7.00 c	2.4	—	—
Eggplant	2.78 d	—	2.45 bc	31.4
Pea	1.20 de	—	0.50 c	10.1
Onion	0.73 e	—	0.28 c	0.6
Carrot	0.71 e	—	0.00 c	4.1
Lettuce	0.65 e	0.02	0.00 c	4.6
French marigold	0.20 e	—	—	—

[v]Days after inoculation.
[w]Values transformed to log $(x + 1)$ before statistic analysis, but untransformed means of five replicates are shown; means in column followed by the same letter do not differ according to Tukey's Honestly Significant Difference Test ($P \leq 0.05$).
[x]Study without statistic analysis.
[y]Duncan's Multiple Range Test ($P \leq 0.05$).
[z]Plant not tested.

Khan's (1992) study these crops resulted in a strong population increase (Pf/Pi > 10).

Experiment 2: Multiplication factors of Pb on sweet pepper, green onion, watermelon and cabbage were below 1.0, and did not differ from French marigold ($P \leq 0.05$; Table 2). Therefore, these plant species were resistant hosts of Pb. Charchar and Huang (1981) found similar results on cabbage, but sweet pepper, green onion and watermelon maintained or increased Pb (Table 2). Khan (1991) reported strong population increase (Pf/Pi > 9) under sweet pepper, watermelon and cabbage. Endo (1959) also obtained contrasting results for watermelon which supported high numbers of Pb during 5 months, although Pf/Pi was not given. Among the vegetable crops tested in experiment 2, cantaloupe was the most susceptible host of Pb, confirming Charchar and Huang's (1981) study. Squash, another cucurbitaceous plant, also increased Pb numbers, although not as much as corn and cantaloupe. Gherkin, cauliflower, Chinese kale and kale were moderate hosts for Pb, with multiplication factors less than unity, but higher than that for French marigold. Comparing our results with those of Charchar and Huang (1981), the multiplication factor of Pb on kale was similar, but on gherkin it was lower (Pf/Pi = 0.47 versus 2.18), and on cauliflower was slightly higher (0.52 versus 0.02). Khan (1992) obtained a

Table 2. Multiplication factors (Pf/Pi) of *Pratylenchus brachyurus* in ten vegetable crops and standard hosts in experiment 2, and in previous reports.

Treatments	Experiment 2 (60 dai[v])	Charchar and Huang, 1981 (90 dai)	Khan, 1992 (75 dai)
Cantaloupe	6.75 a[w]	54.31 a[x]	—
Corn	6.33 a	—[y]	—
Squash	2.61 b	1.25 c	—
Kale	1.00 c	0.80 c	—
Chinese kale	0.96 c	—	—
Cauliflower	0.52 cd	0.02 c	9.8[z]
Gherkin	0.47 cd	2.18 bc	—
Cabbage	0.31 de	0.00 c	9.2
Watermelon	0.16 de	2.21 bc	21.8
Green onion	0.13 de	1.53 c	—
Sweet pepper	0.07 de	1.00 c	27.8
French marigold	0.01 e	—	—

[v]Days after inoculation.
[w]Values transformed to log $(x + 1)$ before statistic analysis, but untransformed means of five replicates are shown; means in column followed by the same letter do not differ according to Tukey's Honestly Significant Difference Test ($P \leq 0.05$).
[x]Duncan's Multiple Range Test ($P \leq 0.05$).
[y]Plant not tested.
[z]Study without statistic analysis.

9.8-fold increase for Pb population on cauliflower. Chinese kale has not been previously tested for Pb reproduction.

Experiments 3 and 4: Low multiplication of Pb on the susceptible standard host corn in experiments 3 and 4, was probably due to low greenhouse temperatures during the autumn and winter test periods. All tested plants had lower multiplication factors for Pb than did the susceptible standard host ($P \leq 0.05$; Table 3). Multiplication of Pb on onion, cabbage, sweet pepper, carrot, and lettuce did not differ from the resistant host in either experiment. Thus, they were confirmed as resistant hosts of Pb. Although Pb had been reported to cause damage on onion in Brazil (Lordello and Mello-Filho, 1981), onion was consistently resistant to Pb in these three experiments and in Charchar and Huang's (1981) report. Carrot was also consistently resistant to Pb in Charchar and Huang's (1981) and our experiments. Moreover, in a greenhouse experiment, carrot cv. Nantes did not increase Pb population and had no damage, even at high initial population densities (27 000 Pb nematodes per 8-liter pot; Bessi and Monteiro, 1990).

Table 3. Multiplication factors (Pf/Pi) of *Pratylenchus brachyurus* in eight vegetable crops and standard hosts.

Treatments	Experiment 3 (60 dai[y])	Experiment 4 (60 dai)
Corn	1.87 a[z]	2.17 a
Watermelon	0.39 b	0.06 d
Onion	0.13 c	0.17 cd
Green onion	0.12 c	0.25 c
Sweet pepper	0.12 c	0.05 d
Cabbage	0.12 c	0.09 cd
Pea	0.11 c	0.66 b
Lettuce	0.09 c	0.16 cd
Carrot	0.01 c	0.06 d
French marigold	0.00 c	0.00 d

[y]Days after inoculation.

[z]Values transformed to log $(x+1)$ before statistic analysis, but untransformed means of six replicates are shown; means in columns followed by the same letter do not differ according Tukey's Honestly Significant Difference Test ($P \leq 0.05$).

Although Pb population densities decreased, watermelon and green onion had higher multiplication factors than French marigold in experiments 3 and 4, respectively. Endo (1959) also reported watermelon as a good host of Pb. Pea was less resistant to Pb than French marigold in experiment 4 and increased Pb population slightly (Pf/Pi = 1.2) in experiment 1 (Table 1). Thus, pea is considered somewhat resistant to Pb, but less useful to decrease Pb populations than are onion, cabbage, sweet pepper, carrot and lettuce.

Most of our results agree with those of Endo (1959), and Charchar and Huang (1981). Differences may be due to the genetic variability of the plants (cultivars) or the nematode (isolate). Among previous reports, Khan's (1992) results differed the most from ours with regard to carrot, lettuce, cabbage, cauliflower and sweet pepper. We suggest that these differences may have been due to the presence of other *Pratylenchus* species in the inoculum used by Khan (1992), who reported that males were commonly recovered at harvest. *P. brachyurus* is parthenogenic and males should be absent or very rare in the population (Corbett, 1976).

In conclusion, among 18 vegetable crops tested, five may be useful as a rotational crop to reduce population densities of Pb: onion cv. Baia Periforme, cabbage cv. Chato de Brunswich, sweet pepper cv. Cascadura Ikeda, carrot cv. Nantes, and lettuce cv. Grandes Lagos. French marigold supported the smallest multiplication factor of Pb in all experiments confirming its resis-

tance to Pb. Additional research is needed to determine if others cultivars of these plant species have the same response to Pb. Moreover, field experiments should be conducted to determine the time necessary for these plants to effectively decrease Pb numbers in soil to non-damaging levels. Cucumber, tomato, okra and cantaloupe should be avoided in soils heavily infested with Pb.

ACKNOWLEDGMENTS

The authors wish to acknowledge Soraya de Carvalho França for manuscript review, and Rosangela Aparecida da Silva for her assistance in managing the experiments.

LITERATURE CITED

BESSI, R., and A. R. MONTEIRO. 1990. Patogenicidade de *Pratylenchus brachyurus* em cenoura. Papers presented at the XIV Congresso Brasileiro de Nematologia, Londrina, Brazil.

CAFÉ-FILHO, A. C., and C. S. HUANG. 1988. Nematóides do gênero *Pratylenchus* no Brasil. Fitopatologia Brasileira 13:232-235.

CAMPOS, V. P., and D. STURHAN. 1987. Ocorrência e distribuição de nematóides em hortaliças em Minas Gerais. Nematologia Brasileira 11:153-158.

CHARCHAR, J. M., and C. S. HUANG. 1981. Círculo de hospedeiras de *Pratylenchus brachyurus*—II: Hortaliças. Fitopatologia Brasileira 6:57-65.

COOLEN, W. A., and C. J. D'HERDE. 1972. A Method for the Quantitative Extraction of Nematodes from Plant Tissue. State Nematology and Entomology Research Station, Ghent, Belgium.

CORBETT, D. C. M. 1976. C.I.H. Descriptions of Plant-parasitic Nematodes. Set 6, no. 89. C.I.H., St. Albans, U.K.

ENDO, B. Y. 1959. Responses of root-lesion nematodes, *Pratylenchus brachyurus* and *P. zeae*, to various plants and soil types. Phytopathology 49:417-421.

FERRAZ, S. 1980. Reconhecimento das espécies de fitonematóides presentes nos solos do estado de Minas Gerais. Experientiae 26: 255-328.

HANDOO, Z. A., and M. A. GOLDEN. 1989. A key and diagnostic compendium to the species of the genus *Pratylenchus* Filipjev. Journal of Nematology 21:202-210.

JATALA, P., and J. BRIDGE. 1990. Nematode parasites of root and tuber crops. Pp. 137-180 *in* M. Luc, R. A. Sikora, and J. Bridge, eds. Plant Parasitic Nematodes in Subtropical and Tropical Agriculture. CAB International, Wallingford, U.K.

JENKINS, W. R. 1964. A rapid centrifugal-flotation technique for separating nematodes from soil. Plant Disease Reporter 48:692.

KHAN, F. A. 1992. Multiplication rates of *Pratylenchus brachyurus* in some vegetable crops in northern Nigeria. Crop Protection 11:127-130.

LOOF, P. A. A. 1978. The Genus *Pratylenchus* Filipjev, 1936 (Nematoda: Pratylenchidae): a Review of its Anatomy, Morphology, Distribution, Systematics and Identification. Swedish University of Agricultural Sciences Research Information Centre, Uppsala, Sweden.

LORDELLO, L. G. E., and A. T. MELLO-FILHO. 1981. Ocorrência de nematóides em cultura de cebola. Pesquisa Agropecuária Brasileira 5:127-128.

LORDELLO, L. G. E., A. P. L. ZAMITH, and O. J. BOOCK. 1954. Novo nematódeo parasito da batatinha. Bragantia 13:141-149.

NETSCHER, C., and R. A. SIKORA. 1990. Nematode parasites of vegetables. Pp. 237-283 *in* M. Luc, R. A. Sikora, and J. Bridge, eds. Plant Parasitic Nematodes in Subtropical and Tropical Agriculture. CAB International, Wallingford, U.K.

OSSENI, B. 1985. Les cultures associées à la culture de l'ananas: action sur le nématode *Pratylenchus brachyurus*, la croissance et le rendement de l'ananas "Cayenne lisse". Fruits 40:709-718.

RIEDEL, R. M., J. G. FOSTER, and W. F. MAI. 1973. A simplified mediem for monoxenic culture of *Pratylenchus penetrans* and *Ditylenchus dipsaci*. Journal of Nematology 5:71-72.

SHARMA, R. D., and R. EKHARDT. 1979. Incidência de nematóides fitoparasitos no estado do Amazonas, Brasil. Fitopatologia Brasileira 4:151.

SHARMA, R. D., and P. A. A. LOOF. 1977. Nematodes of the cocoa region Bahia, Brazil. VII. Nematodes associated with vegetables. Sociedade Brasileira de Nematologia 2:125-133.

SOUTHEY, J. F. 1986. Laboratory Methods for Work with Plant and Soil Nematodes. H.M.S.O., London, U.K.

WINOTO-SUATMADJI, R. 1969. Studies on the Effect of *Tagetes* Species on Plant Parasitic Nematodes. H. Veenman & Zonen N.V., Wageningen, Netherlands.

Received: 9.III.2001

Recibido:

Accepted for publication: 18.V.2001

Aceptado para publicación:

BLANK PAGE USED IN PAGE COUNT