EVALUATION OF SELECTED NEMATICIDES FOR CONTROL OF *MELOIDOGYNE ARENARIA* IN PEANUT: A MULTI-YEAR STUDY

R. Rodríguez-Kábana and P. S. King
Department of Botany, Plant Pathology, and Microbiology, Auburn University, Alabama Agricultural Experiment Station, Auburn, Alabama 36849, U.S.A.

Accepted:
2.X.1985
Aceptado:

ABSTRACT

Rodríguez-Kábana, R., and P. S. King. 1985. Evaluation of selected nematicides for control of *Meloidogyne arenaria* in peanut: a multi-year study. Nematropica 15:155-164.

A 5-year study was conducted to evaluate the relative efficacy of at-plant application of aldicarb, carbofuran, ethylene dibromide (EDB), ethoprop, oxamyl, and phenamiphos for control of the root-knot nematode [*Meloidogyne arenaria* (Neal) Chitwood] on 'Florunner' peanut (*Arachis hypogaea* L.). Each year EDB was applied at rates of 8.4 and 16.8 L/ha, ethoprop at 2.2 and 4.4 kg ai/ha, and the remaining nematicides at 1.1 and 2.2 kg ai/ha. All nematicides and rates reduced larval populations of the nematode in the soil, determined near harvest time, and increased yields. The low rate of all nematicides resulted in the highest ratio of yield increase to the amount of nematicide used. The relation between yield (Y) and nematicide rates (N) could be described by $Y = Ym\text{-}e^{b\text{-}kN}$, where b and k are constants and Ym represents the maximal theoretical yield. Larval numbers in soil were negatively and linearly related to the amount of nematicide added. Highest average yields were obtained with applications of aldicarb, EDB, and oxamyl, and the lowest with carbofuran and ethoprop; yield response to phenamiphos application was intermediate. The most effective nematicides for suppressing larval populations were EDB and aldicarb, and the least effective were carbofuran and ethoprop.

Additional key words: fumigants, Temik, Furadan, Nemacur, Vydate, Mocap, pest management, yield losses.

RESUMEN

Rodríguez-Kábana, R., y P. S. King. 1985. Evaluación de algunos nematicidas para el combate de *Meloidogyne arenaria* en el maní: un estudio multianual. Nematrópica 15:155-164.

Se efectuó un estudio de 5 años de duración para determinar la efectividad relativa de tratamientos durante la siembra con aldicarb, carbofurán, EDB, ethoprop, oxamil y fenamifos para combatir el nematodo nodulador [*Meloidogyne arenaria* (Neal) Chitwood] y aumentar el rendimiento de maní 'Florunner' (*Arachis hypogaea* L.). Cada año se aplicó EDB a razón de 8.4 y 16.8 L/ha, ethoprop en un franja de 20-cm y en dosis 2.2 y 4.4 kg ia/ha y los otros nematicidas también en una franja del mismo ancho pero a razón de 1.1 y 2.2 kg ia/ha. Todos los tratamientos con nematicidas redujeron los poblaciones de larvas del nematodo en el suelo y aumentaron la producción de maní. Las dosis más bajas de todos los nematicidas dieron las proporciónes más altas entre el rendimiento de maní y la cantidad de nematicida utilizado. La relación entre el rendimiento de maní (Y) y la dosis

de nematicida (N) fué definida por $Y=Ym\text{-}e^{b\text{-}kN}$ donde Ym representa el rendimiento máximo teórico y b y k constantes. El número de larvas en el suelo estuvo relacionado de manera linear y negativa con la dosis de nematicida. Los rendimientos promedios más altos del estudio se obtuvieron con aldicarb, EDB o oxamil y los más bajos con carbofurán y ethoprop, siendo los obtenidos con fenamifos intermedios. Los nematicidas más eficaces para reducir las poblaciones de larvas fueron EDB y aldicarb y los menos eficaces: carbofurán y ethoprop.
Palabras claves adicionales: fumigantes, Temik, Furadan, Nemacur, Vydate, Mocap, manejo de plagas, perdidas de rendimiento.

INTRODUCTION

The peanut (*Arachis hypogaea* L.) is a good host for a variety of nematodes (5). Principal among these because of their economic importance are the root-knot nematodes: *Meloidogyne arenaria* (Neal) Chitwood and *M. hapla* Chitwood. In Alabama, *M. arenaria* is the most important, occuring in 47% of peanut fields (2), causing severe damage and yield reductions (11). There are at present no commercially available cultivars resistant to *M. arenaria* and it is unlikely that cultivars with good levels of tolerance (or resistance) to the nematode will be developed in the near future (3). Control of *M. arenaria* has been based on the use of rotations with a less suitable host than peanut (e.g. corn), and on applications of nematicides (4, 5, 6, 7, 9). Reliance on rotations with corn (*Zea mays* L.) or sorghum [*Sorghum bicolor* (L.) Moench.] as the sole means for the management of *M. arenaria* in heavily infested land has shown to be ineffective (10). Thus, the use of nematicides is critical for continued economical production of peanuts in Alabama. The removal by regulatory action of DBCP and later of EDB from use by farmers in the U.S.A. has left the peanut producer with only a few nematicides available to control *M. arenaria*. It is therefore important to determine the relative efficacy of available nematicides for control of nematodes and to increase yields. This paper presents results of a multi-year study conducted to evaluate the efficacy of several commonly available nematicides.

MATERIALS AND METHODS

A 5-year study (1980-1984) was conducted at the Wiregrass Substation near Headland, Alabama, to evaluate the relative efficacy of selected nematicides for control of *M. arenaria* on 'Florunner' peanut. Each year an experiment was established in an irrigated field infested with the nematode. The field had been in peanut culture with a winter cover crop of hairy vetch (*Vicia villosa* Roth) since 1974. This cropping system was maintained through the study period. The soil was a sandy loam [Plinthic paleudults, fine-loamy, siliceous] with pH = 6.2 and organic matter content of less than 1.0% (w/w). Plots in the experiment were 2-rows, each 0.91 m wide and 10 m long. Treatments in the experiment each year consisted of at-plant applications of 5 granular nematicides in a 20-cm band incorporated to a depth of 2-3 cm (6, 9). These nematicides were aldicarb (Temik® 15G), carbofuran (Furadan® 15G), oxamyl (Vydate® 10G), and phenamiphos (Nemacur® 15G) each applied at 1.1 or 2.2 kg ai/ha, and ethoprop (Mocap® 10G) at the rates of 2.2 and 4.5 kg ai/ha. The experiment also contained 2 treatments with EDB (Soilbrom® 90) at 8.4 and 16.8 L/ha injected to a depth of 20 cm using 2 injectors/row set 20 cm apart with the seed furrow in the middle. All treatments were arranged in a randomized complete block design with eight replications (plots) per treatment.

Soil samples for nematode analysis were collected 1-2 weeks before harvest time to coincide with the period of maximal population development (2). Samples consisted of 16-20 cores taken in zig-zag fashion through the center of each plot from the root zone to a depth of 20-25 cm using a 2.5-cm-diam soil auger. Soil cores from each plot were composited and a 100 cm^3 subsample was used to assess nematode number using the "salad bowl" incubation technique (8). At peanut maturity, yield was obtained by harvesting the entire plot area. Fertilization, cultural practices, and control of foliar diseases, insects, and weeds were as recommended for the area for continuous peanut production (1). The field was irrigated as needed.

Data from the study were analyzed following standard procedures for analysis of variance and calculation of Fisher's least significant differences (12). Unless otherwise stated, differences referred to in the text were statistically significant at the 5% or lower level of probability.

RESULTS AND DISCUSSION

Factorial analysis of the data revealed no significant interaction between the efects of nematicide treatments and the effects of the year on the variables (Table 1). There were significant yield differences between years. All nematicide treatments resulted in increased yields over the control, but proportionately the greatest yield response was obtained with the low rate of each nematicide. The high rate of each nematicide resulted in additional increased yield over that obtained with the low rate; however, for aldicarb, carbofuran, and ethoprop the additional increases in yield were not significant. The interaction between the effects of rate and the type of nematicide on yield was not significant, permitting comparisons of the relative effectiveness of nematicides for yield response independently of the effects of rates. Over the 5 years of

Table 1. Effect of selected nematicides on 'Florunner' peanut yields (kg/ha) in a field infested with *Meloidogyne arenaria* at the Wiregrass Substation near Headland, Alabama.

	Rate	Year						Net Return
	(kg ai/ha)	1980	1981	1982	1983	1984	Average	over Control (US$)
Control		2740	2447	2755	1689	2353	2397	
Aldicarb	1.1	3736	3238	3367	2648	4031	3404	185
	2.2	3323	3431	3475	3017	4475	3544	197
Carbofuran	1.1	2960	2868	2851	2631	2821	2826	76
	2.2	2919	3034	3085	2211	3574	2965	93
Ethoprop	2.2	2400	2780	2790	2095	3123	2638	28
	4.4	2428	2726	3017	2255	3061	2697	20
Oxamyl	1.1	2746	3143	3187	2611	3570	3051	116
	2.2	3231	3312	3411	2773	4143	3374	167
Phenamiphos	1.1	2773	2940	3079	3041	2556	2878	82
	2.2	3229	3014	2949	3197	3496	3191	130
EDB	8.4 L/ha	2638	2906	3619	2902	3139	3021	117
	16.8 L/ha	2916	3201	3862	3418	4048	3489	203
LSD (P=0.05):		518	344	517	513	689	237	

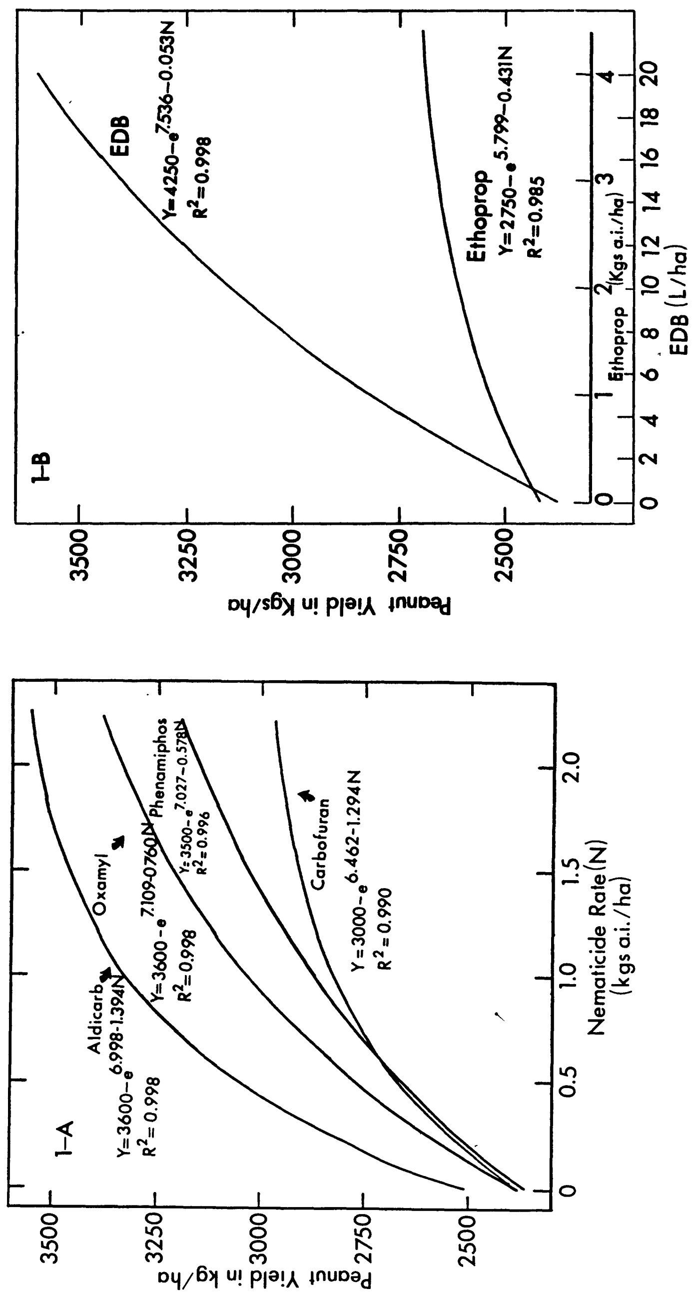

Fig. 1. Relation between peanut yield (Y) and nematicide rate (N).

the study, highest yields were obtained in response to applications of aldicarb, EDB, or oxamyl; the lowest responses corresponded to treatment with carbofuran or ethoprop, and response to phenamiphos application was intermediate.

The general pattern of peanut yield response to all nematicides in the study accorded well to the model:

$$Y = Ym - e^{b-kN} \quad (I)$$

where b and k are constants, Ym represents the theoretical maximal yield for each nematicide, and N nematicide rate. Calculation of equations using the 5-year averages corresponding to each nematicide showed that Ym was greatest for EDB, aldicarb, and oxamyl, and lowest for carbofuran and ethoprop (Fig. 1A,1B). Further, the equations showed that k values for aldicarb and carbofuran were much lower than for the other nematicides indicating that the dosages required to approach Ym were much lower for aldicarb and carbofuran than for the other nematicides. Thus, these two nematicides have "narrow windows" of yield responses, within the range of doses used in this study.

Factorial analysis of the data on larval populations of *M. arenaria* in soil indicated no significant interaction between the effects of year and type of nematicide on the variable (Table 2). Larval populations of *M. arenaria* were lowest in 1980 and highest in 1981. The five-year averages showed that all nematicide treatments but one (low rate of carbofuran) reduced larval populations below those in untreated plots. The averages indicated that treatments with aldicarb, oxamyl, and phenamiphos were equally effective in reducing larval populations; the least effective nematicides for controlling *M. arenaria* larvae in soil were carbofuran and ethoprop. The interaction between the effects of the type of nematicides and rates on larval populations was not significant. Larval populations declined proportionately to the rate of each nematicide used (Fig. 2A,2B). There was a linear relationship between nematicide rate and number of larvae. Among the granular nematicides, aldicarb and oxamyl had the smallest slope values, ethoprop the greatest, and carbofuran and phenamiphos intermediate. Since slope values were inversely related to larval numbers, slope values may serve to rank the chemicals in their order of effectiveness against the nematode.

The general relationship between yield and larval numbers for the 5 years of the study could also be described by a linear equation (Fig. 3). The equation indicates a yield loss of 4.77 kg/ha per larva in 100 cm^3. This magnitude of yield loss agrees with data previously reported for this nematode in 'Florunner' peanut (11).

These data indicate that most nematicide treatments resulted in pro-

Table 2. Effect of selected nematicides on numbers of *Meloidogyne arenaria* larvae in 100 cm^3 soil, in a study conducted in a field at the Wiregrass Substation.

	Rate (kg ai/ha)	Year 1980	1981	1982	1983	1984	Average
Control		78	506	178	314	476	310
Aldicarb	1.1	30	363	100	295	249	208
	2.2	31	238	53	225	230	155
Carbofuran	1.1	35	491	134	250	502	283
	2.2	22	430	131	234	351	234
Ethoprop	2.2	87	488	150	211	366	260
	4.4	55	432	99	243	251	216
Oxamyl	1.1	15	421	103	254	355	229
	2.2	14	255	84	232	168	150
Phenamiphos	1.1	42	431	101	224	391	238
	2.2	22	289	89	296	210	181
EDB	8.4 L/ha	97	364	66	165	328	204
	16.8 L/ha	7	136	4	25	173	69
LSD (P=0.05):		54	92	59	96	101	38

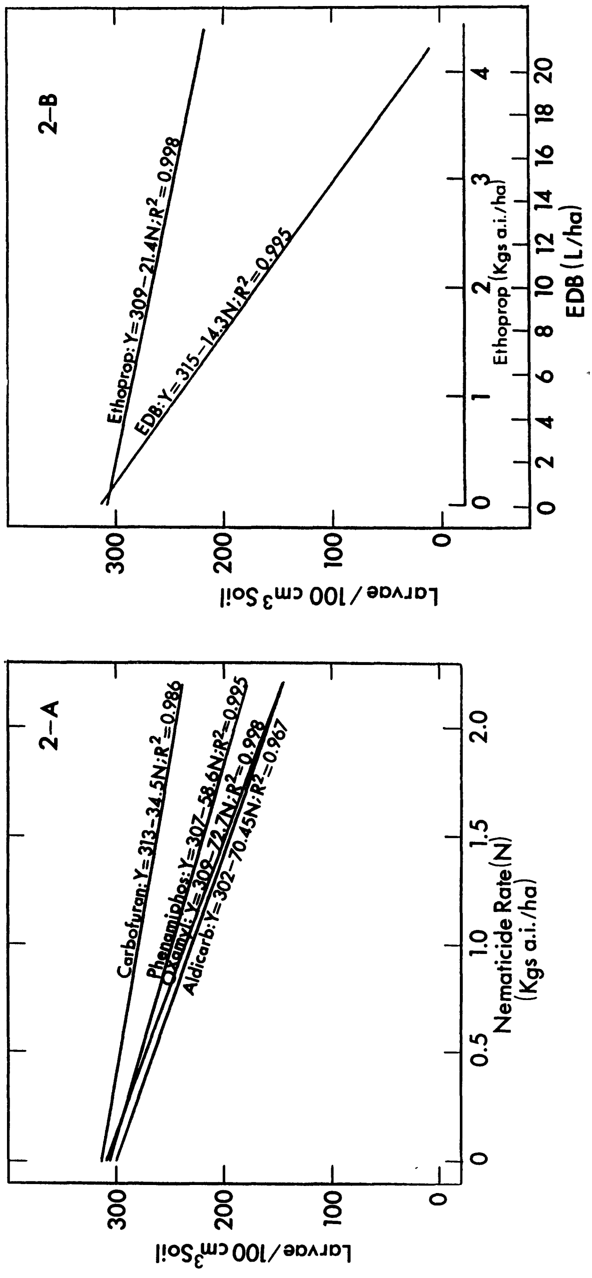

Fig. 2. Relation between numbers of larvae of *M. arenaria* (Y) in soil and nematicide rate (N).

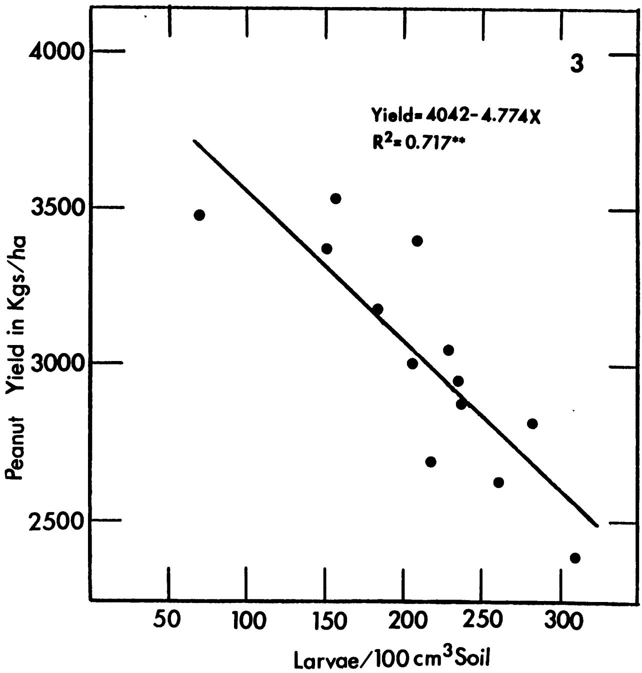

Fig. 3. Relation between peanut yield (Y) and numbers of *M. arenaria* (X).

fitable yield response (Table1). The data also indicate that with the exception of EDB, the greatest returns per dollar invested were obtained with the low rate of each nematicide.

LITERATURE CITED

1. GAZAWAY, W.S., F.A. GRAY, and R.A. ADAMS. 1977. Alabama Plant Disease and Nematicide Chemical Control Handbook. Ala. Coop. Ext. Serv. Cir. ANR-105, Auburn, AL. 94 pp.
2. INGRAM, E.G., and R. RODRIGUEZ-KABANA. 1980. Nematodes parasitic on peanuts in Alabama and evaluation of methods for detection and study of population dynamics. Nematropica 10:21-30.
3. MINTON, N.A., and R.O. HAMMONS. 1975. Evaluation of peanut for resistance to the peanut root-knot nematode, *Meloidogyne arenaria*. Plant Disease Reptr. 59:944-945.
4. MINTON, N.A., and L.W. MORGAN. 1974. Evaluation of systemic and non-systemic pesticides for insect and nematode control in peanuts. Peanut Sci. 1:91-98.

5. PORTER, D.M., D.H. SMITH, and R. RODRIGUEZ-KABANA. 1984. Compendium of peanut diseases. The Disease Series of the American Phytopathological Society. American Phytopathological Society Press, St. Paul, MN. 73 pp.
6. RODRIGUEZ-KABANA, R., P.S. KING, and M.H. POPE. 1981. Comparison of infurrow applications and banded treatments for control of *Meloidogyne arenaria* in peanuts and soybeans. Nematropica 11:53-67.
7. RODRIGUEZ-KABANA, R., P.S. KING, H.W. PENICK, and H. IVEY. 1979. Control of root-knot nematodes on peanuts with planting time and post-emergence applications of ethylene dibromide and ethylene dibromide-chloropicrin mixture. Nematropica 9:54-61.
8. RODRIGUEZ-KABANA, R., and M.H. POPE. 1981. A simple incubation method for the extraction of nematodes from soil. Nematropica 11:175-186.
9. RODRIGUEZ-KABANA, R., R.A. SHELBY, P.S. KING, and M.H. POPE. 1982. Application time and effectiveness of four systemic nematicides against *Meloidogyne arenaria* on Florunner peanuts. Nematropica 12:85-96.
10. RODRIGUEZ-KABANA, R., and J.T. TOUCHTON. 1984. Corn and sorghum as rotational crops for management of *Meloidogyne arenaria* in peanut. Nematropica 14:26-36.
11. RODRIGUEZ-KABANA, R., J.C. WILLIAMS, and R.A. SHELBY. 1982. Assessment of peanut yield losses caused by *Meloidogyne arenaria*. Nematropica 12:279-288.
12. STEEL, R.G.D., and J.H. TORRIE. 1960. Principles and procedures of statistics. McGraw-Hill Book Co., Inc., New York. 481 pp.

Received for publication:

8.IV.1985

Recibido para publicar: