RESEARCH NOTE—NOTA DE INVESTIGACION

RESISTANCE OF MAIZE HYBRIDS TO *MELOIDOGYNE JAVANICA*[†]

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RESUMEN

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Se evaluaron bajo condiciones de invernadero las respuestas de los híbridos resultantes de un cruzamiento dialelo de siete líneas puras de maíz (*Zea mays*) a *Meloidogyne javanica*. Los resultados de generación F1 se analizaron con el Método 4 de Griffing, Modelo I. Las capacidades de combinación general y específica fueron fuentes importantes de variación. Los híbridos con Mp307 como pogenitor fueron los más resistentes, mientras que aquellos descendientes de Ab24E resultaron ser los más susceptibles. El germoplasma necesario para desarrollar híbridos de maíz con resistencia a *M. javanica* que limitan su reproducción, se encuentra disponible en líneas puras de dominio público.

Palabras claves: fitomejoramiento, maíz, *Meloidogyne javanica*, nematodo agallador, resistencia, *Zea mays*.

There are conflicting reports regarding the resistance of maize (*Zea mays* L.) to root-knot nematodes (*Meloidogyne* spp.) (1–3,7–9,11–13). Little information on resistance of maize to *M. javanica* (Treub) Chitwood is available (1,6,9). In a recent greenhouse study, the reproductive potential of a population of *M. javanica* was determined on 64 commercial hybrids and 33 maize inbreds (14). Although levels of reproduction varied, most of the hybrids were excellent hosts for *M. javanica*. Several inbreds were identified as possible sources of resistant germplasm for future breeding programs.

Additional studies are needed, however, to extend knowledge of resistance in maize to *M. javanica*. Furthermore, information on sources and inheritance of resistance is needed for use in the development of resistant maize hybrids. The objective of this investigation was to determine the relative importance of general (GCA) and specific (SCA) com-

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bining ability in the inheritance of resistance to *M. javanica* in a diallel cross of seven maize inbreds.

A diallel cross (without parents or reciprocals) of seven inbred lines of maize, which had exhibited a range of resistance to *M. incognita* (Kofoid & White) Chitwood in greenhouse evaluations (11), was analyzed in this investigation. The 21 F_1 hybrids were tested for response to *M. javanica* under greenhouse conditions at an average temperature of 30 C.

Seeds were planted in Todd Planter Flats (Model 300, Speedling Inc., Sun City, Florida 33586, U.S.A.) which contained a potting mixture of methyl bromide-sterilized sandy loam soil and river sand (1:1). Each flat contained thirty-two 7.6-cm-square × 7.6-cm-deep inverted, pyramid-shaped cells. Hybrids were arranged in a randomized complete block design with 10 replications for two plantings. A population of *M. javanica* was obtained from the Department of Plant Pathology, North Carolina State University, Raleigh, NC and increased on tomato (*Lycopersicon esculentum* Mill. cv. Floradel) in the greenhouse. Eggs were extracted from tomato roots with NaOCl (5). Ten days after planting, seedlings were inoculated by pipetting a water suspension containing 3 000 nematode eggs into each cell.

Sixty days after inoculation, roots were washed free of soil and stained with Phloxine-B to enhance the visibility of egg masses. Egg masses on the roots of each plant were counted and assigned a rating number according to the scale: 0 = no egg masses, 1 = 1–2 egg masses, 2 = 3–10 egg masses, 3 = 11–30 egg masses, 4 = 31–100 egg masses, and 5 = > 100 egg masses (10).

Data from each planting were combined for analyses. Diallel analysis was performed on F_1 hybrid data using Griffing's Method 4, Model I (4). Differences among GCA effects were compared by Fisher's protected LSD. SCA effects were tested for difference from zero by *t*-tests.

Means of egg mass indices on maize roots 60 days after inoculation ranged from 0.65 for GA215 × Mp307 to 3.20 for Ab24E × Mp707. The analysis of variance for combining ability showed that highly significant differences ($P \leq 0.05$) were observed for both GCA and SCA. These results suggested that additive and nonadditive effects were important in the inheritance of maize reaction to *M. javanica*. These results are similar to the reaction of maize hybrids to *M. incognita* (11).

The contribution of the individual lines to resistance of hybrids was determined by comparing the GCA effects (Table 1). Negative values indicate a contribution towards greater resistance, whereas positive values indicate greater susceptibility. Estimates of GCA effects indicate that Mp307 contributed the most to resistance of its hybrids. Although contributions were smaller, GA203 and GA215 also contributed to resistance of their hybrids. Conversely, Ab24E, Mp707, and Mp412 had a negative effect on resistance of their hybrids.

Table 1. Estimates of general combining ability (GCA) effects for egg mass indices of a maize diallel inoculated with *Meloidogyne javanica*.

Parent	GCA
Mp307	–0.80
GA203	–0.19
GA215	–0.16
T216	–0.01
Mp412	0.19
Mp707	0.38
Ab24E	0.52
FLSD (0.05)	0.24

The SCA effects for reaction to *M. javanica* in parental combinations are presented in Table 2. Estimates of SCA effects indicate that there were several cross combinations that showed desirable significant negative SCA effects. These included Ab24E × GA203, Mp307 × Mp707, and GA203 × Mp412. Several hybrids, including Ab24E × Mp412, Ab24E × Mp707, GA203 × GA215, GA203 × Mp307, and Mp307 × T216, exhibited significant positive SCA effects, indicating that these hybrids performed more poorly than would have been predicted from

Table 2. Estimates of specificc combining ability (SCA) effects for egg mass indices of maize hybrids inoculated with *Meloidogyne javanica*.

Hybrid	SCA
Ab24E × GA203	–0.51 **
Ab24E × GA215	–0.29
Ab24E × Mp307	–0.30
Ab24E × Mp412	0.36 *
Ab24E × Mp707	0.82 **
Ab24E × T216	–0.06
GA203 × GA215	0.37 *
GA203 × Mp307	0.36 *
GA203 × Mp412	–0.33 *
GA203 × Mp707	0.08
GA203 × T216	0.05
GA215 × Mp307	0.13
GA215 × Mp412	0.24
GA215 × Mp707	–0.25
GA215 × T216	–0.18
Mp307 × Mp412	–0.17
Mp307 × Mp707	–0.36 *
Mp307 × T216	0.36 *
Mp412 × Mp707	–0.10
Mp142 × T216	0.02
Mp707 × T216	–0.17

*,**Significant difference from 0 at $P = 0.05$ and $P = 0.01$.

the GCA effects of the parental inbreds. These results suggest that in these specific combinations, SCA effects due to nonadditive gene action were probably involved in the inheritance of resistance to *M. javanica.*

This investigation indicated that both GCA and SCA were highly significant sources of variation. Useful sources of resistance to *M. javanica* are available for the development of resistant maize hybrids. Among the maize inbreds included in this study, Mp307 was the best source of resistance to *M. javanica.* In an earlier investigation, Mp307 also had exhibited significant GCA effects for resistance to *M. incognita* (11).

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