Supplement to Journal of Nematology 23(4S):678–681. 1991.

Evaluation of Two Soybean Cultivars and Aldicarb Treatment in Soil Infested with Plant-parasitic Nematodes[1]

D. W. Dickson and R. McSorley[2]

Abstract: The soybean cultivars Davis and Leflore were grown in a northern Florida experimental site infested with eight species of plant-parasitic nematodes. *Meloidogyne incognita* appeared to become the predominant pathogen, suppressing Davis soybean yield regardless of aldicarb treatment. Soybean yields of Leflore were 1.4-fold to 3.5-fold greater than yields of Davis, but aldicarb did not affect yields of either cultivar. Davis soybean yield was negatively correlated with the at-plant density of *M. incognita,* whereas Leflore seed yield was not negatively correlated with any nematode.

Key words: aldicarb, control, *Glycine max, Heterodera glycines, Meloidogyne incognita,* nematicide, nematode, root-knot nematode, soybean, soybean cyst nematode.

In the southeastern United States, many soybean fields contain a polyspecific community of plant-parasitic nematodes (2,11,13,14). A few of these species, namely *Heterodera glycines* and *Meloidogyne* spp., severely damage soybean either singly (4,16) or in combination (15,16). The role of other soybean-parasitic nematodes has been studied less intensively, either singly or in combination (16).

Resistant soybean cultivars are major management tools against *H. glycines* and *M. incognita* (5–8). Aldicarb at low dosages is also a management option for use with susceptible, resistant, or tolerant cultivars (12). Our objective was to evaluate aldicarb at relatively low dosages and compare its efficacy to that of the soybean cvs. Leflore (resistant to *H. glycines* and resistant or partially resistant to *M. incognita*; 8) and Davis (susceptible to *H. glycines* and *M. incognita*; 6) in a field infested with several species of plant-parasitic nematodes.

Materials and Methods

The experiment was conducted in 1990 at the University of Florida agronomy farm located in Alachua County, Florida. The site, which had a history of soybean (*Glycine max* (L.) Merr.) yield suppressed, was infested with *Belonolaimus longicaudatus* Rau, *Criconemella* spp., *Helicotylenchus dihystera* (Cobb) Sher, *H. glycines* Ichinohe race 3, *Meloidogyne incognita* (Kofoid & White) Chitwood, *Paratrichodorus minor* (Colbran) Siddiqi, *Pratylenchus brachyurus* (Godfrey) Filipjev & Schuurmans Stekhoven, and a *Xiphinema* sp. similar to *X. floridae* Lamberti & Bleve-Zacheo. In the previous fall, the site was planted in rye (*Secale cereale* L. cv. Wrens Abruzzi). The soil was an Arredondo fine sand (91% sand, 4.5% silt, 4.5% clay; 1.8% organic matter; pH 5.7). The field design was a 2 × 4 factorial (2 cultivars × 4 nematicide treatments) arranged in a randomized complete block with six replicates. Each plot consisted of two rows, 9.1 m long and 0.9 m apart.

The field was cross-disked and deep-plowed 30 April, and 95 kg P_2O_5/ha was applied broadcast 18 May and disk incorporated. Cultural practices and control of weeds and insects were as recommended for the area (1). Rainfall (75.3 cm) exceeded normal (69.4 cm) during the experimental period, and the longest drought period (days with zero soil water) was 6 days recorded 12–17 June.

Aldicarb was applied at planting in an 18-cm band at rates of 11 g a.i./100 m or 8.4 g a.i./100 m or in furrow at 5.6 g a.i./100 m. A Gandy (Owatonna, MN) applicator was used with the row bander placed directly in front of the planter opening disk

Received for publication 28 March 1991.
[1] Florida Agricultural Experiment Station Journal Series No. R-01473. Supported in part by Rhone-Poulenc Co. The mention of commercial companies or their products is solely for the purpose of providing specific information and does not constitute a guarantee of products.
[2] Professors, Department of Entomology and Nematology, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, FL 32611-0740.
We thank Tom Hewlett, John Frederick, Reginald Wilcox, and Dale Beistrusten for technical assistance.

and the planter shoe. Soybean cvs. Leflore and Davis were planted 21–22 May.

Soil samples to estimate nematode population densities were taken 0–15 cm deep at planting (Pi), near midseason (Pm; 16 July), and at harvest (Pf; 11 October). A sample consisted of a composite of 12 2.5-cm-d cores taken through the root zone of random plants in the two-row plots. Samples were mixed thoroughly, stored in plastic bags at 10 C, and processed by sugar flotation-centrifugation (9) within 5 days after sampling.

The plots were hand harvested 11 October, and seed yields were reported at 9% moisture. Data were subjected to analysis of variance for a factorial design. Correlation coefficients (r) were calculated between densities of different nematode species.

Results and Discussion

The experimental site was infested with eight species of plant-parasitic nematodes. Of theses, the population densities of *B. longicaudatus, H. dihystera,* and *Xiphinema* sp. were widely distributed and very low, with mean Pf over all plots of 2, 8, and 0.1/100 cm^3 soil, respectively. Thus, they were not considered as factors affecting soybean yield and provided insufficient data for further analysis.

The initial population densities of the five remaining nematode species were relatively low (Table 1). The Pm of *H. glycines* and *M. incognita* were lower ($P \leq 0.01$) in Leflore plots than in Davis plots. The reverse was true for *P. brachyurus* ($P \leq 0.05$). Cultivar affected ($P \leq 0.05$) the final population densities of *Criconemella* spp., *P. minor,* and *P. brachyurus.* Densities of *Criconemella* spp. and *P. minor* were lower in Leflore plots than in Davis plots, whereas the reverse was true for *P. brachyurus.* The final population densities of *H. glycines* remained relatively low (28/100 cm^3 soil among all plots), whereas *M. incognita* increased to relatively high numbers (562/100 cm^3 soil among all plots). No differences ($P \leq 0.05$) were observed between population densities of *M. incognita* in Leflore or Davis plots at harvest.

Meloidogyne incognita greatly suppressed Davis soybean yield regardless of the aldicarb treatment (Table 1). There was a negative correlation ($r = -0.487, P \leq 0.05$) between the Pi of *M. incognita* and the yield of Davis; whereas the correlation for Leflore was not significant (Table 2). The development of root-knot disease on Davis was rapid and severe. Plants were severely stunted, and many died.

The Pf of *H. glycines* on Leflore and Davis at harvest was relatively low. The correlations between the Pi of *H. glycines* and yields of Leflore and Davis were positive (r = 0.457 and 0.428, respectively, Table 2). An interaction of *H. glycines* and *M. incognita* on growth and yield of soybean has been shown (15), but whether the effect was additive depended on their Pi. In a microplot study, *H. glycines* caused a greater suppression of Davis soybean yield than *M. incognita,* even when the Pi of *M. incognita* was 1.5 times greater (4). However, in our field test the Pi of *M. incognita* was ca. 3.0 times greater than the Pi of *H. glycines.* The relatively low Pf of *H. glycines* on Leflore and Davis soybean may have resulted from the lack of feeding sites (the roots were heavily infected with root-knot nematodes). Another factor may have been a fungal antagonist that appears to attack eggs within the cysts. The isolation and identification of this fungus are underway. Our experimental site may be suppressive to *H. glycines.*

We suggest that the positive correlations of the Pi of *P. minor* and *P. brachyurus* with yields of Leflore (r = 0.536 and 0.526, respectively) and Davis (r = 0.412 and r = 0.623, respectively) were artifacts, possibly related to the negative correlations of the Pi of these two species with the Pi of *M. incognita* ($r = -0.328$ and -0.330, respectively, Table 2). There was a strong effect of the plot location on the densities of each nematode species at all three sampling dates ($P \leq 0.05$). Location effects were also strongly associated with yield ($P \leq 0.01$), and this association was probably a result

TABLE 1. Yield of soybean and mean numbers of *Criconemella* spp., *Heterodera glycines, Meloidogyne incognita, Paratrichodorus minor,* and *Pratylenchus brachyurus* on three sampling dates as affected by cultivar and aldicarb treatment.

Treatment (application rate in g a.i./100 m, and method)	Seed yield (g/plot)	Nematodes/100 cm³ soil: *Criconemella* spp.†			*H. glycines*			*M. incognita*			*P. minor*			*P. brachyurus*		
		Pi	Pm	Pf	Pi	Pm	Pf	Pi	Pm	Pf	Pi	Pm	Pf	Pi	Pm	Pf
Leflore																
Aldicarb (11, 18-cm band)	975	7	4	5	1	0	30	3	6	545	14	50	1	10	2	52
Aldicarb (8.4, 18-cm band)	840	8	9	3	2	1	40	7	7	603	11	60	0	20	3	137
Aldicarb (5.6, in-furrow)	946	3	2	3	2	1	38	2	9	397	17	58	1	15	6	203
Untreated	736	6	1	3	2	1	24	2	132	850	16	84	2	14	5	172
Mean (over all Leflore plots)	874	6.0	4.0	3.5	1.8	0.8	33	3.5	38.5	599	14.5	63	1.0	14.8	4.0	141
Davis																
Aldicarb (11, 18-cm band)	282	10	6	14	1	3	22	5	10	466	12	86	65	5	0	31
Aldicarb (8.4, 18-cm band)	331	15	2	28	1	10	24	4	29	723	12	71	87	11	0	33
Aldicarb (5.6, in-furrow)	689	6	1	3	2	11	29	5	41	476	19	70	111	14	1	60
Untreated	287	3	9	40	2	6	16	4	220	437	9	72	60	6	7	23
Mean (over all Davis plots)	397	8.5	4.5	21.3	1.5	7.5	22.8	4.5	75	526	13	74.8	80.8	9.0	2.0	36.8
Significant effects from analysis of variance‡																
Cultivar	***	ns	ns	*	ns	***	ns	ns	**	ns	ns	ns	***	ns	*	*
Nematicide	*	ns	ns	ns	ns	ns	ns	ns	***	ns	ns	ns	ns	ns	ns	ns
Replication	***	***	***	***	***	*	***	***	***	***	**	ns	**	***	***	***
Cultivar × nematicide	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

Data are means of six replications. Sampling dates were 21 May (Pi), 21 July (Pm), and 11 October (Pf).
† Mixture of *C. ornata* and *C. sphaerocephala.*
‡ *, **, *** indicate significant effects at $P \leq 0.05$, 0.01, and 0.001, respectively. ns = not significant.

TABLE 2. Correlation coefficients (r) between initial densities of each of five plant-parasitic nematodes and final yield of Leflore and Davis soybean and initial density of *Meloidogyne incognita*.

Nematode	Leflore yield	Davis yield	Pi of *M. incognita*
Criconemella spp.†	−0.233	−0.001	0.034
Heterodera glycines	0.457*	0.428*	0.027
Meloidogyne incognita	0.210	−0.487*	1.000**
Paratrichodorus minor	0.536**	0.412*	−0.328*
Pratylenchus brachyurus	0.526**	0.623**	−0.330*

Correlations were calculated over log-transformed nematode densities from 24 plots (22 df) for each soybean yield and over 48 plots (46 df) for initial *M. incognita* densities (Pi).
† Mixture of *C. ornata* and *C. sphaerocephala*.
*, ** indicate significant r at $P \leq 0.05$ and $P \leq 0.01$, respectively.

of irregular dispersion of *M. incognita* over the field.

Leflore seed yields were 1.4-fold to 3.5-fold greater than yields for Davis. There was no consistent effect of aldicarb treatments on seed yield of either Leflore or Davis soybean. Because the Pf of *M. incognita* on Leflore was similar to that on Davis (Table 1), while the yield of Leflore was unaffected by the Pi of *M. incognita* (Table 2), we conclude that this cultivar was tolerant (3) to this nematode. Leflore was reported as resistant or moderately resistant to *M. incognita* (8).

LITERATURE CITED

1. Bailey, B. A., E. B. Whitty, D. H. Teem, F. A. Johnson, R. A. Dunn, T. A. Kucharek, and B. P. Cromwell. 1980. Soybean production guide. C77E. Institute of Food and Agricultural Sciences, University of Florida, Gainesville.

2. Baird, S. M., and E. C. Bernard. 1984. Nematode population and community dynamics in soybean-wheat cropping and tillage regimes. Journal of Nematology 16:379–386.

3. Cook, R., and K. Evans. 1987. Resistance and tolerance. Pp. 179–231 *in* R. H. Brown and B. R. Kerry, eds. Principles and practice of nematode control in crops. Orlando, FL: Academic Press.

4. Dickson, D. W., and R. McSorley. 1990. Interactions of three plant-parasitic nematodes on corn and soybean. Supplement to the Journal of Nematology 22:783–791.

5. Herman, M., R. S. Hussey, and H. R. Boerma. 1990. Response of resistant soybean plant introductions to *Meloidogyne incognita* in field microplots. Journal of Nematology 22:237–241.

6. Hiebsch, C. 1990. Soybean variety characteristics and performance. Agronomy Facts SS-Agr-026. Florida Cooperative Extension Service, University of Florida, Gainesville.

7. Hussey, R. S., and H. R. Boerma. 1989. Tolerance in maturity groups V–VIII soybean cultivars to *Heterodera glycines*. Supplement to the Journal of Nematology 21:686–692.

8. Hussey, R. S., H. R. Boerma, P. L. Raymer, and B. M. Luzzi. 1991. Resistance in soybean cultivars from maturity groups V–VIII to soybean cyst and root-knot nematodes. Supplement to the Journal of Nematology 23:576–583.

9. Jenkins, W. R. 1964. A rapid centrifugal-flotation technique for separating nematodes from soil. Plant Disease Reporter 48:692.

10. Kinloch, R. 1980. The control of nematodes injurious to soybean. Nematrópica 10:141–153.

11. McSorley R., and D. W. Dickson. 1989. Effects and dynamics of a nematode community on soybean. Journal of Nematology 21:490–499.

12. Noel, G. 1987. Comparison of 'Fayette' soybean, aldicarb, and experimental nematicides for management of *Heterodera glycines* on soybean. Supplement to the Journal of Nematology 19:84–88.

13. Robbins, R. T., R. D. Riggs, and D. Van Steen. 1987. Results of annual phytoparasitic nematode surveys of Arkansas soybean fields, 1978–1986. Supplement to the Journal of Nematology 19:50–55.

14. Rodríguez-Kábana, R., and J. C. Williams. 1981. Soybean yield losses caused by *Meloidogyne arenaria* and *Heterodera glycines* in a field infested with the two parasites. Nematrópica 11:93–104.

15. Ross, J. P. 1964. Interactions of *Heterodera glycines* and *Meloidogyne incognita* on soybeans. Phytopathology 54:304–307.

16. Schmitt, D. P., and G. R. Noel. 1984. Nematode parasites of soybean. Pp. 13–59 *in* W. R. Nickle, ed. Plant and insect nematodes. New York: Marcel Dekker.