# HOST EFFICIENCY OF POTATO TO *MELOIDOGYNE INCOGNITA* AND DAMAGE THRESHOLD DENSITIES ON POTATO[1]

M. Canto-Saenz and B. B. Brodie

Respectively, Associate Professor, Depto. de Fitopatologia, U.N.A. La Molina, Apartado 456, La Molina, Lima, Peru and Visiting Scientist, Department of Nematology and Entomology, International Potato Center, Lima, Peru; Plant Pathologist, USDA, ARS, Department of Plant Pathology, Cornell University, Ithaca, NY 14853, U.S.A.

*Accepted:*

*2.VIII.1986*

*Aceptado:*

ABSTRACT

Canto-Saenz, M., and B. B. Brodie. 1986. Host efficiency of potato to *Meloidogyne incognita* and damage threshold densities on potato. Nematropica 16:109-116.

Host efficiency of selected clones of *Solanum tuberosum* spp. *andigena* (TA) and of *S. sparsipilum* x (*S. phureja* x *S. tuberosum*) (SPT) for 3 geographically isolated populations of race 1 and one population of each of the other 3 races of *Meloidogyne incognita* was studied. All TA clones were efficient hosts for all populations, but efficiency of SPT clones varied. On efficient hosts of *M. incognita,* race 2 was more aggressive than the other races and reproduced under a wider range of temperatures. According to tuber weight at harvest and nematode reproduction 60 days after inoculation, one susceptible TA clone was tolerant to *M. incognita.* Under conditions of our experiment, the damage threshold density of *M. incognita* was 5 eggs/g of soil for a susceptible TA clone and 10 eggs/g of soil for a susceptible SPT clone.

*Additional key words: resistance, nematode races.*

RESUMEN

Canto-Saenz, M. y B. B. Brodie. 1986. Eficiencia de clones de papa como hospederos de *Meloidogyne incognita* y su nivel danīno. Nematropica 16:109-116.

Se estudio la eficiencia de clones selectos de *Solanum tuberosum* spp. *andigena* (TA) y de *S. sparsipilum* x (*S. phureja* x *S. tuberosum*) (STP) a 3 poblaciones, geograficamente aisladas, de la raza l y a una población de cada una de las otras 3 razas de *Meloidogyne incognita.* Todos los clones TA fueron hospederos eficientes para todas las poblaciones, pero esta eficiencia fue variable en los clones SPT. Se reconocio la raza 2 como la mas agresiva, y la que pudo reproducirse bajo un rango mas amplio de temperaturas. De acuerdo al peso de los tuberculos a la cosecha, y a la reproducción del nematodo 60 dias después de la inoculación, se encontro que uno de los clones TA es tolerante al *M. incognita.* Bajo las condiciones de nuestro experimento, el nivel dañino del *M. incognita* fue 5 huevecillos/g de suelo para los clone TA, y de 10 huevecillos/g de suelo para los clones SPT.

*Palabras claves adicionales: resistencia, razas de Meloidogyne incognita.*

## INTRODUCTION

Resistance in *Solanum tuberosum* L. (potato) to *Meloidogyne incognita* (Kofoid & White) Chitwood was first investigated in India where the cultivar 'HC 294' was reported as resistant (11,13). In Peru, the hybrid 'Inti Sipa' (*S. tuberosum* ssp. *tuberosum* x [*S. demissum* Lindl. x *S. tuberosum* ssp. *andigena* (Juz. et Buk.) Hawks]) and the cultivars 'Inca Huasi', 'Porcon Sipa', and 'Chata Negra' were reported as resistant to *M. incognita* (8). Later, different levels of resistance to *M. incognita acrita* were reported for several diploid species of *Solanum* from Peru, but it was concluded that *S. demissum* and *S. sparsipilum* (Britt.) Juz. et Buk. were the most promising sources of resistance (9,10). *Solanum bijugum* Bitter, *S. commersonii* Dun., *S. tascalense* Bruche, and *S. chaconse* Bitter were also reported to possess resistance to *M. hapla* Chitwood, *M. javanica* (Treub) Chitwood, *M. incognita,* and *M. thamesi* Chitwood (4). Several clones of *S. tuberosum* spp. *andigena* were reported as resistant to *M. incognita, M. javanica, M. arenaria* (Neal) Chitwood, and *M. hapla* (3).

Nematode threshold density varies with nematode species, race, host variety, and environment (1). The damage threshold density of *M. hapla* on potatoes was estimated to be one juvenile/100 g of soil (14). We found no reports of the damage threshold density of *M. incognita* on potatoes.

The objectives of this study were to determine host efficiency of several potato clones for different populations of *M. incognita,* and the damage threshold density of *M. incognita* on potato clones of different genotypes.

## MATERIALS AND METHODS

Five clones of *S. tuberosum* ssp. *andigena* (TA) from the Cornell University germplasm collection and 7 clones of *S. sparsipilum* x (*S. phureja* Juz. et Buk. x haploid of *S. tuberosum* ssp. *tuberosum*) (SPT) originally obtained from the International Potato Center, Lima, Peru were used. Rooted stem cuttings were transplanted individually into 500-$cm^3$ clay pots that were filled with a mixture of recycled soil of unknown constitution, sand, and peat (2:1:1). The pots were placed in a greenhouse where the temperature ranged from 23 C at night to 28 C during the day. The plants were inoculated with 10,000 eggs/pot of different *M. incognita* populations two days after transplanting. These populations were from North Carolina (population A), Georgia (population B), and races l, 2, 3, and 4 from the North Carolina International Meloidogyne Project (IMP). Single eggmass subcultures (SP) of populations A and B were compared with the original populations (OP). Final population

(Pf), final/initial population ratios (Pf/Pi), and number of eggs/g of root were measured 50 days after inoculation. If the Pf/Pi ratio was >1, the plants were considered efficient hosts. Three replications were used in the first trial, and clones that were rated nonefficient hosts were reevaluated in a six-replicate test.

Damage to potatoes by *M. incognita* was assessed by transplanting rooted stem cuttings of selected TA clones into 5000-$cm^3$ clay pots that were immersed in sand in a screenhouse where temperature ranged from 20-30 C during the study. The potting mixture was the same as for the host efficiency study. Two days after transplanting, the cuttings were inoculated with *M. incognita* original population B at 0, 0.1, 0.5, 1.0, or 5.0 eggs/g of soil, with each density level replicated 4 times. Selected SPT clones were similarly grown and inoculated with population B at 0, 0.5, 1.0, 5.0, or 10.0 eggs/g of soil. The Pf/Pi ratios and number of eggs/g of root were measured 60 days after inoculation. Plant height and weights of roots, tubers, and foliage were recorded 60 days after inoculation and at harvest (120 days after planting).

## RESULTS

*Host efficiency.* All 5 TA clones and one SPT clone were efficient hosts (EH) for populations A and B of *M. incognita* and 4 SPT clones were nonefficient hosts (NEH) for both populations (data not shown). Two SPT clones, H2 and F2, were nonefficient hosts for population B, but efficient hosts for population A (Table 1). There was very little reproduction of the single eggmass subculture of population A when initially tested on these 2 clones. When retested against the single eggmass population and the original population A, both clones were efficient hosts for both populations (Table 1). The Pf/Pi ratio of the single

Table 1. Pf/Pi ratios of populations A and B of *Meloidogyne incognita* on two clones of *Solanum sparsipilum* x (*S. phureja* x *S. tuberosum* ssp. *tuberosum*).

| | First Trial | | | | Second Trial | |
|---|---|---|---|---|---|---|
| | Population A | | Population B | | Population A | |
| Clone | OP[x] | SP[y] | OP | SP | OP | SP |
| H2 | 6 | 0.2[z] | 0 | 0 | 4.4 | 2.0 |
| F2 | 6 | 0.01 | 0 | 0 | 3.9 | 2.3 |

[x]OP = original population
[y]SP = population obtained from a single eggmass
[z]Pf/Pi <1 = nonefficient host

eggmass population was always lower than that of the original polpulation A. The single eggmass subculture of population B did not differ from original population B in reproduction on these clones.

All TA clones and only one (D6) of 7 SPT clones were efficient hosts of the 4 races of *M. incognita* (data not shown). Although some reproduction of race 2 was noted on SPT clones E2 and H2 in the first trial, it was not enough to consider them efficient hosts. When these two clones were retested against race 2, they were efficient hosts. Because this experiment was conducted partly in the summer, these two clones were tested at different temperatures to determine if temperature influenced their response to race 2. Both clones were nonefficient hosts at 23 C and efficient hosts at 31 and 35 C (Table 2).

*Damage threshold.* Plant height and tuber weights 60 days after inoculation of TA clones 1B32 and 1159, and root weights 60 days after inoculation and at harvest (120 days after planting) were not significantly affected by initial nematode density. Consequently, only data for tuber weights at harvest are shown. Tuber weights of clone 1B32 were not significantly affected by high nematode density. However, tuber weights of clone 1159 were significatly reduced at an initial density of 5 eggs/g of soil (Table 3).

Plant height and root, tuber, and foliage weights 60 days after inoculation of SPT clones E2 and D6 were not influenced by initial nematode density. Tuber weights of clone D6 at harvest were significantly reduced at an initial density of 10 eggs/g of soil (Table 4). Tuber weights at harvest of clone E2 were not affected by any of the nematode densities used.

Table 2. Influence of temperature on reproduction of *Meloidogyne incognita* IMP race 2 on selected clones of *Solanum sparsipilum* x (*S. phureja* x *S. tuberosum* spp. *tuberosum*).

| Clone No. | Temperature (°C) | Pf/Pi[z] |
|---|---|---|
| E2 | 23 | 0.3 |
| | 31 | 7.4 |
| | 35 | 9.5 |
| H2 | 23 | 0.3 |
| | 31 | 15.9 |
| | 35 | 1.3 |

[z]Pf/Pi < 1 = nonefficient host.

Table 3. Effect of different initial densities of *Meloidogyne incognita* population B on yield and nematode Pf/Pi ratio of 2 clones of *Solanum tuberosum* ssp. *andigena*.

| | Clones[z] | | | |
|---|---|---|---|---|
| | 1B32 | | 1159 | |
| Inoculum density (eggs/g of soil) | Tuber wt/pot (g) | Pf/Pi | Tuber wt/pot (g) | Pf/Pi |
| 0.0 | 105 bc | 0 | 70 a | 0 |
| 0.1 | 140 a | 12 | 83 a | 5 |
| 0.5 | 89 c | 24 | 70 a | 18 |
| 1.0 | 93 bc | 19 | 87 a | 18 |
| 5.0 | 122 ab | 5 | 45 b | 9 |

[z]Numbers within each column followed by same letter are not significantly different according to Duncan's MRT (P = 0.05).

Table 4. Effect of several initial densities of *Meloidogyne incognita* population B on yield and nematode Pf/Pi ratio of 2 clones of *Solanum sparsipilum* x (*S. phureja* x *S. tuberosum* ssp. *tuberosum*).

| | Clones[z] | | | |
|---|---|---|---|---|
| | E2 | | D6 | |
| Inoculum density (eggs/g of soil) | Tuber wt/pot (g) | Pf/Pi | Tuber wt/pot (g) | Pf/Pi |
| 0.0 | 113 a | 0 | 37 a | 0 |
| 0.5 | 140 a | 0 | 40 a | 22 |
| 1.0 | 111 a | 0 | 34 a | 6 |
| 5.0 | 106 a | 0 | 32 a | 5 |
| 10.0 | 172 a | 0 | 19 b | 4 |

[z]Numbers within each column followed by the same letter are not significantly different according to Duncan's MRT (P = 0.05).

## DISCUSSION

Host efficiency of TA clones obtained in these experiments differed from those previously reported (3) and are probably due to the different evaluation method used in the present experiments. Galls frequently do not form on potato roots infected with *M. incognita* and eggmasses

appear late. Evaluation based solely on gall or eggmass indicies before 50 days after inoculation may be misleading. Gall indicies are useful criteria for general screening, but negative results should be retested (6). Because most SPT clones tested were nonefficient hosts, our data confirm that this *Solanum* species is the most promising source of resistance to *M. incognita* (10).

Populations A and B of *M. incognita* used in our studies were previously identified by the IMP differential host test as race 1. Their differences in parasitism on potato indicate differences in parasitism within a single race of *M. incognita.* The identification of races of *Meloidogyne* spp. using different crops as differential plants (15) complicates the resistance research programs for a given crop. This problem will intensify when more resistant varieties of a crop are developed or more races of *Meloidogyne* spp. are identified. We suggest that races of *Meloidogyne* spp. be based on their reaction on differential varieties or species of the same crop genus rather than different crops.

Race 2 from the IMP collection seemed to be more aggressive and to reproduce under a wider range of temperatures on potatoes than did the other IMP races of *M. incognita,* suggesting the existence of thermotypes of *M. incognita* (5). At 31 C, race 2 reproduced abundantly on potato clones previously identified as nonefficient hosts but exhibited a much higher Pf/Pi ratio on one clone, indicating that differences in clones as well as races may be involved in altering host efficiency.

Of the yield parameters measured in our tests, tuber weight 120 days after planting seemed to be the best indicator of nematode damage. Based on tuber weights and nematode reproduction 60 days after inoculation, TA clone 1B32 was tolerant and clone 1159 was susceptible to *M. incognita.* The threshold density for nematode damage to TA clone 1159 as measured in our tests was 5 eggs/g of soil. The threshold density for nematode damage to SPT clone D6 was 10 eggs/g of soil. Difference in the damage threshold density for the SPT and TA clones apparently is a function of the genetic difference in the clones. The damage threshold density of *M. incognita* in our experiments was higher than that reported for *M. hapla* on potatoes (one juvenile/g of soil) and other crops (2,7), but similar to that of *M. incognita* on soybeans (12).

## LITERATURE CITED

1. BARKER, K. R., and T. H. A. OLTHOF. 1976. Relationships between nematode population densities and crop responses. Ann. Rev. Phytopathol. 14:327-353.
2. BARKER, K. R., P. B. SHOEMAKER, and L. A. NELSON. 1976. Relationships of initial population densities of *Meloidogne incognita* and *Meloidogyne hapla* to yield of tomato. J. Nematol. 8:232-239.

3. BRODIE, B. B., and R. L. PLAISTED. 1976. Resistance to root-knot nematodes in *Solanum tuberosum* ssp. *andigena*. J. Nematol. 8:280-281 (abstr.).
4. BRUCHER, H. 1967. Root-knot eelworm resistance in some South American tuber forming *Solanum* species. Amer. Potato J. 44:370-375.
5. DAO, F. 1970. Climatic influence on the distribution pattern of plant parasitic and soil inhabiting nematodes. Meded. Landbouwhogesch. Wageningen. 70-2. pp. 61-80.
6. FASSULIOTIS, G., J. R. DEAKIN, and J. C. HOFFMAN. 1970. Root-knot nematode resistance in snap beans: Breeding and nature of resistance. J. Amer. Soc. Hort. Soc. 95:640-645.
7. FERRIS, H. 1978. Development of nematode damage functions and economic thresholds using *Meloidogyne incognita* on tomatoes and sweet potatoes. J. Nematol. 10:286-287.
8. FRANCO, P. J. 1971. Evaluation of potato *Solanum* spp. resistance to the attack of the root knot nematode, *Meloidogyne incognita* (Kofoid and White 1919) Chitwood 1949 in Peru. Nematropica 1:13.
9. JATALA, P., H. A. MENDOZA, and F. L. HAYNES. 1976. The reaction of some clones of diploid cultivated potatoes to infection by the root-knot nematode *Meloidogyne incognita acrita*. Amer. Potato J. 53:395-396.
10. JATALA, P., and P. R. ROWE. 1977. Reaction of 62 tuber bearing *Solanum* species to root-knot nematode: *Meloidogyne incognita acrita*. J. Nematol. 8:290 (abstr.).
11. KHANNA, M. L., and K. K. NIRULA. 1961. Breeding potatoes for resistance to root-knot nematode. Current Sci. 33:314.
12. NARDACCI, J. F., and K. R. BARKER. 1979. The influence of temperature on *Meloidogyne incognita* on soybeans. J. Nematol. 11:62-70.
13. NIRULA, K. K., C. L. KHUSHU, and B. T. RAJ. 1969. Resistance in tuber bearing *Solanum* species to root-knot nematode *Meloidogyne incognita*. Amer. Potato J. 46:251-253.
14. OLTHOF, T. H. A., and J. W. POTTER. 1972. Relationship between population densities of *Meloidogyne hapla* and crop losses in summer-maturing vegetables in Ontario. Phytopathology 62:981-986.
15. TAYLOR, A. L., and J. N. SASSBR. 1978. Biology, identification and control of root-knot nematodes (*Meloidogyne* species). North Carolina State University Graphics, Raleigh. 111 pp.

*Received for publication:*
*23.VIII.1985*
*Recibido para publicar:*

---

[1]Cooperative investigations, U.S. Department of Agriculture, Agricultural Research Service and Cornell University, Agricultural Experiment Station. Portion of a Ph.D. thesis by the senior author. This research was supported in part by the International Potato Center, Lima, Peru.