NEMATICIDE SEED TREATMENTS FOR CONTROL OF SOYBEAN NEMATODES

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ABSTRACT

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A greenhouse experiment with field soil infested with *Meloidogyne incognita* was conducted to determine the relative efficacy of seed treatments with aldoxycarb, thiodicarb, and Gus 6015 for control of the nematode in 'Kirby' soybean (*Glycine max*). Aldoxycarb was the most effective for reducing juvenile populations in soil and in roots of soybean. Data from a second greenhouse experiment with the same soil indicated that aldoxycarb rates higher than 0.189 kg a.i./100 kg seed were required to suppress juvenile population development of the nematode in soil and in the roots of 'Essex' soybean. Field experiments were conducted at two locations in south Alabama in fields infested with *M. arenaria* + *Heterodera glycines* (Kaiser farm) and with *M. incognita* + *H. glycines* (Gottler farm). In each experiment, seed of 'Ransom' (susceptible to the nematodes) and 'Kirby' (tolerant to *M. incognita* and to *H. glycines*) were treated with aldoxycarb at rates of 0, 0.126, 0.251, 0.377, 0.503, and 1.005 kg a.i./100 kg seed. The soybeans were planted at a rate of 67 kg/ha. Yields of 'Kirby' were increased in the Gottler field with rates of 0.377 kg or higher, but 'Ransom' yields were increased only at the 1.0-kg rate. Seed treatments at the Kaiser farm had no consistent effect on yields of 'Ransom'; 'Kirby' yields were increased by the 0.251 and the 0.377-kg rates. Seed treatments had no effect on juvenile populations of *H. glycines* in soil on either farm, but suppressed juvenile populations of *M. incognita* early in the season at the Gottler location; however, this effect was not evident late in the season. Seed treatments of nematode-tolerant soybean cultivars can result in significant yield improvements and should be considered as a means to supplement the tolerance available in cultivars for the management of soybean nematodes.

Additional key words: pest management, root-knot nematodes, cyst nematodes, chemical control, breeding, pesticides, methods of application.

RESUMEN

Rodríguez-Kábana, R. y C. F. Weaver. 1987. Tratamientos con nematicidas a semillas para combatir los nematodos de la soya. Nematrópica 17:79-93.

Se efectuó un experimento de invernadero con un suelo infestado con *Meloidogyne incognita* para determinar la eficacia relativa de tratamientos a semillas con aldoxicarb, tiodicarb y Gus 6015 para el combate de nematodos de la soya (*Glycine max*). Los resultados señalaron que aldoxicarb fué el nematicida más efectivo de los tres probados para disminuir las poblaciones de larvas tanto en el suelo como en las raíces del cultivar 'Kirby'. Datos obtenidos con un segundo experimento de invernadero con suelo de la misma provenencia demostraron que es necesario utilizar dosis de aldoxicarb superiores a 0.189 kg i.a./100 kg semillas para controlar el desarrollo de poblaciones del nematodo en el suelo y en las raíces del cultivar Essex. Se efectuaron también experimentos en dos localidades del sur de Alabama: uno ubicado en la finca Kaiser en un campo infestado con *M. arenaria* + *H. glycines*, y el otro en la finca Gottler con suelo infestado con *M. incognita* + *H. glycines*. En estos experimentos se usaron los cultivares Ransom, susceptible a las especies de fitonematodos presentes, y 'Kirby' tolerante a los nematodos. Las semillas recibieron tratamientos con aldoxicarb en dosis de 0, 0.126, 0.251, 0.377, 0.503, y 1.005 kg i.a./100 kg semillas. La soya en cada experimento se plantó a razón de 67 kg semilla/ha. Los rendimientos de 'Kirby' aumentaron en la finca Gottler en respuesta a dosis de aldicarb de 0.377 kg o más altas. En esta finca los rendimiento de 'Ransom' aumentaron sólo con la dosis más alta del nematicida. Los tratamientos en la finca Kaiser no dieron efectos consistentes en los rendimientos de 'Ransom' aunque las dosis de 0.251 y 0.377 si aumentaron los rendimientos de 'Kirby'. Los tratamientos no afectaron las poblaciones de larvas de *H. glycines* en el suelo en ambas fincas. No fué así con las poblaciones de *M. incognita* las que fueron reducidas en las fase inicial del cultivo en la finca Gottler. Los efectos de los tratamientos de semilla sobre las poblaciones de *M. incognita* fueron de corta duración ya que no se notaron en la fase final del cultivo. Nuestros resultados señalan que se pueden utilizar tratamientos de semillas con nematicidas para aumentar rendimientos de cultivares de soya tolerantes de fitonematodos siempre y cuando se les consideren como una manera de suplementar la tolerancia existente en los cultivares para el manejo de los fitonematodos de la soya.

Palabras claves adicionales: manejo de plagas, nematodos agalladores, nematodo del quiste, combate químico, fitomejoramiento, plaguicidas, métodos de tratamiento, manejo integrado de plagas.

INTRODUCTION

The production of soybean [*Glycine max* (L.) Merr.] in the southeastern United States is limited by nematode damage (5,16,17,18). The most economically important nematodes in the region are species of root-knot (*Meloidogyne* spp.) nematodes and the cyst nematode (*Heterodera glycines* Ichinohe) (5). Production of soybean in the area has been possible through use of nematicides and of cultivars tolerant to some of the important nematode species (5); however, even the most tolerant cultivars sustain significant yield losses from nematodes (4,6,9,14,22). The use of inexpensive nematicides was recommended for use with tolerant cultivars to assure maximal, and usually the most profitable, production of soybean (5), especially in fields infested with several nematode species (13,16). The elimination through regulatory action of the inexpensive nematicides (DBCP, EDB) for use by soybean farmers has created a need for development of inexpensive treatments to maintain profitable soybean production in the southeastern United States. Seed treatments with nematicides for control of nematodes have been proposed as a precisely targeted and inexpensive means of suppressing nematodes during the first few weeks after planting (10,19,20). The treatments are thought to afford a measure of protection against nematodes during the seedling stage, permitting development of an adequate root system (20). Seed treatments with carbofuran, oxamyl, and phenamiphos have been shown to work well under greenhouse conditions (11,20); however, only in a few cases have seed treatments with these nematicides been effective in the field (1,2,8). It is implicit that a nematicide for seed treatment must have a high degree of intrinsic nematicidal activity combined with little or no phytotoxicity against the treated seed or the resulting seedling. Nematicides used for seed treatments in the past may not have had these characteristics. The recent development of new nematicides and new seed treatment technologies prompted us to study seed treatments as a means for the management of soybean nematodes. This paper presents results of a 2-year study on the efficacy of seed treatments with three new nematicides against root-knot and cyst nematodes in soybeans.

MATERIALS AND METHODS

Two greenhouse experiments were conducted to study the efficacy of nematicide seed treatments for control of phytonematodes. Experiment I surveyed the effectiveness of treatments with aldoxycarb (Standak®), Gus 6015 (Gustafson, Dallas, Texas), and thiodicarb (Magnum®) for control of *Meloidogyne incognita* (Kofoid & White) Chitwood. Soil for the experiment was obtained from a soybean field infested with the nematode. The soil was a sandy loam with less than 1.0% (w/w) organic matter and pH=6.2. The soil was screened (<1 mm) and apportioned in 1-kg amounts into cylindrical 10-cm-diam 1-L capacity PVC pots. Seed of 'Kirby' soybeans were treated with each nematicide at rates of 0, 0.50, 0.75, 1.00, and 1.50 kg a.i./100 kg seed. All seeds had received a standard fungicide treatment with carboxin (Vitavax® 200 FF). All nematicide and fungicide applications to the seed were performed by Gustafson (P.O. Box 660065, Dallas, Texas) using standard commercial equipment. Five seeds were planted in each pot and plants were grown in a greenhouse under good growing conditions. There were eight replications (pots) per treatment arranged in a completely randomized design. After 6 weeks of growth, the plants in each pot were separated carefully from the soil and the roots were examined to determine the number of galls caused by *M. incognita.* The fresh weights of roots and shoots were determined and the roots were incubated in water for 72 hr to assess numbers of juvenile nematodes (12). Soil from each pot was mixed well and a 100-cm^3 subsample was used for nematode analysis with the "salad bowl" incubation method (12).

Aldoxycarb was the most effective nematicide in experiment I. The second greenhouse experiment was conducted to define the relation between rates of aldoxycarb and degree of control of *M. incognita* when the nematicide was used to treat seed of 'Essex' soybeans. The 'Essex' cultivar was chosen for the experiment since it is more susceptible to *M. incognita* than the 'Kirby' cultivar. Seed treatments with aldoxycarb for this experiment were at rates of 0, 0.031, 0.062, 0.125, 0.187, 0.250, 0.312, 0.375, 0.437, and 0.500 kg a.i./100 kg seed. The experimental design and procedures were the same as for experirent I.

Field Experiments. Field performance of aldoxycarb seed treatments for control of root-knot nematodes was assessed in the vicinity of Elberta, Baldwin County, Alabama. One experiment was on the Gottler farm and the other within the Kaiser property. The fields had been in continuous soybean for the previous 5 years and were infested with *M. arenaria* (Neal) Chitwood (Kaiser) and *M. incognita* (Gottler). Both fields had low levels of infestation of *H. glycines* (races 3,4). The soils were a sandy loam (Gottler) and a loamy sand (Kaiser), both with less than 1.0% (w/w) organic matter and pH=6.1-6.4. In each experiment, seed of 'Ransom' (susceptible to the nematode species present) and 'Kirby' (tolerant to *M. incognita* and *H. glycines*) were planted at a rate of 67 kg/ha. Seed were treated with aldoxycarb at rates of 0, 0.126, 0.251, 0.377, 0.503, and 1.005 kg a.i./100 kg seed. Aldoxycarb and a standard fungicide (Vitavax® 200FF) were applied to the seed by Gustafson using commercial equipment and technology that permitted delivery of high rates of the nematicide to the seed. Each experiment included the two cultivars with all the treatments, and each treatment was represented by eight replications (plots) arranged in a randomized complete block design. The two-row plots were each 6 m long and 1.6 m wide. Soybeans were planted the last week of May.

Control of weeds, foliar insects and diseases, and agronomic practices followed were as recommended for the area (3). Soil samples for nematode analysis were taken the second week of July and in mid-September. A soil sample consisted of 16-20 2.5-cm-diam cores taken to a depth of 20-25 cm from the root zone and were taken from both rows of each plot at 0.3-0.5 m spacings. The cores from a plot were composited and a 100-cm^3 subsample was used to determine nematode numbers with the "salad bowl" incubation method (12). Yield was determined by harvesting the entire plot area at maturity of the crop.

All data were analyzed statistically by standard procedures for analysis of variance (21). Fisher's least significant differences (L.S.D.) were calculated and are included in the tables of results to facilitate interpretation. Regression analysis and least squares procedures for curve fitting were also according to standard methods (7,21). Unless otherwise stated, all differences referred to in the text were significant at the 5% (or less) level of probability.

RESULTS

Greenhouse Studies. Experiment I. Aldoxycarb had no effect on the height of plants; however, treatments with the 1.50-kg rate of Gus 6015 and the 0.75-kg rate of thiodicarb increased plant height (Table 1). All rates of aldoxycarb and thiodicarb increased fresh shoot weights. Fresh roots of plants with the 0.75-kg treatment of thiodicarb and those with the 1.50-kg of Gus 6015 were heavier than those of control plants. All treatments with thiodicarb or with aldoxycarb reduced the number of galls caused by *M. incognita* in the roots. Differences in gall numbers among rates of thiodicarb or aldoxycarb were not significant.

Aldoxycarb was the most effective ($P=0.01$) nematicide for reducing juvenile populations of *M. incognita* in soil and Gus 6015 the least effective (Table 2); all treatments with aldoxycarb practically eliminated juvenile populations from soil. The 0.50-kg treatment with Gus 6015 did not affect juvenile soil populations; the same rate of thiodicarb reduced numbers of juveniles but not to the degree observed with aldoxycarb at this rate.

Juvenile populations of *M. incognita* in the roots were lowest in plants with aldoxycarb. All treatments with thiodicarb or with Gus 6015 reduced root populations of *M. incognita,* but not to the degree obtained with aldoxycarb.

Experiment II. Data from this experiment are presented in Table 3. All seed treatments but the 0.50-kg rate resulted in taller plants than those with no nematicide; however, a relation between aldoxycarb rate and height of plants could not be established. Seed treated with the nematicide resulted in plants with heavier shoots than those from untreated seed. The relation between aldoxycarb rate (x) in kg a.i./100 kg seed and fresh shoot weight (Ys) in g followed ($R^2=0.94^{**}$) a reciprocal hyperbolic model described by the function:

$$Ys = x/(0.538x+0.0007)$$

All seed treatments but two (0.312 and 0.375 rates) resulted in heavier root systems; however, as with shoot height, no clear relation could be established between nematicide rate and root weight.

Aldoxycarb treatments had a repressive effect on development of root galls by *M. incognita;* the relation between number of root galls (G) and aldoxycarb rate was expressed ($R^2=0.78^{*}$) by:

$$G = 1/[0.0679(x+0.2175)^2+0.0259]$$

The relation between numbers of *M. incognita* juveniles in 100 cm^3 soil (Js) and aldoxycarb rates followed ($R^2=0.79^{*}$) the normal model:

$$Js = 128.858e^{z}$$

where $z = (x-0.159)^2/(-0.0739)$. A similar pattern of response was observed for numbers of *M. incognita* juveniles per root system (Jr) and aldoxycarb rates; however, the relation was best described ($R^2=0.92^{**}$) by the Cauchy equation:

Table 1. Effect of seed treatments with three nematicides on growth of 'Kirby' soybeans and on root galls caused by *Meloidogyne incognita* in a greenhouse experiment.

	Thiodicarb				Gus 6015				Aldoxycarb			
Rate (kg a.i./100 kg seed)	Plant height (cm)	Fresh plant weight (g)	Fresh root weight (g)	No. galls/ root system	Shoot height (cm)	Fresh plant weight (g)	Fresh root weight (g)	No. galls/ root system	Plant height (cm)	Fresh plant weight (g)	Fresh root weight (g)	No. galls/ root system
0	37.5	4.2	2.2	13.0	37.5	4.2	2.2	13.0	37.5	4.2	2.2	13.0
0.50	38.2	4.2	2.3	6.6	36.2	4.8	2.5	10.5	37.3	4.9	2.4	6.7
0.75	42.9	5.3	3.1	7.8	39.2	4.3	2.0	8.8	37.7	5.3	2.5	5.7
1.00	39.3	5.1	2.5	6.1	39.9	5.5	2.8	13.4	37.1	5.4	2.6	5.0
1.50	36.8	4.7	2.7	4.2	41.3	7.0	3.3	12.4	36.5	4.6	1.8	3.2
LSD (P=0.05)	3.5	1.6	0.8	4.3	3.5	1.6	0.8	4.3	3.5	1.6	0.8	4.3
Standard error	1.7	0.8	0.4	2.1	1.7	0.8	0.4	2.1	1.7	0.8	0.4	2.1

Table 2. Effect of seed treatments with three nematicides on soil and root populations of *Meloidogyne incognita* in a greenhouse experiment with 'Kirby' soybeans.

Rate (kg a.i./100 kg seed)	Juveniles per 100 cm^3 soil			Juveniles per root system		
	Thiodicarb	Gus 6015	Aldoxycarb	Thiodicarb	Gus 6015	Aldoxycarb
0	57	57	57	381	381	381
0.50	35	61	3	217	302	2
0.75	19	6	1	159	199	4
1.00	13	20	1	240	104	2
1.50	12	16	2	176	230	1
LSD (P=0.05)	14	14	14	58	58	58
Standard error	7	7	7	29	29	29

Table 3. Effect of seed treatments with aldoxycarb on growth of 'Essex' soybeans and development of *Meloidogyne incognita* in a greenhouse experiment with soil infested with the nematode.

Rate (kg a.i./100 kg seed)	Plant height (cm)	Fresh plant weight (g)	Fresh root weight (g)	No. galls/ root system	Juveniles/ 100 cm^3 soil	Juveniles/ root system
0	16.8	0.8	0.6	42.0	104	165
0.031	20.1	1.6	0.6	27.0	110	218
0.062	20.4	1.9	1.0	38.9	94	402
0.125	19.5	1.6	0.8	27.2	98	468
0.187	19.4	2.0	0.9	23.0	148	306
0.250	19.7	1.6	0.7	23.4	141	300
0.312	21.7	2.1	0.8	27.4	92	303
0.375	20.4	2.2	0.8	19.4	87	195
0.437	19.2	2.0	0.9	20.9	26	148
0.500	17.0	1.8	0.8	14.8	34	80
LSD (P=0.05)	2.3	0.4	0.2	8.1	39	161
Standard error	0.8	0.1	0.1	2.8	14	57

$$Jr = 1/[0.0969(x-0.1889)^2+0.0021]$$

Field Experiments. Gottler Farm. All aldoxycarb rates in 'Ransom' plots reduced juvenile populations of *M. incognita* at the first sampling (Table 4); the relation between numbers of juveniles of *M. incognita* in 100 cm^3 soil (Js) and nematicide rate (x) for this variety followed ($R^2=0.88^{**}$) the function:

$$Js = 33.812+37.441x-0.0372/(x^2)$$

where $x > 0$. An analogous function described ($R^2=0.88^{**}$) the relation for juvenile populations from this date in 'Kirby' plots, i.e.,

$$Js = 34.225+13.161x-0.0131/(x^2)$$

where $x > 0$. Aldoxycarb did not reduce populations of *M. incognita* juveniles in soil for either cultivar in September. *H. glycines* juvenile population in soil was reduced only in 'Ransom' plots in July with the 0.251-kg rate; no clear pattern of response was detected between numbers of *H. glycines* juveniles and aldoxycarb rates.

Yields of 'Ransom' soybean (kg/ha) were related ($R^2=0.87^{**}$) to aldoxycarb rate by a quadratic equation (Fig. 1A). Yields for 'Kirby' followed ($R^2=0.80^{*}$) a similar model (Fig. 1B).

Kaiser Farm. Data on nematodes for this experiment are presented in Table 5. Seed treatments of 'Kirby' soybeans did not result in reductions in *M. arenaria* juvenile populations on either of the two sampling

Table 4. Effect of seed treatments with aldoxycarb on juvenile populations of root-knot (*Meloidogyne incognita*) and cyst (*Heterodera glycines*) nematodes in a field at the Gottler farm planted with 'Ransom' and 'Kirby' soybeans.

Aldoxycarb[x] (kg a.i./100 kg seed)	'Ransom'				'Kirby'			
	M. incognita[y]		*H. glycines*		*M. incognita*		*H. glycines*	
	8 July	16 Sept.	8 July	16 Sept.	8 July	16 Sept.	8 July	16 Sept.
0	264	392	396	116	122	441	64	90
0.126	358	339	445	101	148	443	86	102
0.251	117	329	303	128	61	368	44	108
0.377	124	357	326	88	71	301	70	85
0.503	115	294	331	101	63	306	44	105
1.005	109	288	324	100	58	478	44	82
LSD (P=0.05)	109	N.S.[z]	85	N.S.	109	N.S.	85	N.S.
Standard error	55	—	43	—	55	—	43	—

[x]Soybeans planted at 67 kg seed/ha.
[y]Juvenile populations per 100 cm^3 soil.
[z]N.S. = not significant.

dates. The treatments also had no effect on *M. arenaria* juvenile populations in July in plots with 'Ransom', however, at the September sampling, juvenile populations of the nematode in 100 cm^3 soil could be described (R^2=0.95**) by

$$Js = 1/[0.0037(x-0.118)^2+0.0028]$$

Juvenile populations of *H. glycines* also were not reduced by aldoxycarb at either of the two samplings nor could a clear pattern of response be established between these populations and the nematicide rate.

Yields of 'Ransom' were not increased by any of the treatments; however, aldoxycarb at all but the highest rates had a beneficial effect on yield of 'Kirby'. The relation between yield and aldoxycarb rate was best described (R^2=0.98**) by an exponential function (Fig. 2). In calculating this equation the zero rate was transformed to 0.1, since zero is not defined by the equation.

DISCUSSION

Results from the greenhouse experiments indicated that thiodicarb and Gus 6015, non-systemic compounds, were not as effective against *M. incognita* as aldoxycarb, a systemic nematicide. These findings suggest that emphasis should be given to the use of systemic nematicides for development of seed treatments. Our results showed that aldoxycarb maintained the roots essentially free of nematodes for a time sufficient

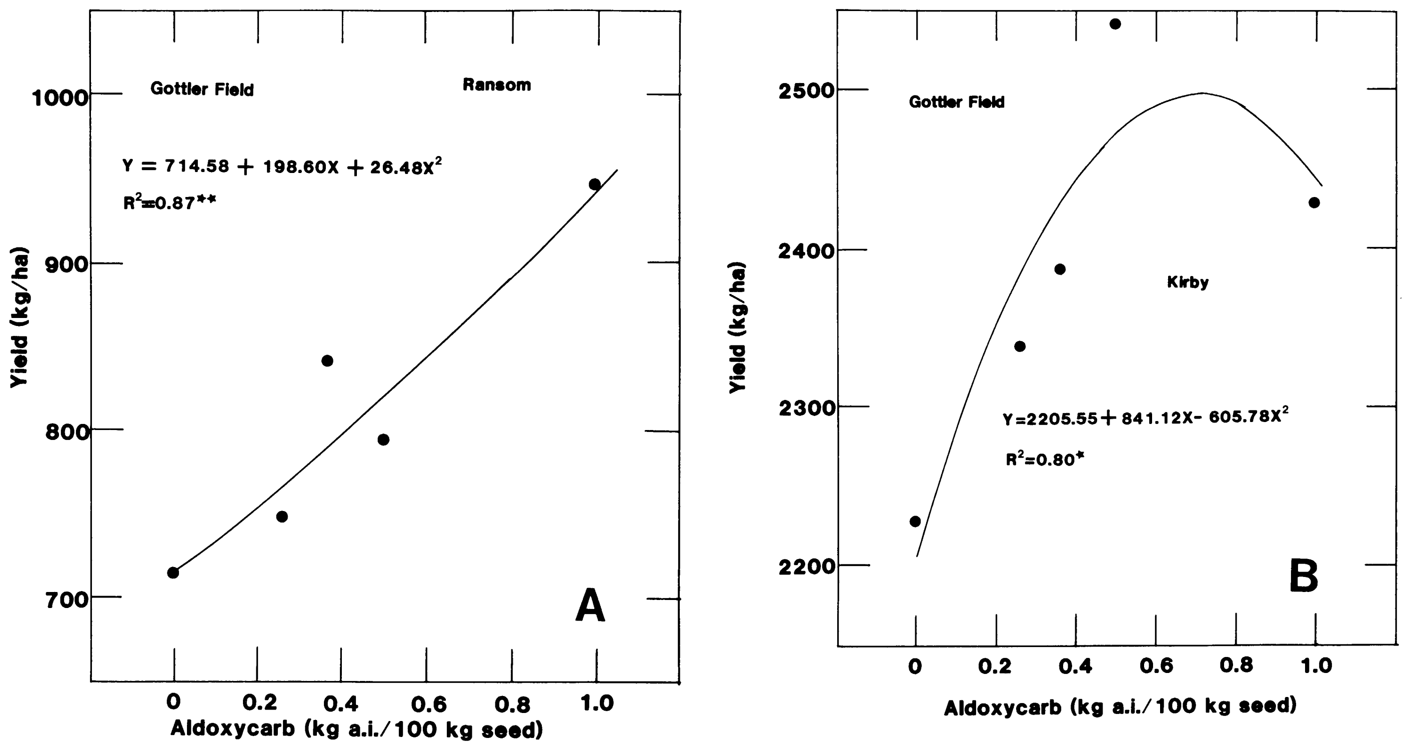

Fig. 1. Relation between yields of 'Ransom' or 'Kirby' soybeans and aldoxycarb rates used for seed treatment in an experiment conducted in a field infested with *Meloidogyne incognita* and *Heterodera glycines*. Soybeans were planted at a rate of 67 kg seed/ha.

Table 5. Effect of seed treatments with aldoxycarb on juvenile populations of root-knot (*Meloidogyne incognita*) and cyst (*Heterodera glycines*) nematodes in the Kaiser field experiment with 'Ransom' and 'Kirby' soybeans.

	'Ransom'				'Kirby'			
	M. arenaria[y]		*H. glycines*		*M. arenaria*		*H. glycines*	
Aldoxycarb[x] (kg a.i./100 kg seed)	11 July	24 Sept.	11 July	24 Sept.	11 July	24 Sept.	11 July	24 Sept.
0	65	352	96	124	36	199	80	159
0.126	34	385	114	166	34	224	62	82
0.251	40	299	76	182	78	217	93	184
0.377	46	330	72	89	25	223	84	109
0.503	43	317	98	202	35	295	70	158
1.005	33	174	99	147	72	170	48	178
LSD (P=0.05)	29	132	N.S.[z]	70	29	132	N.S.	70
Standard error	14	66	—	35	14	66	—	35

[x]Soybeans were planted at 67 kg seed/ha.
[y]Juvenile populations per 100 cm^3 soil.
[z]N.S. = not significant.

to permit development of an extensive root system without significant phytotoxic effects. Systemic nematicides such as aldoxycarb would be preferred over non-systemic ones because the materials move in the roots and are not subject to dilution and leaching losses as would be expected of non-systemic materials. Results from the second greenhouse experiment emphasized the importance of determining the correct application rate to achieve good performance of a nematicide used in seed treatments. The types of functions relating application rates and numbers of juveniles in the soil or in the roots represent models in which juvenile populations are stimulated by low doses of nematicides. The models predicted that juvenile populations increased in response to aldoxycarb applications in the range of 0-0.159 kg a.i./100 kg seed for soil populations and between 0-0.189 kg for root populations. It was only when application rates exceeded the upper limits of these ranges that significant suppression in development of juvenile populations was observed. It is possible that this same pattern of response may be true for other nematicides. This could explain discrepancies in results obtained in the past when other systemic nematicides were used at various rates as seed treatments (1,8,11,19,20). Our results suggest that a necessary prerequisite to the use of nematicides as seed treatments is the establishment of the relation between application rate and efficacy as well as plant response for individual crop species and cultivars.

The field experiments demonstrated that the greatest yield response was obtained with the use of a tolerant cultivar (e.g., 'Kirby'). Results from the Gottler farm indicated that the effect of aldoxycarb on juvenile

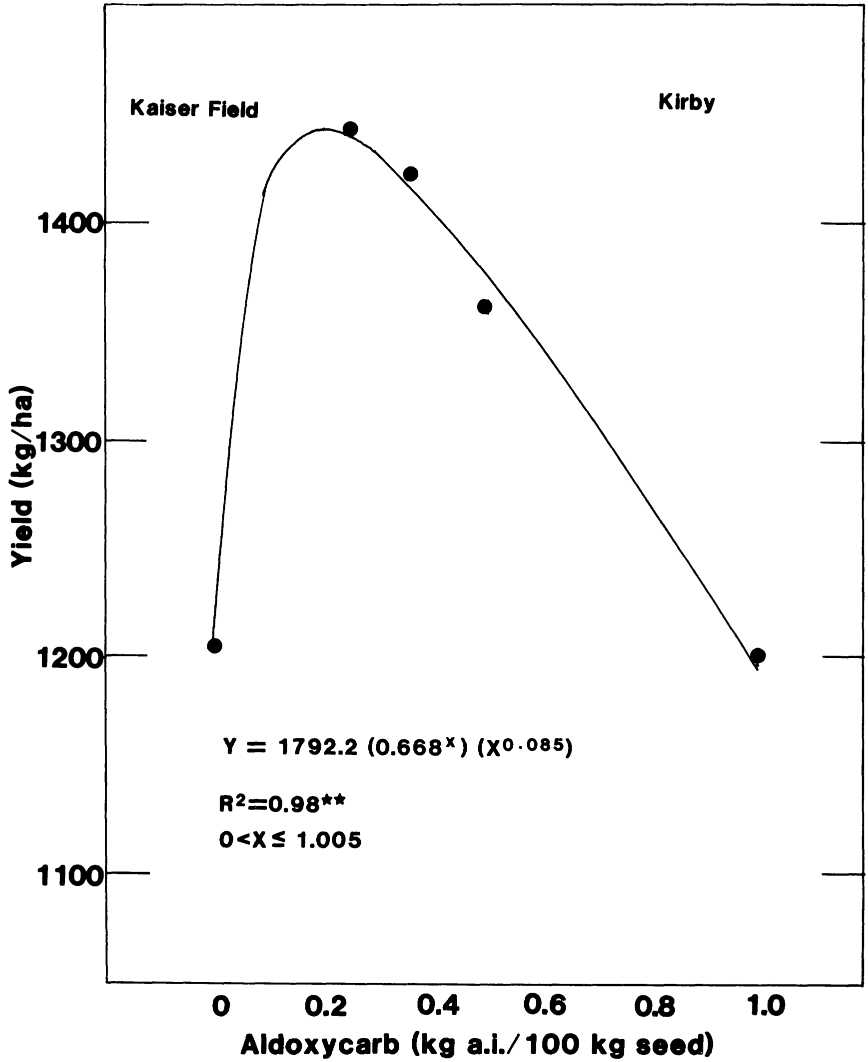

Fig. 2. Relation between yields of 'Kirby' soybean and aldoxycarb rates used for seed treatment in an experiment conducted in a field infested with *Meloidogyne arenaria* and *Heterodera glycines*. Soybeans were planted at a rate of 67 kg seed/ha.

populations was short-term, being evident in July but not in September; however, the effect was sufficiently prolonged to result in significant yield increases. For both cultivars the relation between yield and numbers of juveniles in July was inverse and described (R^2=0.58*) by a hyperbolic function in the case of 'Ransom' and by a Cauchy type distribution (7) equation (R^2=0.92**) in the case of 'Kirby'. The effect of aldoxycarb on *H. glycines* juvenile populations in the Gottler farm was as expected for 'Kirby'; this cultivar has a high level of tolerance to races 3 and 4 of the nematode, therefore, we expected little or no population development of the nematode. Data on *H. glycines* juvenile populations in plots with 'Ransom' suggested that aldoxycarb treatments were ineffective for controlling this species. Also, the data suggest that for this cultivar, *M. incognita* may have been ultimately the dominant species in the Gottler field; we have observed before in Baldwin county (13,16,22) that where *H. glycines* and *M. incognita* (or *M. arenaria*) occur together in a field planted with a cultivar susceptible to both species, the root-knot nematode becomes prevalent through the season.

Results from the Kaiser farm experiment represented a different situation from that in the Gottler field. Yields of both cultivars and especially of 'Kirby' were much lower than in the Gottler field. Soil in the Kaiser farm is considerably sandier than that of the Gottler field. Consequently, we expected nematode damage to roots to affect yields more severely than in the Gottler experiment through limitations in the water uptake capacity of the damaged plants. The data from the Kaiser field presented a different type of relation between 'Kirby' yields and aldoxycarb rates than that found in the Gottler experiment. The model chosen to describe the relation indicated that maximal yields would be obtained with aldoxycarb rates in the range of only 0.21 kg a.i./100 kg seed. This contrasts with the findings in the Gottler field. Although we have no explanation for this discrepancy, we believe that it is possible that the sandier nature of the Kaiser soil could have resulted in significant if inconspicuous phytotoxicity from the treatments. The 'Kirby' soybean has no tolerance to *M. arenaria.* It is possible that differences in yield response to aldoxycarb with this cultivar may have been related in some manner to its lack of tolerance to *M. arenaria* in the Kaiser field

Results from the field experiments demonstrated clearly that it is possible to increase soybean yields with seed treatments with an effective systemic nematicide. Our findings suggest that the success of nematicide treatments depends not only on the choice of nematicides but also on the use of nematode tolerant cultivars and appropriate rate of nematicide. Our results demonstrated that it is not necessary to have "season-long" suppression of nematode populations to obtain economical yield increases from nematicide applications; this is consistent with what we know about population dynamics of root-knot nematodes in soybeans in our area (15).

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