Host Suitability of Selected Hybrids, Varieties and Inbreds of Corn to Populations of *Meloidogyne* spp.[1]

J. G. BALDWIN AND K. R. BARKER[2]

Abstract: Rates of reproduction of root-knot nematodes on corn varied with *Meloidogyne* species, with different populations of certain species, and with corn cultivars. *M. arenaria, M. incognita* and *M. javanica* reproduced at varying rates on all corn cultivars tested. None of the three selections of *M. hapla* reproduced on corn. Most of the *Meloidogyne* populations increased more rapidly on 'Coker' and 'Pioneer' hybrids than on 'McNair' hybrids or on open-pollinated varieties or inbreds. Nematodes often reduced root growth, but the differences within given nematode-cultivar treatments were not usually significant. Root growth of 'Coker 911,' which supported a high rate of reproduction, was affected less than 'Pioneer 309B' which supported a low rate of nematode reproduction. *Key Words:* Host suitability, Corn, Cultivars, *Meloidogyne arenaria, M. incognita, M. javanica,* Nematode populations, Reproduction.

Corn (*Zea mays* L.) is important in crop rotations used in North Carolina for control of several diseases, including *Meloidogyne* infections of tobacco, peanut, cotton and other crops. *M. hapla* Chitwood does not reproduce on corn (9, 13), and other *Meloidogyne* spp. usually decrease under rotations which include corn (e.g. corn, tobacco, soybean). In some fields, however, control is not maintained, and population densities actually increase with corn in the rotation. Such failures may arise from natural selection of nematode biotypes adapted to corn (10), or from variable resistance in newly-developed corn hybrids. Nelson (8) and Dropkin (5) reported differences in susceptibility among certain corn inbreds which indicated some may be more effective than others against root-knot nematodes.

This investigation was initiated to determine the reproduction rates of populations of *Meloidogyne* spp. on various cultivars (Note: "cultivar" is a general term including hybrids, open-pollinated varieties, and inbreds) of corn, and to measure the resulting host response to infection under greenhouse conditions.

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MATERIALS AND METHODS

Experiments were designed to measure the interactions of 10 populations of *Meloidogyne* spp. (Table 1) and 14 corn cultivars under greenhouse conditions. These populations were originally collected from a wide range of crops and included one, *M. incognita* III, that increased readily on corn under field conditions. The following corn hybrids were selected: 'Coker 911', 'Coker 912', 'Pioneer 309A', 'Pioneer 309B', 'Pioneer 3009', 'Pioneer 511A', 'McNair 340' and 'McNair 440.' The open-pollinated varieties 'Indian Chief' and 'Jarvis' were also included, as well as the inbreds 'N. C. 230', 'N. C. 222', 'N. C. 224' and 'N. C. 601'. Five replicates of each cultivar-nematode population combination, except *M. hapla* which had three replicates, were set up in completely randomized blocks in a series of five experiments as outlined in Table 2. Each treatment replicate consisted of a single 10-day-old corn seedling transferred to a 15-cm pot, with inoculated plants receiving 20 egg masses of the indicated nematode population. In addition to noninoculated controls, 'Coker 911' and *M. incognita* II were included as

TABLE 1. Source of *Meloidogyne* species and populations.

Species	Population†	Field host
M. incognita	I	celery
M. incognita	II	unknown
M. incognita	III	corn
M. javanica		corn
M. arenaria	I	unknown
M. arenaria	II	tobacco
M. arenaria	III	tobacco
M. hapla	I	peanut
M. hapla	II	unknown
M. hapla	III	peanut

† All nematode populations were isolated from North Carolina fields, except *M. javanica* which was from Georgia.

"susceptible standard checks" in each of the five experiments. Sixty days after inoculation, the corn was harvested and the fresh weights of roots and tops of each plant were determined. Nematode populations were estimated by egg extraction, determined by the method of Loewenberg *et al.* (7) which was modified by Nusbaum (personal communication) as follows: the entire root system was chopped finely; a 5-g sample was placed in a 50-ml beaker; the volume in the beaker was increased to 50 ml with 0.5% sodium hypochlorite solution prepared from Clorox®; after stirring 5 min to dissolve the gelatinous matrix of the eggs, the solution with suspended eggs was rinsed into a 400-ml beaker and the volume increased to 250 ml with water; 30 ml of the egg suspension were poured through a 28-mesh strainer to remove root debris; two 6-ml samples were pipetted into calibrated counting dishes. From the egg count of this aliquot, the number of eggs per gram of root was calculated.

RESULTS

Eggs/g of root differed widely among cultivars. Coker hybrids generally supported greatest nematode egg production (Figs. 1, 2). Pioneer hybrids had moderate production of eggs, and McNair hybrids consistently had relatively few (Fig. 1). Results with 'Coker 912' (not included) were similar to 'Coker 911', and 'Pioneer 3009' and 'Pioneer 309A' (not included) were similar to 'Pioneer 309B'. Most of the inbreds tested, e.g., 'N. C. 222' (Fig. 2), 'N. C. 230' and 'N. C. 224' (not included) supported low rates of nematode reproduction. Yet, inbred 'N. C. 601' had high egg numbers when inoculated with *M. incognita* I. Few eggs were generally recovered from roots of open-pollinated varieties, 'Indian Chief' (Fig. 2) and 'Jarvis' (not included).

Some species and populations of *Meloidogyne* produced more eggs than others on most corn cultivars. *Meloidogyne incognita* often produced more eggs than *M. javanica* or *M. arenaria* (Figs. 1, 2). Yet, among *M.*

TABLE 2. Distribution of treatments/experiment.

Experiment number	Treatments: Corn cultivars	Treatments: Nematode populations	date Inoculation
1	Coker 911 Coker 912 Pioneer 309A Pioneer 3009 Pioneer 309B Pioneer 511A	*M. incognita* I *M. incognita* II *M. incognita* III *M. javanica*	6/1/68
2	Coker 911 McNair 340 McNair 440	Same as for experiment 1	9/9/68
3	Coker 911 Coker 912 Pioneer 309A Pioneer 3009 Pioneer 309B Pioneer 511A McNair 340 McNair 440	*M. incognita* II *M. arenaria* I *M. arenaria* II *M. arenaria* III	2/10/69
4	Same as for experiment 3	*M. incognita* II *M. hapla* I *M. hapla* II *M. hapla* III	5/1/69
5	Coker 911 N. C. 230 N. C. 222 N. C. 224 N. C. 601 Indian Chief Jarvis	*M. incognita* I *M. incognita* II *M. incognita* III *M. arenaria* I *M. arenaria* II *M. arenaria* III *M. javanica*	6/16/69

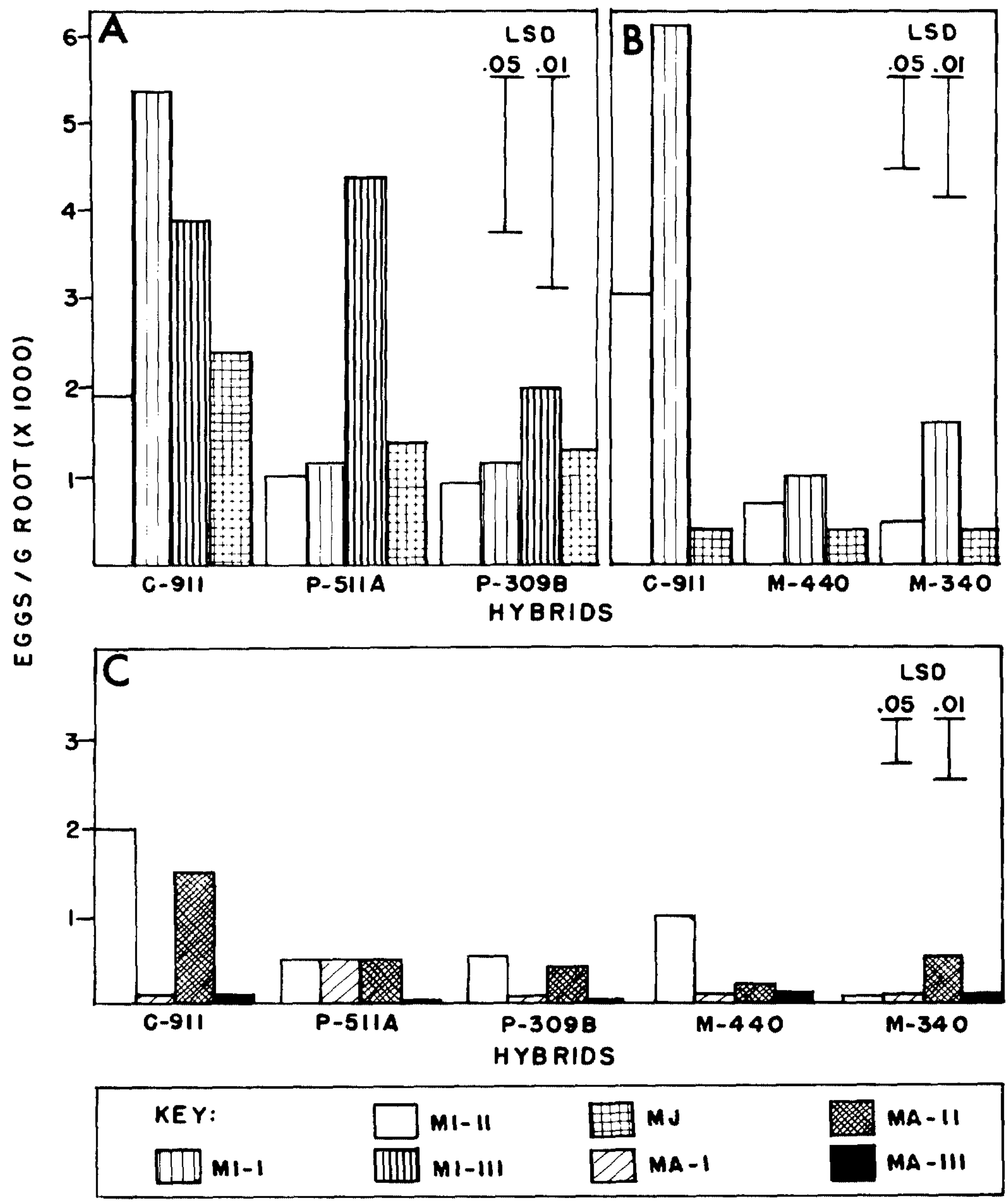

FIG. 1. Reproduction of *Meloidogyne* species and selections on hybrids of corn. **A.** *M. incognita* and *M. javanica* on Pioneer hybrids (experiment 1); **B.** *M. incognita* and *M. javanica* on McNair hybrids (experiment 2, results for *M. incognita* III which are not shown were similar to *M. incognita* II); **C.** Selections of *M. arenaria* (experiment 3). 'Coker 911'/*M. incognita* II combination were "susceptible standard checks" in all experiments.

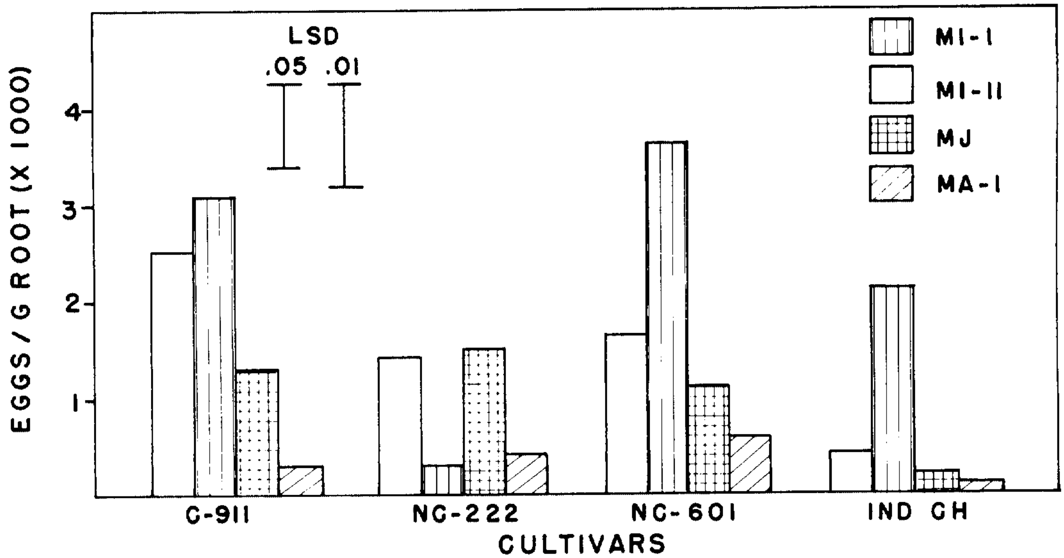

FIG. 2. Reproduction of *Meloidogyne* species on inbreds 'NC-222' and 'NC-601' and 'Indian Chief,' an open-pollinated variety of corn (experiment 5). 'Coker 911'/*M. incognita* II combinations were "susceptible standard checks" in all experiments.

incognita, population I and III reproduced more readily than *M. incognita* II (Fig. 1A, B). No population of *M. hapla* reproduced on the cultivars tested.

Interactions among nematode populations and cultivars were frequent. For example, *M. incognita* I reproduced rapidly on 'Coker 911' but relatively slowly on 'Pioneer 309B' (Fig. 1A). Similarly, *M. arenaria* II reproduced more rapidly than *M. arenaria* I and III on 'Coker 911' (Fig. 1B).

In several instances, mean root weights of inoculated plants were significantly lower than noninoculated controls, whereas top weights were not affected. Significant differences in root growth within a given nematode-cultivar treatment were limited to the Pioneer hybrids in Experiment 1 (Table 3). Although 'Coker 911' generally supported high numbers of *M. incognita,* the root weight of this hybrid was affected little by the nematode. On the other hand, the fresh root weights of 'Pioneer 309B', which supported fewer *M. incognita* eggs per gram of root, were significantly lower than the control in several instances. Significant differences among growth data (not given) for experiments 2, 3, 4 and 5 were limited to hybrid means and to some of the control means vs. the means of all inoculated plants.

The degree of root-galling at 60 days after inoculation varied greatly with cultivar (Fig. 3), however, there was no apparent correlation between degree of galling and host suitability.

DISCUSSION

The widely different degrees of success in controlling root-knot in North Carolina by rotations with corn can be accounted for by differences in suitability of corn hybrids for nematode reproduction and by variation in adaptation of different nematode populations to reproduction on corn roots. In previous experiments, most observations favored the use of corn in rotations to control root-knot

TABLE 3. Effect of *Meloidogyne incognita* and *M. javanica* on the root growth of Coker and Pioneer hybrids (Experiment 1).†

Nematode population	P-511A					
	Hybrid	C-911	C-912	P-309A	P-309B	P-3009
	Root weight (g)					
M. incognita I	154	151	151	134*	139*	130*
M. incognita II	145	130	138	138*	147*	137
M. incognita III	150	163	144	169	161	154
M. javanica	125	120	134	153*	156*	127*
None (control)	150	149	162	195	194	170
					.05	.01
LSD for camparing treatments within cultivars					37	NS
LSD for control (mean = 166) vs. others (mean = 145)					12	16

† Weights of top growth had a range of 282–349 g (mean = 332 g) and differences were not significant.
* Difference from noninoculated control significant at .05 level.

(11, 12), whereas others discouraged this practice (2). It is apparent from these experiments that a rotation program in a field infested primarily with *M. incognita* I would be much more successful if 'Pioneer 511A' was used, rather than 'Coker 911'. On the other hand, if *M. incognita* III was predominant, 'Pioneer 309B' would be much more likely to reduce root-knot than 'Pioneer 511A'. Similar differences occur with *M. arenaria*. 'McNair 440' would effectively control *M. arenaria* II, but 'Coker 911' would not. Yet, 'Coker 911' or 'McNair 340' would control *M. arenaria* I better than 'Pioneer 511A'.

Specialized populations, such as some of those used in this study, probably arise by natural selection of those individuals best able to reproduce on a crop planted very frequently. For example, *M. incognita* III, which was isolated from a corn field, reproduced rapidly on most cultivars. Because *M. incognita* and other root-knot nematode species respond to selection pressures, there is need for caution when corn or any other crop is used frequently in rotations. This is sup-

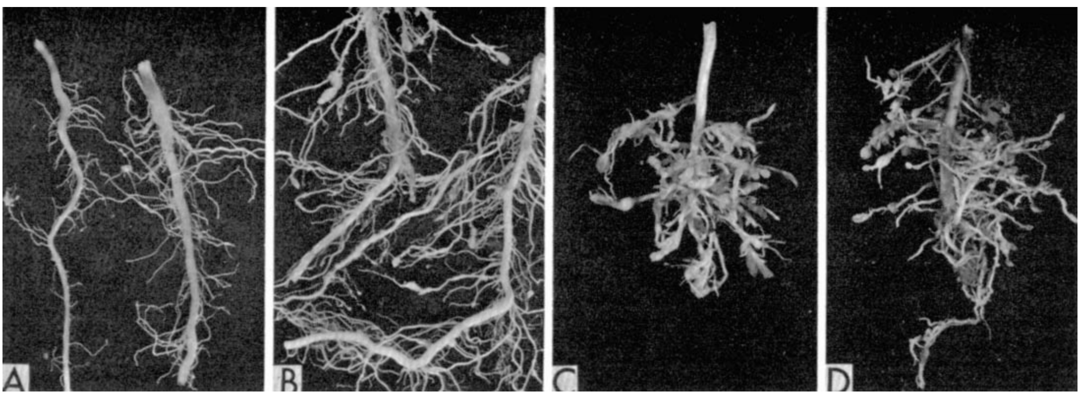

FIG. 3. Representative portions of galled roots of hybrids and inbreds 60 days after inoculation with *Meloidogyne incognita* II. **A.** 'Coker 912' hybrids; **B.** 'Pioneer 309B' hybrid; **C.** 'NC-222' inbred; **D.** 'NC-230' inbred.

ported by the findings of Sasser and Nusbaum (10) which show that corn-tobacco rotations may eventually become ineffective as strains of root-knot nematodes become adapted to both crops.

Environmental variation may also be a factor interacting with populations and corn to give different rates of reproduction of root-knot nematodes (3). Thus, the low rate of reproduction of *M. javanica* on 'Coker 911' in Experiment 2 (Fig. 1B) conducted in the fall as compared to the greater rate in Experiment 1 in the summer (Fig. 1A) is probably due to a more favorable greenhouse environment during the latter experiment. In other cases, differences among treatments common to all experiments were small.

Root-knot nematode populations which reproduce at the highest rate on corn may affect growth least under greenhouse conditions. This suggests that resistant reactions are sometimes accompanied by damage to roots and at least temporarily limited growth as has been reported for root-knot resistant tobacco (6) and tomato (4). Histological comparisons of *M. incognita* on poor ('Pioneer 309B') and good ('Coker 911') hosts indicate that hypersensitive responses to nematode infection, which in this case is accompanied by considerable necrosis, partially account for root damage and stunting in 'Pioneer 309B' (1).

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