CONTROL OF ROOT-KNOT NEMATODES AND THE COLORADO POTATO BEETLE ON POTATOES WITH IN-FURROW APPLICATIONS OF SYSTEMIC NEMATICIDES

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ABSTRACT

Rodríguez-Kábana, R., P. S. King, and M. H. Pope. 1981. Control of root-knot nematodes and the Colorado potato beetle on potatoes with in-furrow applications of systemic nematicides. Nematropica 11: 17-25.

Aldicarb (Temik 15G), phenamiphos (Nemacur 15G), carbofuran (Furadan 10G), and oxamyl (Vydate 10G) were applied in-furrow at 1, 2, 3, 4, and 6 lbs a.i./acre to determine their effectiveness for control of *Meloidogyne arenaria* (Neal) Chitwood and the Colorado potato beetle (*Leptinotarsa decemlineata* Say) on potatoes. Significant control (P = 0.05) of *M. arenaria* was obtained with aldicarb at all rates, phenamiphos at 2, 3, 4, and 6 lbs a.i./acre, and oxamyl at 3 and 4 lbs a.i./acre. All treatments with aldicarb, phenamiphos, and oxamyl resulted in significant (P = 0.05) yield increases. Treatments with carbofuran did not increase yield and only the three highest rates reduced populations of root-knot nematode larvae in soil. Use of the nematicides resulted in significant control of the potato beetle at all rates tested.

Additional key words: Solanum tuberosum, pest management, determination of yield losses, chemical control

RESUMEN

Rodríguez-Kábana, R., P. S. King, y M. H. Pope. 1981. Combate de nematodos noduladores y del escarabajo de Colorado en la papa con aplicaciones en la sementera de nematicidas sistémicos. Nematropica 11: 17-25.

Se efectuaron aplicaciones de aldicarb (Temik 15G), fenamifos (Nemacur 15G), carbofurán (Furadan 10G), y oxamil (Vydate 10G) en la sementera y en dosis de 1, 2, 3, 4, y 6 lbs i.a./acre para determinar sus eficacias en el combate de *Meloidogyne arenaria* (Neal, 1889) Chitwood, 1949, y en el del escarabajo de Colorado (*Leptinotarsa decemlineata* Say, 1824) en papa. Los resultados obtenidos señalaron un grado significativo (P = 0.05) de reducción del número de larvas de *M. arenaria* en el suelo con aldicarb, en todas las dosis, con fenamifos en las dosis de 2, 3, 4, y 6 lbs i.a. acre, y con oxamil con las de 3 y

4 lbs i.a./acre. Todos los tratamientos con aldicarb, fenamifos y oxamil dieron aumentos significativos (P = 0.05) en rendimiento. Los tratamientos con carbofurán no dieron aumentos en rendimientos y sólo las tres dosis más altas redujeron las poblaciones de larvas del nematodo en el suelo. La aplicación de todos los nematicidas resultó en reducciones significativas en el número de escarabajos sin observarse relación con las dosis utilizadas.
Palabras claves adicionales: Solanum tuberosum, manejo de plagas, cálculo de pérdidas en producción, combate químico.

INTRODUCTION

The potato is subject to attack by several nematode species (12). In the southeastern U.S.A. the principal parasites of the crop are the root-knot nematodes (*Meloidogyne* spp). Damage by these nematodes is so severe that potato production in this region requires routine applications of nematicides (4, 7, 11). The traditional nematicides used in Alabama have been fumigants containing dichloropropenes applied 1-2 weeks before planting (4). Since potatoes are planted in Alabama during late February through March weather conditions and soil temperature are often unsuitable for effective applications of the fumigants. The development of systemic nematicides in granular form has made it possible to apply the nematicides during the planting operations (1, 2, 7, 8, 9, 11). In addition, because these nematicides have insecticidal properties their use in potatoes is desirable (5, 6).

A very frequently occurring parasite of potatoes in Alabama is the southern root-knot nematode *Meloidogyne arenaria* (Neal) Chitwood. Although much data are available on control of other *Meloidogyne* spp. in potatoes, data for *M. arenaria* are limited and information on the use of systemic nematicides for control of this nematode is unavailable. This paper presents results obtained from experiments conducted to determine the relative efficacy of planting-time applications of systemic nematicides for control of *M. arenaria* and the Colorado potato beetle (*Leptinotarsa decemlineata* Say).

MATERIALS AND METHODS

Effects on Nematodes. The efficacy of aldicarb (Temik 15G), carbofuran (Furadan 10G), oxamyl (Vydate 10G), and phenamiphos (Nemacur 15G) for control of *M. arenaria* was studied in a field infested with the parasite (ca. 100 larvae/100 cm^3 soil) located at the Gulf Coast Substation, near Fairhope, Alabama. The field, previously in soybeans, consisted of a sandy loam with a pH of 6.0 and with less than 1 % oxidizable organic matter. The experiments were established in 1979 with Red La Soda potatoes. Plots in the experiments were 1 row (36 inches wide) x 20 feet long. Each treatment was replicated seven times in randomized complete blocks. Each nematicide was applied in the seed furrow below the seed at planting at rates of 0, 1, 2, 3, 4, and 6 lbs a.i./acre. Control of insects, foliar diseases, weeds and other cultural practices followed were as recommended for the area (4). Two contiguous experiments were established in the field. One experiment tested the performance of aldicarb and phenamiphos, and the other those of carbofuran and oxamyl.

Soil samples for nematode analyses were collected one week before harvest. The samples consisted of 16-20 one-inch diam soil cores collected from the root zone in each plot to a depth of 8 inches. The cores from each plot were composited and a 100 cm^3 subsample was used for nematode analysis by a modified Baerman technique. The soil was spread evenly over a double layer of "Scotties" tissue paper on a 1 mm mesh fiberglass screen which was then immersed in a bowl with 1 L of water so as to have the water just covering the soil. The soil was incubated for 72 hurs at 25C and the nematodes in the water were collected in a 38-μm mesh stainless steel sieve. Yields were determined from the entire plots.

Effects on Colorado Potato Beetles. Two other experiments in 1979 were established at Cullman, Alabama to determine the efficacy of the nematicides against the Colorado potato beetle. The experiments were identical to those described above but were located in a field with no nematode problem. Cultural conditions were as for the Fairhope experiment except that no insecticides were applied to the foliage. The number of beetles per plot was determined 45 days after planting by counting all adults and juveniles present in each plot.

All data were analyzed following standard procedures for analysis of variance and differences among treatments were evaluated for significance by a modified Duncan's multiple range test (10). Values for the least significant difference (L.S.D.) also were calculated and are included in the graphs for ease of interpretation. Except where otherwise specified, differences referred to in the text were significant at the 5% or lower level of probability. Linear correlation coefficients and determinations of the slope and intercept values of linear equations were also performed following standard statistical procedures (10).

RESULTS AND DISCUSSION

Applications of aldicarb, oxamyl, and phenamiphos reduced larval populations of *M. arenaria* (Fig. 1 A-C). The rate of decline in populations in relation to the amount of nematicide used was greatest with applications of 1.0 lb/A for aldicarb and phenamiphos and up to 2.0 lb/A for oxamyl; additional reductions in larval populations in response to higher nematicide dosages occurred but were at a reduced rate for aldicarb and phenamiphos. No additional reduction in larval populations beyond that obtained with the 2.0 lb rate was observed in oxamyl-treated plots. Reductions in larval populations in response to applications of carbofuran (Fig. 1-D) were obtained only

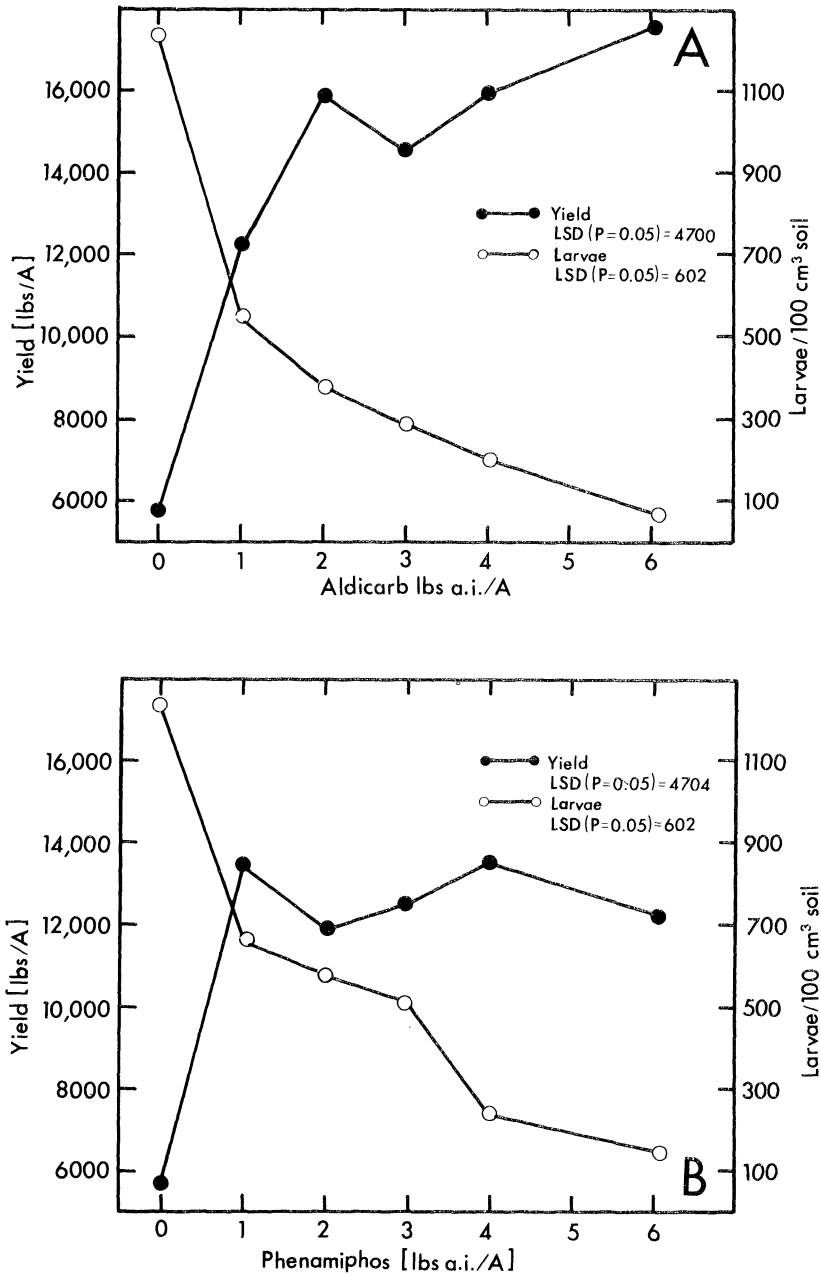
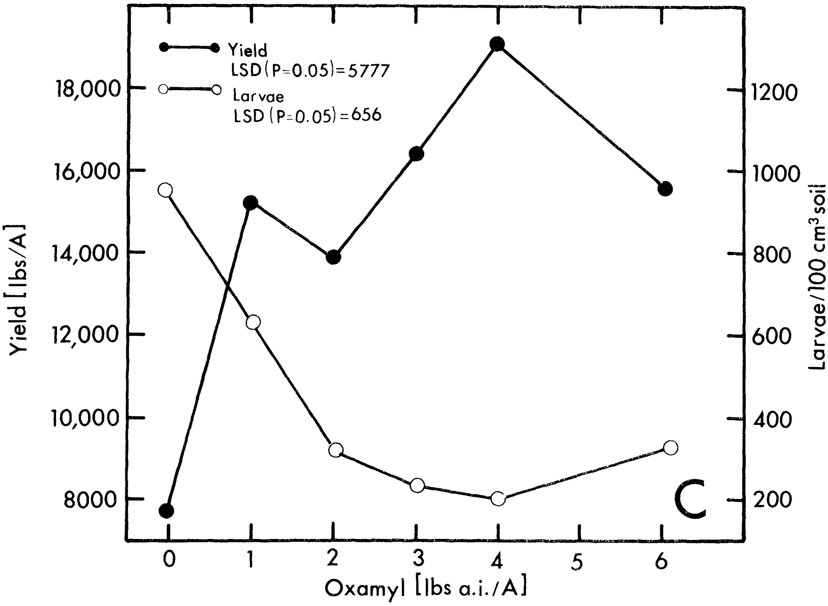


Fig. 1. Relationship between potato yields and number of larvae of *Meloidogyne arenaria* in response to in-furrow applications of: A. aldicarb (Temik®15G); B. phenamiphos (Nemacur®15G); C. oxamyl (Vydate®10G); and D. carbofuran (Furadan®10G).


Yield
LSD (P=0.05)=5777
Larvae
LSD (P=0.05)=656
18,000
16,000
14,000
12,000
10,000
8000
Yield [lbs/A]
1200
1000
800
600
400
200
Larvae/100 cm³ soil
C
0
1
2
3
4
5
6
Oxamyl [lbs a.i./A]

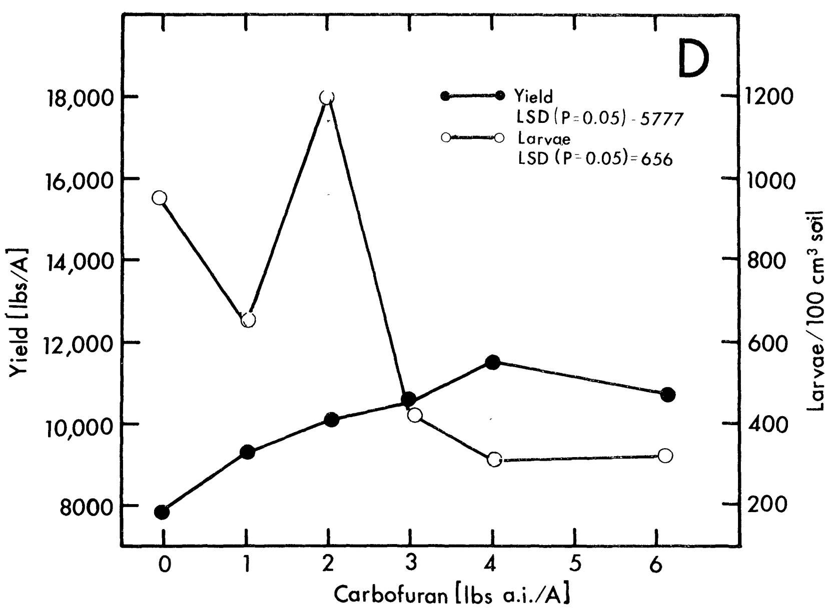

D
Yield
LSD (P=0.05) - 5777
Larvae
LSD (P=0.05)=656
18,000
16,000
14,000
12,000
10,000
8000
Yield [lbs/A]
1200
1000
800
600
400
200
Larvae/100 cm³ soil
0
1
2
3
4
5
6
Carbofuran [lbs a.i./A]

Table 1. Regression equations and correlation coefficients (r) between yield in pounds per acre (y) and number of larvae per 100 cm^3 soil (x) in potato tests at Fairhope, Ala., in 1979.

Aldicarb (Temik 15G)	y = -8.82x + 17491	r = -0.905**[z]
Phenamiphos (Nemacur 15G)	y = -6.60x + 15348	r = -0.800*
Oxamyl (Vydate 10G)	y = -11.49x + 19819	r = -0.871**
Carbofuran (Furadan 10G)	y = -2.15x + 11243	r = -0.544N.S.

[z] * = significant at P=0.05; ** = significant at P=0.01;N.S.=not significant.

with the three highest dosages; the size of populations in plots that received 1.0 or 2.0 lb/A of the chemical was not significantly different from those in control plots.

Yield response to aldicarb (Fig. 1-A) application was sharp and almost linear in the range of 0-2.0 lb/A, but no significant additional yield increments were obtained with the use of dosages above 2.0 lb/A. A similar type of yield response was observed for phenamiphos (Fig. 1B); however, maximal yield for this nematicide was obtained with the 1.0 lb rate with no additional yield increment being derived from higher dosages.

Yield response to oxamyl was, with one exception (1.0 lb/A), proportional to the amount of nematicide used in the range of 0-4.0 lb/A. No "plateauing" was observed in this range of concentrations in the curve that related nematicide rates to yields.

Carbofuran failed to produce significant yield increases at any of the application rates used in the experiment even though larval populations were reduced to levels similar to those obtained with the other nematicides, suggesting a phytotoxic effect by carbofuran on the crop.

The relation between larval numbers and yields expressed as the correlation coefficient between the two variables was highly significant for aldicarb, oxamyl, and phenamiphos (Table 1) but not for carbonfuran. The slopes of the linear regression equations between yields and larval numbers indicated that yield losses varied from 6.6 lbs/larva (phenamiphos data) to 11.49 lbs/larva (oxamyl data). The equations also indicated that the greatest potential for yield response among the three nematicides with significant correlation coefficients corresponded to oxamyl followed by aldicarb and phenamiphos in decreasing order. The average slope of the equations relating yield to

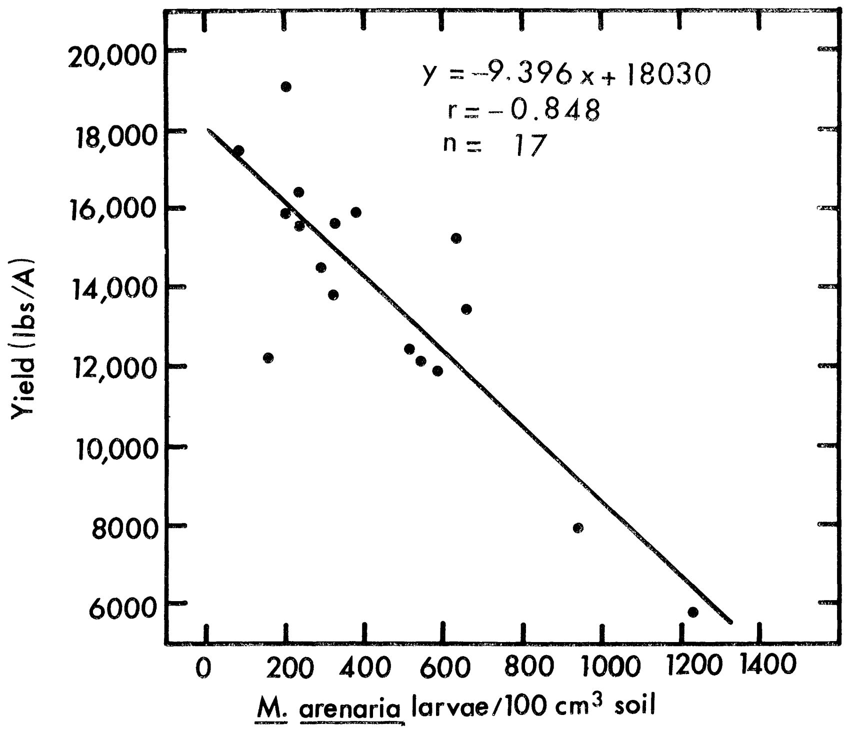


Fig. 2. Linear regression between potato yields and number of larvae of *Meloidogyne arenaria* in soils treated with aldicarb (Temik® 15G), oxamyl (Vydate® 10G) and phenamiphos (Nemacur® 15G).

numbers of larvae (excluding carbofuran data) for the experiments (Fig. 2) indicated close correspondence among the treatments; the overall yield loss was 9.4 lbs/larva for the field and season.

All nematicides reduced numbers of the Colorado potato beetle in the Cullman tests (Table 2) when used at the one pound rate, but no additional reduction in numbers was obtained with higher rates of the chemicals with the exception of phenamiphos; greatest reductions in numbers with phenamiphos were obtained with rates of two pounds or higher.

CONCLUSIONS

Our results show that planting-time applications of aldicarb, oxamyl and phenamiphos in potato seed furrow provide good control of *M. arenaria* and consequent yield increases. The systemic nature of these materials also provides for excellent control of the Colorado potato beetle. Similar applications

Table 2. Effect of aldicarb (Temik 15G), phenamiphos (Nemacur 15G), carbofuran (Furadan 10G), and oxamyl (Vydate 10G) on the number of Colorado potato beetles (*Leptinotarsa decemlineata*) in field tests at Culman, Ala., in 1979.

Rate (lbs a.i./acre)	Beetles per twenty feet of row			
	aldicarb	phenamiphos	carbofuran	oxamyl
0	60.2 A[x]	60.2 A	47.8 A	47.8 A
1	1.4 B	23.9 B	0.0 B	0.0 B
2	1.2 B	8.7 C	0.0 B	1.5 B
3	0.1 B	5.0 C	0.1 B	0.0 B
4	0.0 B	7.2 C	2.4 B	0.0 B
6	0.1 B	2.9 C	0.0 B	8.9 B

[x] Figures are averages of seven replications; those within the same column with a common letter were not significant (P=0.05).

of carbofuran, reduced the number of larvae at high dosages but did not result in significant yield increases. However, carbofuran did control the Colorado potato beetle.

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