Annals of Applied Nematology 1:46–49. 1987.

Response of Cowpea Breeding Lines and Cultivars to *Meloidogyne incognita* and *M. arenaria*

T. L. KIRKPATRICK[1] AND T. E. MORELOCK[2]

Abstract: Twenty-four cowpea breeding lines and four cultivars were tested for resistance to *Meloidogyne incognita* in the greenhouse. Gall and egg mass ratings indicated a range of responses from susceptible to highly resistant. Five breeding lines—VS84-2, VS84-8, VS84-12, VS84-14, and VS84-22—and the cultivar Erectset had gall and egg mass ratings comparable to the *M. incognita*-resistant cultivar Mississippi Silver. All of these were also resistant to *M. arenaria*. Significantly fewer *M. incognita* juveniles were found in roots of resistant than in roots of susceptible plants at 7 and 21 days after inoculation; however, no differences were found at 14 days.

Key words: breeding line, cowpea, *Meloidogyne incognita, Meloidogyne arenaria,* resistance, root-knot nematode, southern pea, *Vigna unguiculata.*

Cowpea, *Vigna unguiculata* (L.) Walp., is an important crop in many parts of the United States. It is grown in the Ozark Region of Arkansas as a processing crop. A cowpea breeding program underway at the Arkansas Agricultural Experiment Station has resulted in the release of several high-quality, well-adapted cowpea cultivars (1–5).

As a result of this program, high levels of resistance to bacterial blight, a major cowpea disease, have been incorporated into the more recently released cultivars (4,5). Resistance to root-knot nematodes *Meloidogyne* spp., however, has received little attention.

Meloidogyne spp. are important cowpea pests worldwide (7,9,10,16). Although *M. incognita* is the most widespread (8,9,12), *M. javanica* (11,12,18,19), *M. hapla* (8,12), and *M. arenaria* (7,12) also have been associated with crop damage. Resistance to *M. incognita* has been identified (13,14) and is inherited as a single dominant gene (8). Resistance to *M. incognita* appears to confer some degree of resistance to other *Meloidogyne* spp., although pathogenic variability within the nematode species can influence the degree of resistance expressed (8,18).

Received for publication 1 April 1987.

[1] Assistant Professor, Department of Plant Pathology, University of Arkansas Southwest Research and Extension Center, Route 3, Box 258, Hope, AR 71801.

[2] Associate Professor, Department of Horticulture and Forestry, University of Arkansas, Fayetteville, AR 72701.

The authors thank Patricia Nichols and Cynthia Smith for technical assistance.

Meloidogyne incognita is the most commonly encountered root-knot nematode species in Arkansas, although *M. arenaria, M. javanica,* and *M. hapla* also are found occasionally (R. D. Riggs, pers. comm.). Because of the wide distribution of *M. incognita* throughout the cowpea production area of the state, an evaluation of the resistance to this pest in the cowpea breeding material used to develop new cultivars was needed. Our objectives were to evaluate advanced breeding lines of cowpea for *M. incognita* resistance and to identify candidates with the most potential for use in development of root-knot nematode resistant cowpea cultivars.

Materials and Methods

Twenty-four advanced breeding lines of cowpea, three cultivars, and a resistant cultivar standard (Mississippi Silver) were evaluated for resistance to *M. incognita*. Individual seeds of each breeding line or cultivar were planted into methyl bromide-treated sandy loam soil in 10-cm-d clay pots. When the first leaf was fully expanded, 10 seedlings of each breeding line and cultivar were selected for plant uniformity, arranged in a completely random design on a greenhouse bench, and each was inoculated with 5,000 eggs of a population of *M. incognita* race 3. The nematode was collected from cotton in 1984 and maintained in the greenhouse on tomato (*Lycopersicon esculentum* Mill. cv. Rutgers).

Eggs were collected by the NaOCl method (15) and added by pipetting them in 10

TABLE 1. Egg mass and root gall ratings for cowpea cultivars and breeding lines following inoculation with *Meloidogyne incognita* race 3.

Cultivar or breeding line	Egg masses	Galls
VS84-1	4.8 ab	4.9 a
VS84-2	2.7 d	3.2 cd
VS84-3	4.6 abc	4.7 ab
VS84-4	4.5 abc	4.6 ab
VS84-5	5.0 a	5.0 a
VS84-6	4.9 ab	4.9 a
VS84-7	4.3 abc	4.3 ab
VS84-8	2.6 d	2.7 d
VS84-9	4.2 abc	4.7 ab
VS84-10	4.5 abc	4.7 ab
VS84-11	4.9 ab	5.0 a
VS84-12	2.9 d	3.1 d
VS84-13	3.8 c	3.9 bc
VS84-14	1.6 ef	1.9 e
VS84-15	4.7 abc	4.8 a
VS84-16	4.3 abc	4.5 ab
VS84-17	4.7 abc	4.9 a
VS84-18	4.9 ab	5.0 a
VS84-19	4.7 abc	5.0 a
VS84-20	4.7 abc	4.8 a
VS84-21	5.0 a	5.0 a
VS84-22	1.0 f	1.8 e
VS84-24	4.7 abc	5.0 a
VS81-92	4.0 bc	4.5 ab
Elite	4.2 abc	4.3 ab
Erectset	1.0 f	1.9 e
Crimson	4.6 abc	4.8 a
Mississippi Silver	2.3 de	2.5 de

Means followed by the same letter are not significantly different ($P = 0.05$) according to Duncan's multiple-range test.

Rating scale: 0 = no egg masses or galls, 1 = 1–2, 2 = 3–10, 3 = 11–30, 4 = 31–100, 5 = > 100 egg masses or galls/root system. Data are averages of 10 replicates.

ml distilled water into three holes (0.5 cm d × 4 cm deep) in the soil around each seedling. After 45 days, each plant was removed from the soil and its roots were rinsed thoroughly with water and rated for galling. Each root system was then stained with Phloxine B (0.15 g/liter tapwater) for 15 minutes and rated for the presence of egg masses. Both galling and egg mass ratings were made according to the following scale: 0 = no galls or egg masses, 1 = 1–2, 2 = 3–10, 3 = 11–30, 4 = 31–100, and 5 = more than 100 galls or egg masses/root system (20).

On the basis of these ratings, breeding lines VS84-2, VS84-8, VS84-12, VS84-14, and VS84-22 and the cultivars Erectset and Mississippi Silver were selected for evaluation of resistance to *M. arenaria*. The cultivar Elite was included in this test as an *M. incognita*-susceptible check. Ten seedlings of each line or cultivar were planted and arranged in a completely random design in the greenhouse. Each seedling was inoculated as in the previous experiment except that a population of *M. arenaria* race 1 from North Carolina, maintained on Rutgers tomato, was used. After 45 days, the roots were washed and stained with Phloxine B and the egg mass ratings were made.

TABLE 2. Egg mass ratings for five cowpea breeding lines and three cultivars following inoculation with *Meloidogyne arenaria* race 1.

Cultivar or breeding line	Egg masses
Elite	3.0 a
VS84-12	1.7 b
VS84-2	1.5 bc
VS84-14	1.4 bc
VS84-8	1.2 bcd
VS84-22	0.9 cd
Mississippi Silver	0.9 cd
Erectset	0.5 d

Means followed by the same letter are not significantly different ($P = 0.05$) according to Duncan's multiple-range test.

Rating scale: 0 = no egg masses or galls, 1 = 1–2, 2 = 3–10, 3 = 11–30, 4 = 31–100, 5 = > 100 egg masses/root system. Data are averages of 10 replicates.

In an additional study, individual seedlings of Mississippi Silver (resistant) and Crimson (susceptible) grown in fumigated sandy loam soil were arranged in pairs on a greenhouse bench. Each seedling was inoculated with 1,000 eggs of *M. incognita*. At 7, 14, and 21 days, four pairs of plants were sacrificed. Roots were thoroughly washed and stained with acid fuchsin–acetic acid (6), and the numbers of juveniles per root system were recorded.

RESULTS AND DISCUSSION

Significant differences in root galling and egg mass production by *M. incognita* occurred on the cowpea breeding lines and cultivars (Table 1). Mississippi Silver, which has been shown to be resistant to *M. incognita* (8,12,14), was moderately resis-

TABLE 3. Number of *Meloidogyne incognita* race 3 juveniles in roots of Mississippi Silver and Crimson cowpeas at 7, 14, and 21 days after inoculation.

Days after inoculation	Avg. no. juveniles/root system		
	Mississippi Silver	Crimson	*t* value†
7	1	32	7.1*
14	89	93	2.1 NS
21	37	132	6.2*

† Means for cultivars were compared within sampling periods by the *t*-test method (17).

tant to the nematode population used in this study as indicated by an egg mass rating of 2.3. Five of the breeding lines—VS84-2, VS84-8, VS84-12, VS84-14, and VS84-22—as well as the cultivar Erectset were not significantly different from Mississippi Silver for either egg mass or gall ratings. Because only race 3 of *M. incognita* was studied in this evaluation, the possibility exists that these breeding lines and cultivars may respond differently to other populations and races of *M. incognita* as has been reported in other experiments (12,18).

Mississippi Silver has been reported to be resistant to *M. arenaria* as well as to *M. incognita* (12). The breeding lines and cultivars which yielded low egg mass ratings for *M. incognita* also yielded low ratings for *M. arenaria* (Table 2). The gene responsible for resistance to *M. incognita* in cowpea also appears to confer some resistance to other *Meloidogyne* spp. (8,13).

Significantly greater numbers of *M. incognita* juveniles were found in roots of susceptible than in roots of resistant cowpeas 7 and 21 days after inoculation (Table 3). At 14 days, however, the number of juveniles in both resistant and susceptible plants were similar. By 21 days after inoculation, significantly more juveniles were found in the roots of susceptible plants. At this sampling period, the majority of the juveniles found in the roots of both resistant and susceptible plants had developed beyond the early second stage and appeared to be developing normally.

These studies indicate a wide range in root-knot nematode resistance in the cowpea breeding material in the Arkansas program. At least five advanced breeding lines appeared to have good resistance to both *M. incognita* race 3 and *M. arenaria* race 1. The resistance to these nematode species was comparable to Mississippi Silver, which has been the standard for resistance comparisons in other studies. These breeding lines appear to have considerable potential for use in the development of new root-knot nematode resistant cowpea cultivars.

LITERATURE CITED

1. Bowers, J. L., C. M. Bittle, and H. H. Vose. 1956. Monarch Blackeye—a new variety of southern peas. Arkansas Farm Research 5:4.

2. Bowers, J. L. 1965. Crimson—a new southern pea. Arkansas Farm Research 14:12.

3. Bowers, J. L. 1973. Bush Purple Hull, a new southern pea. Arkansas Farm Research 22:4.

4. Bowers, J. L., M. J. Goode, and W. A. Sistrunk. 1981. Erectset, a new type of cream southern pea cultivar. Arkansas Farm Research 30:9.

5. Bowers, J. L., and W. A. Sistrunk. 1978. Elite, a new cream type southern pea for home gardeners and processors in Arkansas. Arkansas Farm Research 27:2.

6. Byrd, D. W., T. Kirkpatrick, and K. R. Barker. 1983. An improved technique for clearing and staining plant tissues for detection of nematodes. Journal of Nematology 15:142–143.

7. Caveness, F. E. 1979. Cowpea, lima bean, cassava, yams, and *Meloidogyne* spp. in Nigeria. Pp. 295–300 *in* F. Lamberti and C. E. Taylor, eds. Root-knot nematodes (*Meloidogyne* species) systematics, biology and control. London and New York: Academic Press.

8. Fery, R. L., and P. D. Dukes. 1980. Inheritance of root-knot resistance in cowpea (*Vigna unguiculata* (L.) Walp.). Journal of the American Society of Horticultural Science 105:671–674.

9. Fery, R. L. 1981. Cowpea production in the United States. HortScience 16:474.

10. Gad Elhak, S. H., A. A. Gazar, and Z. A. Shihata. 1984. Varietal response of cowpea (*Vigna unguiculata* Walp.) plants to root-knot nematode infestation. Annals of Agricultural Science 21:533–540.

11. Gupta, D. C. 1979. Studies on the pathogenicity and relative susceptibility of some varieties of cowpea against *Meloidogyne javanica*. Forage Research 5: 141–145.

12. Hadisoeganda, W. W., and J. N. Sasser. 1982. Resistance of tomato, bean, southern pea, and garden pea cultivars to root-knot nematodes based on host suitability. Plant Disease 66:145–150.

13. Hare, W. W. 1959. Resistance to root-knot nematodes in cowpea. Phytopathology 49:318 (Abstr.).

14. Hare, W. W. 1967. A combination of disease

resistance in a new cowpea, Mississippi Silver. Phytopathology 57:460 (Abstr.).

15. Hussey, R. S., and K. R. Barker. 1973. A comparison of methods for collecting inocula of *Meloidogyne* spp. including a new technique. Plant Disease Reporter 57:1025–1028.

16. Singh, D. B., and P. Parvatha Reddy. 1982. Cultivars of cowpea resistant to root-knot nematode in India. Tropical Pest Management 28:185–186.

17. Steel, R. G. D., and J. H. Torrie. 1980. Principles and procedures of statistics. New York: McGraw-Hill.

18. Swanson, T. A., and S. D. Van Gundy. 1984. Cowpea resistance to root-knot caused by *Meloidogyne incognita* and *M. javanica.* Plant Disease 68:961–964.

19. Taha, A. H. Y., and A. S. Kassab. 1979. The histopathological reactions of *Vigna sinensis* to separate and concomitant parasitism by *Meloidogyne javanica* and *Rotylenchulus reniformis.* Journal of Nematology 11:117–123.

20. Taylor, A. L., and J. N. Sasser. 1978. Biology, identification and control of root-knot nematodes (*Meloidogyne* species). Cooperative Publication, Department of Plant Pathology, North Carolina State University, and U.S. Agency of International Development, Raleigh.