# Influence of Maize Rotations on the Yield of Soybean Grown in *Meloidogyne incognita* Infested Soil[1]

ROBERT A. KINLOCH[2]

*Abstract:* A replicated field study was conducted from 1972 to 1980 involving soybeans grown in 2-, 3-, and 4-year rotations with maize in soil infested with *Meloidogyne incognita.* Monocultured soybeans were maintained as controls. Cropping regimes involved root-knot nematode susceptible and resistant soybean cultivars and soybeans treated and not treated with nematicides. Yields of susceptible cultivars declined with reduced length of rotation. Nematicide treatment significantly increased yields of susceptible cultivars when monocultured, but had little influence on yield when susceptible cultivars were grown in rotation. Yields of monocultured resistant cultivars were significantly lower than yields of resistant cultivars grown in rotation. However, yields of resistant cultivars grown in rotation were not influenced by the length of the rotation. Nematicide treatment significantly increased yields of monocultured resistant cultivars over the latter years of the study. *Key words: Glycine max, Zea mays,* root-knot, nematicides.

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Soybean, *Glycine max* (L.) Merr., has become a major source of agricultural income in the southeastern USA. Many pathogenic nematodes can limit production of the crop in this region. A widespread pathogen is the southern root-knot nematode, *Meloidogyne incognita* (Kofoid and White) Chitwood. Its influence on soybean production stimulated the development of resistant soybean cultivars (8). Several resistant cultivars adapted to production in the southeastern states have been released over the last decade (7). These cultivars have received increasing acceptance among growers. However, their resistance is horizontal in nature (17), and some yield reduction can be expected where soil infestation levels of *M. incognita* are high. In these areas, resistant cultivar yields have responded significantly to nematicidal treatment (6). Prior to the introduction of resistant cultivars and the use of nematicides, crop rotation with maize (*Zea mays* L.) was traditionally recommended for the management of root-knot nematode on soybean. Though widely used in rotation with soybean for the control of the soybean cyst nematode (*Heterodera glycines* Ichinohe) to which it is a nonhost (10,14), maize never has been generally accepted as an alternative rotation crop for managing *M. incognita.* This has been due, in part, to the development of the resistant cultivars and also to an awareness among agricultural specialists that maize may be a sufficiently good host for *M. incognita* to render it useless for control of this nematode by rotation. In some studies, root-knot nematodes did not develop significantly on maize (3,15) while in others, maize cultivars varied in their abilities to support populations of the nematode (1,11). It has been suggested that frequent maize plantings may select populations of *M. incognita* with abilities to thrive on this crop (13) and that there is need for caution when maize is used frequently in rotations (1). Consequently, a rotation study was designed to determine the influence of various maize rotations on soybean yield when grown in soil infested with *M. incognita* (Race 1.).

## MATERIALS AND METHODS

A rotation study was established at the University of Florida, Agricultural Research Center, Jay, Florida, in the spring of 1972. The site was chosen for its soil uniformity (loamy sand ultisol-typic paleudult —70% sand, 15% silt, 15% clay) and low infestation of *M. incognita* (< 1 infective juvenile per 10 $cm^3$ soil). The site was divided into 160 plots, each measuring 15 m long and 3.6 m wide and designed to accommodate four crop rows set 0.9 m apart. A preplanting sampling determined no significant ($P < 0.05$) differences in the level of infestation of *M. incognita* juveniles among the plots. Cropping regimes included soybean grown in 2-, 3-, and 4-year rotations with maize. To accommodate seasonal influences on yield, the cropping sequences were planted in multiple series such that all

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[2]University of Florida, Agricultural Research Center, Jay, FL 32565-9524.

Table 1. Rotation regimes of soybean (S) and maize (M) grown in multiple series, 1972–80. Each regime series was replicated four times.

| Year | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 |
|---|---|---|---|---|---|---|---|---|---|
| Monoculture | S | S | S | S | S | S | S | S | S |
| 2-yr. rotation | S | M | S | M | S | M | S | M | S |
| (two series) | M | S | M | S | M | S | M | S | M |
| 3-yr. rotation | S | M | M | S | M | M | S | M | M |
| (three series) | M | S | M | M | S | M | M | S | M |
| | M | M | S | M | M | S | M | M | S |
| 4-yr. rotation | S | M | M | M | S | M | M | M | S |
| (four series) | M | S | M | M | M | S | M | M | M |
| | M | M | S | M | M | M | S | M | M |
| | M | M | M | S | M | M | M | S | M |

crops in a given sequence were planted every year (Table 1). Monocultured soybean plots were maintained as controls.

The study consisted of four experiments, each replicated four times and randomized in a complete block design. These were rotation regimes involving:

- SO—*M. incognita* susceptible soybean cultivars grown without nematicidal treatment
- SN—*M. incognita* susceptible soybean cultivars treated annually with a nematicide
- RO—*M. incognita* resistant soybean cultivars grown without nematicidal treatment
- RN—*M. incognita* resistant soybean cultivars treated annually with a nematicide

Each year the experiments were planted with the same cultivar of maize, and similar nematicides were applied to the soybean plots in experiments SN and RN. Plots planted with maize were not treated with a nematicide. Crop cultivar selections were determined by the choice of growers in the vicinity, and nematicides were selected on the recommendations of the Florida Cooperative Extension Service (2) (Table 2).

Standard practices of fertilizing, planting, and weed and insect control were employed uniformly in each rotation experiment (5). Apart from the experimental treatments, pesticides with known nematicidal properties were never employed in this study. Although planting and harvesting dates varied from year to year, the maize crop was normally maintained from March through September, while the soybean crop

Table 2. Maize and soybean (susceptible or resistant to *Meloidogyne incognita*) cultivars and nematicides employed in rotations conducted, 1972–80.

| Year | Maize | Soybean: Susceptible | Soybean: Resistant | Nematicide* |
|---|---|---|---|---|
| 72 | Pioneer 3369A | Ransom | Bragg | ethoprop |
| 73 | Pioneer 3369A | Ransom | Bragg | dibromochloropropane |
| 74 | McNair 508 | Ransom | Hutton | dibromochloropropane |
| 75 | McNair 508 | Ransom | Cobb | dibromochloropropane |
| 76 | DeKalb XL80 | Pickett 71 | Centennial | dibromochloropropane |
| 77 | DeKalb XL80 | Pickett 71 | Centennial | dibromochloropropane |
| 78 | DeKalb XL80 | Pickett 71 | Centennial | dibromochloropropane |
| 79 | DeKalb XL80 | Davis | Centennial | dibromochloropropane |
| 80 | DeKalb XL80 | Pickett 71 | Centennial | dibromoethane |

*Nematicides were applied at planting at rates per 100-m row as follows: 20.5 g ethoprop in 16-cm band, soil incorporated to 8-cm depth; 75 ml dibromochloropropane single chisel injected at 23-cm depth; 95 ml dibromoethane single chisel injected at 23-cm depth.

was maintained from May to October or November. The entire area was left as uncultivated fallow during the winter months.

In late August of each year, the roots of plants from the border rows of each plot were inspected for galls. Four groups of plants, averaging four plants per group, from the soybean plots and four single plants from the maize plots were subjectively rated as follows: 0 = roots free of galls; 1 = < 5% (trace); 2 = 5–25%; 3 = 26–50%; 4 = 51–75%; 5 = > 75% root surface galled.

Yield data were collected from the two middle rows of each plot, adjusted to 14% seed moisture content, and converted to kg/ha.

Following soybean harvest, all plots were assayed for nematodes. This consisted of taking a soil core (2.5 × 20 cm deep) from each 2 m of the harvested rows. The cores from each plot were bulked and mixed manually and a subsample of 100 $cm^3$ was subjected to sugar-centrifuge flotation for nematode extraction (4). The extracted nematodes were dispersed in water in a gridded dish and their numbers per 10 $cm^3$ soil were counted.

The study was terminated following the nematode assay in 1980.

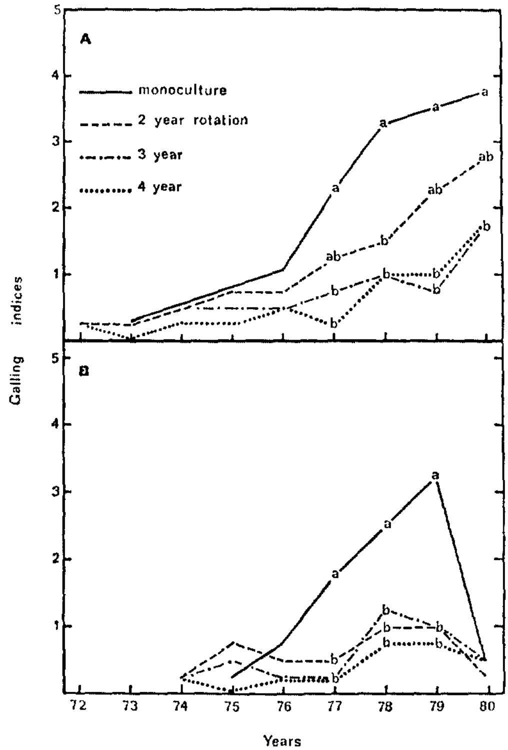


Fig. 1. Indices of root-knot galling on susceptible soybean cultivars. A) Cultivars not treated with nematicides. B) Cultivars treated with nematicides. Rated as follows: 0 = roots free of galls, 1 = < 5%, 2 = 5–25%, 3 = 26–50%, 4 = 51–75%, 5 = > 75% root surface galled. Data points for a given year within each figure having similar letters are not significantly different according to Duncan's multiple-range test ($P < 0.05$).

## RESULTS

Galls were never observed on maize roots throughout the course of this study. Galling sufficient for statistical comparison was found only on *M. incognita* susceptible soybean cultivars (Fig. 1). In experiment SO, trace amounts of galling were recorded for the first 5 years. Thereafter, galling steadily increased such that by the end of the study almost 50% of the roots in monocultured soybean plots were galled. In the last 4 years of the study, soybeans in the monoculture regime were significantly ($P < 0.05$) more galled than soybeans grown following 2 or 3 years of maize (3- and 4-year rotations, respectively). Galling on soybean following one year of maize (2-year rotation) was intermediate, being significantly less than the monocultured crop in only 1 year.

In experiment SN, the use of nematicides suppressed root galls on susceptible soybeans to trace amounts in all soybeans in rotation throughout the study. However, galling in the monoculture regime increased annually until the final year when application of dibromoethane suppressed galling to trace amounts. Nematicidal treatment significantly reduced galling in comparable cropping regimes only in the final year and only in the monoculture and in the 2-year rotation regimes.

Galling never exceeded trace levels in resistant soybean (experiments RO and RN) and was never found in the longer rotations where soybean was treated with a nematicide.

Yields of maize varied greatly among years (Table 3) and, except in 1979, were not significantly influenced by any of the rotational regimes. In 1979, a year of low maize yields, significantly higher yields were obtained from crops grown in the 3rd and 2nd year following soybean (Table 4). In-

Table 3. Annual maize yields, averaged across treatments, 1972–80.*

| Year | Kg/ha† |
|---|---|
| 72 | 6,262c |
| 73 | 4,914d |
| 74 | 3,158f |
| 75 | 9,220b |
| 76 | 11,545a |
| 77 | 545g |
| 78 | 6,122c |
| 79 | 3,159f |
| 80 | 4,157e |

*Averages of 24 replicates.

†Numbers followed by the same letter are not significantly different according to Duncan's multiple-range test ($P < 0.01$).

Table 4. Yields of maize grown in various rotations with soybean in 1979.*

| Rotation (years) | Years following soybean | Kg/ha† |
|---|---|---|
| 4 | 3 | 3,626a |
| 3 | 2 | 3,579a |
| 4 | 2 | 3,506a |
| 4 | 1 | 3,315ab |
| 2 | 1 | 2,553b |
| 3 | 1 | 2,552b |

*Averages of 16 replicates.

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

teraction terms from the analysis of variance indicated that rotating with susceptible or resistant soybean cultivars, whether or not they were treated with a nematicide, had no influence on maize yields.

Yields of soybean varied with each year (Table 5). In the early years of the study, *M. incognita* susceptible cultivars generally outyielded resistant cultivars, irrespective of rotational or nematicidal treatment. This was due to their better agronomic traits in the absence of nematode induced stress. The reverse was true in the latter half of the study, with the exception of the last year when there was no significant difference in overall yield between susceptible and resistant cultivars. However, in that year, resistant cultivars significantly outyielded susceptible cultivars when monocultured or grown following only 1 year of maize.

Nematicide treated soybeans consistantly outyielded those not receiving treatment. Significant increases in yield were more prevalent in the latter years of the study.

Monocultured soybeans, irrespective of cultivar or nematicidal treatments, consistently yielded less than those grown in rotation with maize. Although there were no significant differences among the rotational treatments in the first 2 years of the study, yields generally increased with the length of the rotation. An anomalous result was recorded in 1977 when soybeans grown in the 3-year rotation yielded significantly

Table 5. Influence of sources of variation on soybean yield (kg/ha) grown in monoculture and in rotation with maize, averaged across other treatments, 1972–80.

| | Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Treatment | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 |
| Cultivar:* | | | | | | | | | |
| Susceptible | 2,009a† | 1,520a | 3,306a | 2,269a | 2,175a | 2,153b | 2,054b | 2,116b | 1,814a |
| Resistant | 1,794b | 1,561a | 2,999b | 1,664b | 2,235a | 2,579a | 2,744a | 2,512a | 1,967a |
| Nematicide:* | | | | | | | | | |
| Nontreated | 1,900a | 1,469a | 3,039b | 1,874a | 2,130a | 2,233b | 2,190b | 2,219b | 1,729b |
| Treated | 1,903a | 1,612a | 3,266a | 2,059a | 2,280a | 2,499a | 2,608a | 2,409a | 2,052a |
| Rotation:‡ | | | | | | | | | |
| Monoculture | 1,762a | 1,424a | 2,845b | 1,603b | 1,946b | 1,947c | 1,758c | 1,820b | 1,541b |
| 2-yr. | 1,868a | 1,601a | 3,085b | 2,047ab | 2,225a | 2,557a | 2,476b | 2,372a | 1,754b |
| 3-yr. | 1,942a | 1,523a | 3,338a | 2,117a | 2,274a | 2,291b | 2,487b | 2,535a | 2,049a |
| 4-yr. | 2,036a | 1,612a | 3,338a | 2,096a | 2,374a | 2,670a | 2,875a | 2,529a | 2,218a |

*Averages of 32 observations.

†Numbers followed by the same letter within source columns are not significantly different according to Duncan's multiple-range test ($P < 0.05$).

‡Averages of 16 observations.

less than those grown in either the 2- or 4-year rotations.

Average yield data from all treatments for all years are presented in Table 6. Significant differences among treatments were not recorded until the 3rd year. Among regimes involving susceptible soybeans not treated with nematicides (SO), the 4-year rotation consistantly yielded the most soybeans, although the 3-year rotation yielded significantly less in only 1 year. Monocultured soybeans yielded significantly less than those in the 2-year rotation for the last 5 years of the study. Among regimes involving susceptible cultivars treated with nematicides (SN), significant differences in yield were not recorded until the 6th year. From that time, monocultured plots yielded significantly fewer soybeans than those in the 4-year rotation. Yields from the 2- and 3-year roations were intermediate during the last 4 years of the study. Although nematicide treatment of susceptible cultivars consistantly increased yields, significant increases between comparable regimes were recorded in the monocultured cultivars only in 1976 and 1980, and only in 1978 from cultivars grown in the longer rotations. Among regimes involving resistant cultivars not treated with nematicides (RO), there were no significant differences among soybeans grown in rotation with maize. The monocultured soybeans yielded significantly less than those grown in the longer rotations in 3 separate years. Fewer differences in yields were recorded when resistant cultivars were treated with nematicides (RN). Significant yield increases between comparative regimes due to nematicidal treatment occurred only in the monocultured soybeans in 1978. These data are compared, averaged across the years, and transformed to percentages relative to the yields of the resistant cultivars grown in 4-year rotations and treated with nematicides (Table 7). Monocultured soybeans, irrespective of cultivar or nematicidal treatment, yielded significantly less than those grown in rotation. Monocultured susceptible cultivars benefitted from nematicidal treatment when data was averaged across the 9 years. Beneficial nematicidal treatment of the monocultured resistant cultivars was apparent only across the last 3 years. Beneficial nematicidal treatments of rotated soybean were apparent only from data averaged across the

Table 6. Yields (kg/ha) of *Meloidogyne incognita* susceptible and resistant soybean grown with or without nematicide treatment in various rotations with maize, 1972–80.*

| Treatment and rotation† | Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 |
| SO1 | 1,998 | 1,410 | 2,898b-d‡ | 1,681b-e | 1,652c | 1,516e | 1,249i | 1,242e | 932f |
| SO2 | 1,892 | 1,333 | 3,036a-d | 2,312a-c | 2,067ab | 2,267a-c | 1,988fg | 2,055d | 1,433e |
| SO3 | 1,925 | 1,579 | 3,281a-c | 2,198a-d | 2,242a | 1,734c-e | 1,910gh | 2,307a-d | 1,996a-d |
| SO4 | 2,177 | 1,621 | 3,411ab | 2,413a-c | 2,417a | 2,532ab | 2,294e-g | 2,341a-d | 2,184a-c |
| SN1 | 1,831 | 1,436 | 3,354a-c | 2,141a-d | 2,331a | 1,645de | 1,487hi | 1,620e | 1,707b-e |
| SN2 | 2,043 | 1,717 | 3,338a-c | 2,430a-c | 2,169a | 2,637ab | 2,144e-g | 2,232b-d | 1,751b-e |
| SN3 | 1,983 | 1,555 | 3,556a | 2,458ab | 2,169a | 2,182b-d | 2,483d-f | 2,611a-c | 2,058a-d |
| SN4 | 2,226 | 1,507 | 3,570a | 2,519a | 2,348a | 2,715ab | 2,883a-d | 2,596a-c | 2,450a |
| RO1 | 1,583 | 1,412 | 2,548d | 1,156e | 1,760bc | 2,216a-c | 1,765gh | 2,149cd | 1,645c-e |
| RO2 | 1,827 | 1,558 | 2,803cd | 1,640c-e | 2,246a | 2,483ab | 2,635b-e | 2,457a-d | 1,660c-e |
| RO3 | 1,929 | 1,373 | 3,179a-c | 1,856a-e | 2,283a | 2,471ab | 2,639b-e | 2,592a-c | 1,958a-d |
| RO4 | 1,872 | 1,462 | 3,154a-c | 1,733a-e | 2,368a | 2,646ab | 3,038a-c | 2,595a-c | 2,028a-d |
| RN1 | 1636 | 1,439 | 2,584d | 1,436de | 2,040ab | 2,410ab | 2,532c-f | 2,270b-d | 1,881b-e |
| RN2 | 1,709 | 1,798 | 3,167a-c | 1,811a-e | 2,471a | 2,841a | 3,138ab | 2,744a | 2,174a-d |
| RN3 | 1,929 | 1,586 | 3,337a-c | 1,957a-d | 2,401a | 2,776ab | 2,916a-d | 2,620ab | 2,183a-c |
| RN4 | 1,873 | 1,860 | 3,220a-c | 1,721a-e | 2,361a | 2,788ab | 3,284a | 2,651ab | 2,210ab |
| | NSD | NSD | | | | | | | |

*Averages of four replicates.

†S = susceptible soybean; R = resistant soybean; O = not treated with nematicide; N = treated with nematicide. 1, 2, 3, 4 = monoculture and soybean every 2, 3, and 4 years, respectively.

‡Numbers followed by the same letter in each column are not significantly different according to Duncan's multiple-range test ($P < 0.05$).

Table 7. Yields of *Meloidogyne incognita* susceptible and resistant soybean grown with or without nematicide treatment in various rotations with maize expressed as percentage of yield from nematicide treated resistant soybean grown in the longest rotation. Data averaged across years.

| Treatment and rotation* | Years 1972–80 | 1975–80 | 1978–80 |
|---|---|---|---|
| SO1 | 69g† | 58f | 42h |
| SO2 | 86de | 84cde | 67fg |
| SO3 | 90bcde | 87bcd | 78def |
| SO4 | 100ab | 98abc | 86bcde |
| SN1 | 83ef | 76de | 61g |
| SN2 | 96abcd | 93abc | 76ef |
| SN3 | 98abc | 97abc | 89abcd |
| SN4 | 105a | 107a | 99a |
| RO1 | 75fg | 72e | 70fg |
| RO2 | 88cde | 88bcd | 83cde |
| RO3 | 93bcde | 94abc | 89abcd |
| RO4 | 95abcd | 96abc | 94abc |
| RN1 | 83ef | 84cde | 82de |
| RN2 | 99abc | 101ab | 99a |
| RN3 | 99abc | 100ab | 96ab |
| RN4 | 100ab | 100ab | 100a |
| 100 = | 2,441 | 2,503 | 2,715kg/ha |

*S = susceptible soybean; R = resistant soybean; O = not treated with nematicide; N = treated with nematicide. 1, 2, 3, 4 = monoculture and soybean every 2, 3, and 4 years, respectively.

†Numbers followed by the same letter in each column are not significantly different according to Duncan's multiple-range test ($P < 0.05$).

last 3 years. These were in the 4-year rotation of susceptible cultivars and in the 2-year rotation of resistant cultivars.

Other plant parasitic nematodes concomitant with *M. incognita* in the soil were *Helicotylenchus dihystera* (Cobb) Sher, *Pratylenchus scribneri* Steiner, *P. zeae* Graham, *Criconemella sphaerocephala* (Taylor) Luc and Raski, and *Paratrichodorus christiei* Allen. The spiral nematode was the most abundant and was more prevalent following soybean than maize. None of these species, which were found in numbers lower than normally recovered for the area (9), were considered to be factors in influencing the yields of either soybean or maize.

The numbers of *M. incognita* juveniles recovered from soil following maize were extremely variable and were not significantly influenced by the rotation regimes. Maximum numbers recovered were approximately 30 per 10 $cm^3$ soil. It is notable that in rotations with resistant soybean cultivars, greater numbers were usually recovered following maize than soybean.

The numbers of *M. incognita* juveniles recovered from soil following soybean remained low for the first 5 years of the study. Significant increases, specifically among the susceptible cultivars, were not obtained until 1976. The numbers recovered from soil following the various regimes are presented averaged over the years (Table 8). No significant differences occurred among the treatments when the data were averaged over the 9 years of the study. This was due to the low numbers of juveniles recovered from all treatments through the first 5 years. Among regimes planted with susceptible cultivars, significantly more juveniles were recovered following monocultured soybean than following those planted in 4-year rotations with maize. The 2- and 3-year rotations were intermediate in their influence on populations of the nematode. In mono-

Table 8. Numbers of *Meloidogyne incognita* infective juveniles per 10 $cm^3$ soil following harvest of soybeans grown in monoculture and in various rotations with maize. Numbers averaged across years.

| Treatment and rotation* | Years 1975–80 | 1978–80 |
|---|---|---|
| SO1 | 123a† | 210a |
| SO2 | 94ab | 141ab |
| SO3 | 44cde | 80bc |
| SO4 | 58bcd | 73bc |
| SN1 | 76bc | 142ab |
| SN2 | 59bcd | 99bc |
| SN3 | 33cde | 59bc |
| SN4 | 21de | 33c |
| RO1 | 44cde | 86bc |
| RO2 | 17de | 30c |
| RO3 | 9de | 16c |
| RO4 | 17de | 31c |
| RN1 | 11de | 22c |
| RN2 | 5e | 9c |
| RN3 | 2e | 4c |
| RN4 | 3e | 2c |

*S = susceptible soybean; R = resistant soybean; O = not treated with nematicide; N = treated with nematicide. 1, 2, 3, 4 = monoculture and soybean every 2, 3, and 4 years, respectively.

†Numbers within each column followed by the same letter are not significantly different according to Duncan's multiple-range test ($P < 0.05$).

cultured and 2-year rotated soybean, significantly fewer juveniles were recovered following resistant than susceptible cultivars. Significant differences in influencing juvenile populations were not so apparent between resistant and susceptible cultivars among the 3- and 4-year rotations. However, populations of *M. incognita* juveniles following nematicide treated resistant cultivars grown in these longer rotations remained very low, even in the latter years of the study.

## DISCUSSION

Soybeans in the southeastern United States are generally monocultured, and until recently, this has involved cultivars susceptible to *M. incognita*. This led to widespread damage caused by this pathogen. The introduction of resistant cultivars during the last decade has relieved the problem considerably, and numerous growers have been satisfied with maintaining monocultures of the resistant cultivars and resorting to complementary treatment with nematicides in severe root-knot nematode infestations. Yields from these monoculture regimes have remained stable over the years, and the author is unaware of any instance where the continuous culture of *M. incognita* resistant cultivars has resulted in less than profitable yields attributable to this nematode.

Data from this study demonstrate that significantly higher yields of resistant cultivars, irrespective of nematicide treatment, can be achieved when they are grown in rotation with maize. Crop rotation, and any other nematode management strategy, is utilized to preserve rather than enhance the inherent yield capability of a crop. Consequently there is a limit beyond which extended rotations do not enhance yield responses. Data from this study show that a 2-year rotation with maize, coupled with nematicide treatment of the soybean crop (RN2), is adequate to achieve optimum yields of resistant cultivars and to maintain low numbers of *M. incognita* residual in the soil. The 2-year rotation without nematicide treatment (RO2) produced yields equivalent to the nematicide treated monoculture (RN1) but less than the comparative nematicide treated rotation (RN2) over the last 2 years of the study.

The success of a rotation program depends primarily on its economic merits compared with monoculture. The 2-year rotation with resistant cultivars increased soybean yields approximately 20 percent above that achieved by monoculturing. A similar increase was achieved between comparative regimes when nematicides were employed. This additional increase from a reduced soybean hectarage, together with a grower's ability to produce maize with a profit margin competitive with monocultured soybean, will be an important factor in deciding the justification of a 2-year rotation. Maize production in the southeastern USA has been historically erratic. However, recent technological advances designed to increase and stabilize yield should favor the adoption of soybean-maize rotations (12,16).

These data demonstrate the deleterious effects on yield of monoculturing susceptible soybean cultivars in soil infested with *M. incognita*. Although the greatest response to nematicides occurred by treating these cultivars, there was a progressive decline in yields from this cropping regime through the course of the study. Longer rotations are required to maintain optimum yields of susceptible cultivars. The 3-year rotations with nematicide treatment (SN3) maintained yields through the course of this study as did the 4-year rotation without nematicide (SO4). However, the long-term benefits of planting susceptible cultivars without nematicides, even in long rotations, is questionable since yield data collected during the last 3 years indicate a decline in the relative yields of these cropping regimes.

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