SUSCEPTIBILITY OF SIX SOYBEAN CULTIVARS TO *MELOIDOGYNE INCOGNITA*[1] RACE 4.

N. Acosta and J.A. Negrón
Respectively, Associate Nematologist and Research Assistant, University of Puerto Rico, Department of Crop Protection, Mayagüez, Puerto Rico 00708.

Accepted: *20.X.1982*
Aceptado:

ABSTRACT

Acosta, N., and J.A. Negrón. 1982. Susceptibility of six soybean cultivars to *Meloidogyne incognita* race 4. Nematropica 12:181-187.

Bedford, Bragg, Forrest, Hardee Late Selection, Hutton and Jupiter soybeans were tested for their susceptibility to a race 4 population of *Meloidogyne incognita* from okra in greenhouse studies. Based on gall index and larval population levels, Hutton is highly resistant to this root-knot nematode population, while the remaining cultivars were susceptible. Many well-developed females with eggs were present in the roots of susceptible plants, while few were present in the roots of Hutton. Histological examination of roots of susceptible cultivars showed an average of six thick wall, multinucleated giant cells within parenchyma cells of the vascular tissue. Very few small giant cells were located in the vascular tissue of Hutton around the head of female nematodes.
Additional key words: root-knot nematodes, reniform nematode, cyst nematodes, Abelmoschus esculentus, Glycine max, plant breeding.

RESUMEN

Acosta, N. y J.A. Negrón. 1982. Susceptibilidad de seis variedades de soya a la raza 4 de *Meloidogyne incognita.* Nematroópica 12:181-187.

La susceptibilidad de seis variedades de soya Bedford, Bragg, Forrest, Hardee Late Selection, Hutton y Jupiter a una población de la raza 4 de *Meloidogyne incognita* de quimbombó fue examinada en el invernadero. Basándose en el índice de nodulación y en los niveles poblacionales de las larvas, en contramos que Hutton es altamente resistente a esta población del nematodo nodulador, mientras que las demás variedades fueron susceptibles. Muchas hembras bien desarrolladas con huevos estaban presentes en las raíces de plantas susceptibles, mientras que en las raíces de Hutton, había muy pocas. El examen histológico de las raíces demostró un promedio de seis células gigantes de paredes gruesas y multinucleadas dentro de las células de parenquima del tejido vascular de variedades susceptibles. Se encontraron pocas células gigantes en el tejido vascular de Hutton localizadas alrededor de la cabeza de la hembra.
Palabras claves adicionales: nematodo nodulador, nematodo reniforme, nematodo de quiste, Abelmoschus esculentus, Glycine max., fitomejoramiento.

INTRODUCTION

Soybean [*Glycine max* (L.) Merr.] is the most important cash crop in the United States, which produces approximately 75% of the world supply (5). Soybeans are widely utilized in human foods, animal feeds, and in industrial applications due to its high protein content, oil and meal production from the seed (10).

Production and quality of soybeans can be reduced by a number of pathogens and/or pests (1,10). Important diseases are caused by fungi, insects, bacteria, viruses, weeds, and nematodes (4,5,15,17,18,19).

Nematodes, especially *Heterodera glycines* Ichinohe (soybean cyst nematode), *Meloidogyne incognita* (Kofoid and White) Chitwood (root-knot nematode) and *Rotylenchulus reniformis* Linford and Oliveira (reniform nematode) are often reported lowering soybean production. Barker *et al.* (2) and Lehman *et al.* (16) demonstrated that the soybean cyst nematode inhibits N_2 fixation by *Rhizobium japonicum* (Kirch.) Buchanan, which may result in N. deficient soybean plants. Kinloch (14) demonstrated that *M. incognita* may cause up to 90% yield loss. Yield reductions by 33% have been reported by Rebois (20) on resistant and susceptible soybeans. Birchfield and Brister (3) observed yield reductions caused by the reniform nematode in commercial plantings. Rodríguez-Kábana and Thurlow (21) obtained significant increments in yield of most soybean cultivars tested with planting time applications of DBCP (14 l/ha). They obtained highest numbers of root-knot nematode larvae in untreated plots planted to Mack soybeans and lowest in those with Bragg, Cobb, Coker 338, Forrest and Hutton. Moderate to high levels of resistance of Bedford, Bragg, Forrest, Hardee and Hutton to *M. incognita* populations have been reported (8,9,21,23). Nevertheless, no references to the race used have been made.

During the period covered from 1973 to 1980, scientists from the International Soybean Program (INTSOY) and from the University of Puerto Rico, conducted research on soybean breeding, maturity of various genotypes, effects of day length on flowering, effects of soil types, seed vigor, seed and plant pathology, weed competition and nematode distribution and control at the Isabela Agricultural Experiment Substation, Puerto Rico (1).

Due to the increase in acreage planted with soybeans and due to continuous plantings in the Isabela area, an increase in diseases and pests has become evident.

In order to determine the susceptibility or resistance of some of the cultivars from the southern United States to an endemic population of the race 4 of *M. incognita* from Puerto Rico, two greenhouse studies were conducted.

MATERIALS AND METHODS

Greenhouse tests were conducted to determine the effects of a race 4 population of *Meloidogyne incognita* from okra (*Abelmoschus esculentus* (L.) Moench) from Isabela on six soybean cultivars. The race was determined according to the method of host differentials described by Sasser (22). This population reproduced in all differentials but peanut (*Arachis hypogaea* L.) cv. Florunner. The reaction of these cultivars to *M. incognita* has been reported as follows: Bragg, Forrest (resistant); Bedford, Hardee Late Selection, Hutton (moderately resistant) (23); and Jupiter (susceptible). Eight replications of nematode inoculated and uninocualted plantas of each cultivar were grown. The experiment was conducted with plastic pots (12-cm diameter) filled with steam-sterilized sandy soil (60% sand, 14% clay, 26% silt, and pH=6.5). The uninoculated pots received supernatant (suspension with microorganisms free of nematodes). The inoculated pots received 1,400 *M. incognita* eggs and second stage juveniles per pot. They were extracted from roots according to the method described by Hussey and Barker (11).

The treatments were arranged in a completely-randomized design on a greenhouse bench and the plants were grown for 45 days. Root-knot indices and numbers of nematodes per plant were determined at the termination of the experiment. The experiment was repeated using 2,000 *M. incognita* eggs and juveniles per plant.

Roots from infected plants were examined histologically using the methods of Johansen (12) to determine the effects of the nematodes on the roots. Root segments (1-cm long) were fixed in formalin-aceto-alcohol (FAA) solution, dehydrated in tertiary butyl alcohol and subsequently embedded in 47-56C paraplast. Longitudinal and transversal sections 20 μm thick were cut with a rotary microtome. The sections were mounted on glass slides and stained with safranin O and fast green and examined with the microscope.

RESULTS AND DISCUSSION

None of the six soybean cultivars were immune to the *M. incognita* population from Isabela. Based on gall index and larval population levels, Hutton is highly resistant to this root-knot nematode population, while the remaining cultivars were susceptible (Table 1). Thus, our results differ widely from those of others (8,9,21,23) who reported a moderate to high level of resistance in Bedford, Bragg, Forrest and Hardee, suggesting that they were dealing with similar races, different from the one used in the present study. Dropkin (6) reported differences in reaction, from low to high levels of susceptibility of Harosoy and Roanoke soybeans depending on the population of root-knot nematodes used. Our results and those obtained by Rodríguez-Kábana and Thurlow (21) with Hutton, suggest that apparently this cultivar is resistant to several races of *M. incognita.* Many well-developed females with eggs were present in roots of susceptible plants, while few were present in the roots of Hutton. According to Dropkin (8) there is a correlation between giant cell structure and egg mass production. Histological examination of roots of susceptible cultivars showed an average of six thick-walled, multinucleated giant cells within parenchyma cells of vascular tissue (Fig. 1). This type of cells are associated with rapid growth of the parasite and abundant production of

Table 1. Comparison of root-knot indices and numbers of nematodes from six soybean cultivars grown in soil inoculated with *M. incognita*[x]

	Root-knot Index (0-5)		Number of Nematodes (Root + soil)	
Host	Experiment 1	Experiment 2	Experiment 1	Experiment 2
Bedford	3.0 A	3.8 A	2987 A	8191 A
Bragg	3.0 A	3.4 BD	2450 A	1460 A
Forrest	3.9 B	4.1 A	1777 A	10394 B
H.L.S.[y]	3.9 B	3.5 AD	3790 A	621 A
Hutton	1.3 C	0.4 C	177 A	16 A
Jupiter	4.0 B	3.4 BD	3797 A	407 A

[x]Means within each column followed by the same letter do not differ significantly (P = 0.05) according to Duncan's new multiple range test.
[y]H.L.S. = Hardee Late Selection.

eggs (7). The reduced size and number of syncytia and few adult females within roots of Hutton could be the expression of resistance by this cultivar to the race 4 population of *M. incognita* from Isabela. Similar results were obtained by Dropkin (6) working with resistant Seminole and susceptible Richland soybeans. He stated that the contrast between giant cell structure on susceptible and resistant cultivars suggests that resistance is related to the cellular response of the host to the parasite.

Based on our findings, the use of different sets of resistant cultivars depending on the race of *M. incognita* present is highly recommended.

LITERATURE CITED

1. ANONYMOUS. 1979. Annual Report of Grant AID/CM/Ta-G-73-50-to Strengthen the Institutional Response Capabilities of the University of Puerto Rico in Crop Protection of Soybeans for Tropical and Subtropical areas. 59 pp.
2. BARKER, K.R., D. HUSINGH and S.A. JOHNSTON. 1972. Antagonistic interaction between *Heterodera glycines* and *Rhizobium japonicum* on soybean. Phytopathology 62:1201-1205.
3. BIRCHFIELD, W. and L.R. BRISTER. 1969. Reactions of soybean

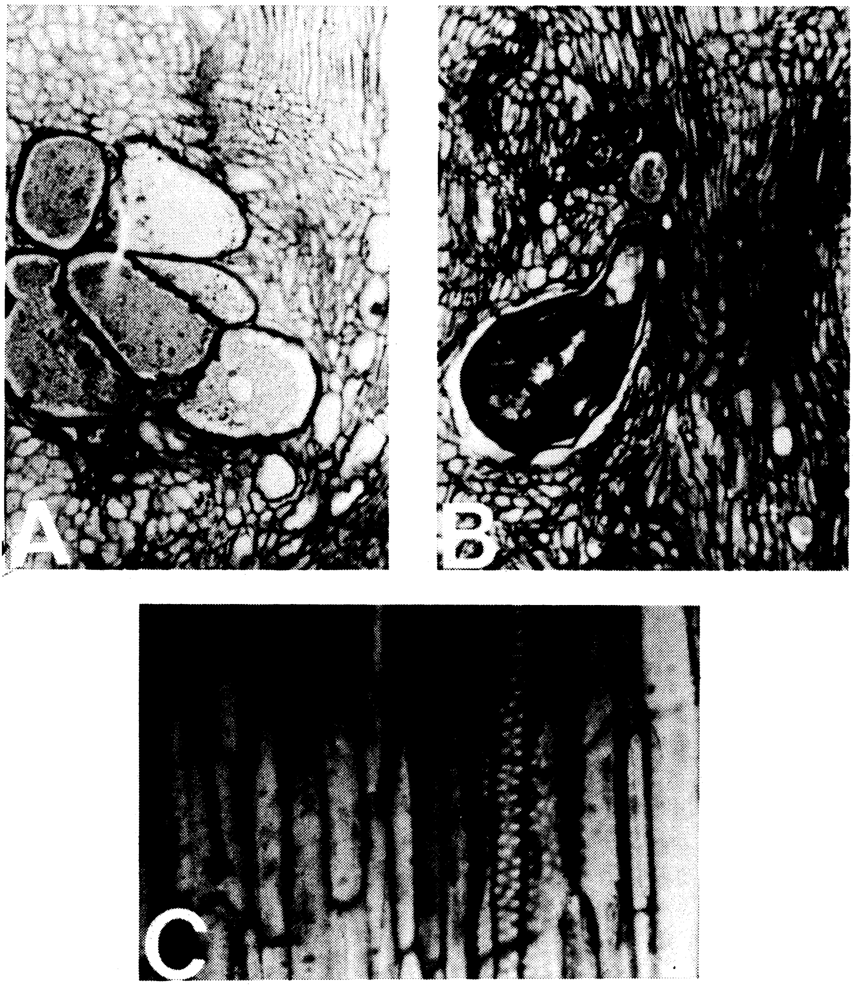

Figure 1. Longitudinal sections of *Meloidogyne incognita* infected and uninfected soybean roots: A) Section of root of susceptible Jupiter with several large, thick-walled multi-nucleated giant cells near nematode head; B) Section of root of resistant Hutton with several small giant cells near nematode head; C) Section of root from uninfected Hutton (X 1000).

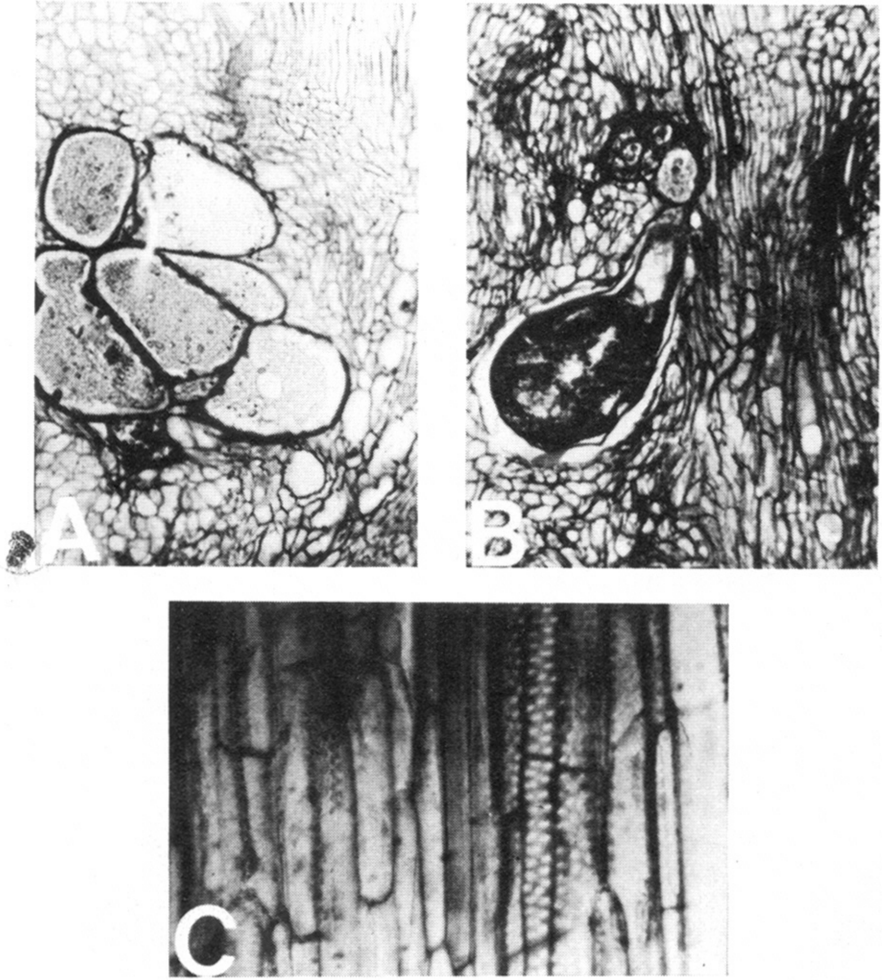

Figure 1. Longitudinal sections of *Meloidogyne incognita* infected and uninfected soybean roots: A) Section of root of susceptible Jupiter with several large, thick-walled multi-nucleated giant cells near nematode head; B) Section of root of resistant Hutton with several small giant cells near nematode head; C) Section of root from uninfected Hutton (X 1000).

varieties to the reniform nematode *Rotylenchulus reniformis.* Plant Dis. Rep. 53:999-1000.

4. CHAMBERLAIN, D.W. 1973. Soybean diseases in Illinois. Circular 1085. Univ. of Illinois. Illinois. 31 pp.
5. CORBIN, F.T. 1979. World Soybean Research Conference II: Proceedings. West View Press, Boulder, Colorado. 897 pp.
6. DROPKIN, V.H. 1959. Varietal response of soybeans to *Meloidogyne*-A bioassay system for separating races of root-knot nematodes. Phytopathology 49:18-23.
7. DROPKIN, V.H. and P.E. NELSON. 1960. The histopathology of root-knot nematode infection in soybeans. Phytopathology 50:442-447.
8. DUNN, R.A. 1978. Nematode pests of soybeans and their control. Nematol. Fact Sheet No. 2, IFAS. Univ. of Florida, Gainesville. 3 pp.
9. HARTWIG, E.E. and J. EPPS. 1978. Bedford a new soybean resistant to cyst nematode. Mississippi Agric. and Forestry Exp. Sta. Inf. Sheet 1280. 2 pp.
10. HILL, L.D. 1976. World soybean research proceedings of the world soybean research conference. The Interstate Printers and Publishers Inc. Danville, Illinois. 1973 pp.
11. HUSSEY, R. and K.R. BARKER. 1973. A comparison of methods of collecting inocula of *Meloidogyne spp.* a new technique. Plant Dis. Rep. 57:1025-1028.
12. JOHANSEN, D.A. 1940. Plant Microtechnique. McGraw-Hill Book Co. Inc. New York. 523 pp.
13. KEELING, B.L. 1979. Research on *Phytophthora* root and stem rot: isolation, testing procedures, and seven new physiological races pp. 367-370. *In:* World soybean Res. Conf. II Proceeding ed: West View Press, Colorado.
14. KINLOCH, R.A. 1974. Response of soybean cultivars to nematicidal treatments of soil infested with *Meloidogyne incognita.* J. Nematol. 6:7-11.
15. KOGAN, M. 1979. Insect problems of soybean in the United States. pp. 303-325. *In:* World Soybean Research Conference II: Proceedings ed. West View Press, Colorado.
16. LEHMAN, P.S., D. HUISINGH, and K.R. BARKER. 1971. The influence of races of *Heterodera glycines* on nodulation and nitrogen-fixing capacity of soybean. Phytopathology 61:1239-1244.
17. McWHORTER, C.G. and J.M. ANDERSON. 1979. Hemp sesbania (*Sesbania exaltata*) competition in soybeans (*Glycine max*). Weed Sci. (In press).
18. McWHORTER, C.G. and E.E. HARTWIG. 1972. Competition of Johnsongrass and cocklebur with six soybean varieties Weed Sci. 20:56-59.
19. McWHORTER, C.G. and D.T. PATTERSON. 1979. Ecological fac-

tors affecting weed competition in soybeans pp. 371-392. *In:* World soybean Res. Conference II. Proceeding ed. West View Press, Colorado.

20. REBOIS, R.V. 1973. Effect of soil temperature on infectivity and development of *Rotylenchulus reniformis* on resistant and susceptible soybeans, *Glycine max*. J. Nematol. 5-10-13.
21. RODRIGUEZ-KABANA, and D.L. THURLOW. 1980 Effect of *Hoplolaimus galeatus* and other nematodes on yield of selected soybean cultivars. Nematropica 20:130-138.
22. SASSER, J.N. 1954. Identification and host-parasite relationships of certain root-knot nematodes (*Meloidogyne spp.*). Univ. of Md. Bull. A-27. (Technical). 31 pp.
23. SASSER, J.N., and M.F. KIRBY. 1969. Crop cultivar resistant to root-knot nematodes, *Meloidogyne species*, with information on seed sources. North Carolina. 24 pp.

Received for publication:
20.VIII.1982
Recibido para publicar:

[1] Technical contribution of Puerto Rico Agricultural Experiment Station, University of Puerto Rico. This research was supported in part by the INTSOY project from the University of Illinois at Urbana, Illinois 61801.