# FOLIAR APPLICATIONS OF OXAMYL WITH ALDICARB FOR THE MANAGEMENT OF *MELOIDOGYNE INCOGNITA* ON COTTON

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## ABSTRACT

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The efficacy of foliar applications of oxamyl were evaluated for the management of *Meloidogyne incognita* on cotton in Mississippi. Two tests were established in Leflore County on a fine sandy loam soil (56.8% sand, 37.8% silt, 5.3% clay, pH 5.4 and 0.3% OM) naturally infested with *M. incognita*. Oxamyl was applied as a foliar spray at 0.14, 0.27, or 0.53 kg a.i./ha to cotton plants that had reached the sixth true leaf growth stage. A second oxamyl application was applied 14 days after the first treatment at the same rates. All oxamyl treatments also received aldicarb at 0.59 kg a.i./ha at planting. Controls consisted of aldicarb alone, disulfoton (an insecticide) and an untreated control. Oxamyl reduced *M. incognita* numbers at 79 days after planting in Test 1 and 63 and 72 days after planting in Test 2 compared to aldicarb at 0.59 kg a.i./ha alone or the controls that received neither material. Average reniform population densities in oxamyl-treated plots were 38.3% and 44% lower than with aldicarb alone and the controls, respectively. Cotton plant height was greater in plots that received oxamyl at all rates than in the controls. Cotton in oxamyl plus aldicarb and aldicarb alone treatments produced more bolls per plant and had a greater total boll weight than disulfoton or the untreated control. Seed cotton yields were greater in oxamyl-treated plots than for disulfoton-treated and the untreated control.

*Key words:* aldicarb, cotton, *Gossypium hirsutum*, management, *Meloidogyne incognita*, nematicide, nematode, oxamyl, root-knot nematode.

## RESUMEN

Lawrence, G. W. y K. S. McLean. 2002. Aplicaciones foliares de oxamylo con aldicarb para el manejo de *Meloidogyne incognita* en algodón. Nematrópica: 32:103-112.

Se evaluó la eficacia de las aplicaciones foliares de oxamilo para el manejo de *Meloidogyne incognita* en algodón en Mississippi. Se establecieron dos ensayos en el Condado de Leflore en un suelo franco arenoso con fracción fina de arena (56,8% arena, 37,8% limo, 5,3% arcilla, pH 5,4 y 0,3% MO) que estaba infestado naturalmente con *M. incognita.* El oxamilo se aplicó a dosis de 0,14, 0,27, y 0,53 kg i.a. /ha al algodón cuando las plantas habían desarrollado la sexta hoja verdadera. Se realizó una segunda aplicación de oxamilo a las mismas dosis14 días después de la primera. Todos los tratamientos con oxamilo también recibieron aldicarb a una dosis de 0,59 kg de i.a. /ha en el momento de plantar. Los controles fueron aldicarb solo, disulfoton (un insecticida) y parcelas control no tratadas. El oxamilo reducía el número de *M. incógnita* 79 días después de plantar en el Ensayo 1 y 63 y 72 días después de plantar en el Ensayo 2 comparado con el control de aldicarb a dosis de 0,59 kg i.a./ ha o con los controles que no recibieron ningún nematicida. Las densidades promedio de las poblaciones del nematodo reniforme en las parcelas tratadas con oxamilo fueron 38,3% y 44% inferiores a las encontradas en las parcelas tratadas solo con aldicarb o en los controles no tratados, respectivamente. La altura de las plantas de algodón fue mayor en las parcelas que recibieron oxamilo a cualquiera de las dosis ensayadas que en los controles. El algodón en las parcelas tratadas con oxamilo más aldicarb, o bien, solo aldicarb producían más cápsulas por planta y estas tenían mayor peso total que en las parcelas tratadas con disulfoton o en las control no tratadas. La producción de semillas de algodón fue mayor en las parcelas tratadas con oxamilo que en las parcelas tratadas con disulfoton o en las control no tratadas.

*Palabras clave*: aldicarb, algodón, *Gossypium hirsutum,* manejo, *Meloidogyne incognita* nematicida, nematodo, nematodo agallador, oxamilo.

## INTRODUCTION

Cotton, *Gossypium hirsutum,* is a major agricultural crop in Mississippi where it is produced annually on more than 2.5 million ha in 70 of the 82 counties in the state. The majority (70%) of cotton production occurs in 16 counties which comprise the Mississippi Delta (Southern Mississippi Valley Alluvium) (Pettry, 1977).

Plant-parasitic nematodes are economically important pests in Mississippi cotton production. The root-knot nematode, *Meloidogyne incognita* (Koford and White) Chitwood host race 3, is the second most important species of plant-parasitic nematodes in cotton fields in the state and has been found to infest more than 13.3% of the cotton hectarage (Hankins *et al.*, 1997). Cotton yield reduction due to *Meloidogyne incognita* has averaged 32% in disease loss study plots over the past five years (Lawrence, unpub.) Statewide, yield losses attributed to this nematode are estimated to be greater than 1.5%, valued at $10.9 million dollars (Blasingame and Patel, 2002).

Nematode management tactics available to Mississippi cotton growers are limited. Some cotton growers have established rotation practices with corn, grain sorghum, *M. incognita*-resistant soybeans, and less susceptible cultivars to maximize cotton yields and help manage *M. incognita* in cotton. Although corn is susceptible to the root-knot nematode, many cotton growers believe that the benefits from the addition of organic matter benefit the subsequent crop even in the presence of the nematode (Creech *et al.*, 1995). Cotton yields followings these rotation crops generally are higher the year after the rotation crop due to lower initial nematode population densities. However, *M. incognita* will increase during that first year of cotton production and the subsequent cotton crop requires additional management strategies. In addition, the higher value of cotton relative to most rotation crops often encourages monoculture cotton production. *Meloidogyne incognita* resistant varieties are not available in the mid-south cotton region, however, cultivars differ in susceptibility (Jenkins *et al.*, 1993; Robinson and Percival, 1997; Creech *et al.*, 1998); therefore, cotton growers depend primarily on nematicides to reduce nematode populations at planting.

Aldicarb is the most widely used insecticide/nematicide in cotton production in Mississippi (Lawrence and McLean, 2000). It is applied at planting in or near the seed furrow at rates varying from 0.59 to 1.19 kg a.i./ha to lower the numbers of plant-parasitic nematodes in the soil, thus allowing a time period of reduced stress for plant establishment. Aldicarb degrades and (or) leaches rapidly, allowing nematode populations to increase to high levels during the growing season (Lawrence and McLean, 1995, 1996, 1997; Lawrence *et al.*, 2000). Therefore, maximum nematode densities occur at the time cotton is in its peak reproductive state. The additional plant stress from nematode parasitism results in suppressed lint yield and the need for additional nematode management tactics for the subsequent cotton crop. Nematicide applications after cotton plant establishment have been shown to suppress the rate of nematode population increase. Post-plant applications reduce nematode stress at the critical growth stages of cotton development (Lawrence and McLean, 2000).

Oxamyl is a systemic insecticide/nematicide that is registered for use as a foliar treatment for the management of plant-parasitic nematodes on many field crops. When applied to the leaf surface, oxamyl penetrates the cuticle and is translocated to the root system through the phloem where it provides a degree of nematode management (Hsu and Kleier, 1996). Foliar applications on cotton are recommended following a pre-plant or at-plant soil nematicide treatment. The objective of this study was to examine the efficacy of foliar applications of oxamyl in combination with soil application of aldicarb for the management of *M. incognita* and to determine the effects of this application on subsequent cotton growth and yield.

## MATERIALS AND METHODS

Tests were conducted in 1998 and 1999 in a field that was naturally infested with *M. incognita* and in continuous cotton production. The tests were located in Leflore County in a Dubbs very fine sandy loam soil (56.8% sand, 37.8% silt, 5.3% clay, pH 5.4 and 0.3% OM)

Oxamyl (Vydate C-LV, DuPont Agricultural Products, Wilmington, DE) was applied as a foliar spray at 0.14, 0.27, or 0.53 kg a.i./ha on cotton at the sixth true-leaf growth stage. All oxamyl treatments followed an at-plant application of aldicarb (Temik 15G, Bayer CropScience, Research Triangle Park, NC), which was applied in the seed furrow at 0.59 kg a.i./ha and is recommended in Mississippi for early season insect control (Layton, 2002). Aldicarb, at the same rate, has demonstrated some nematicidal activity (Lawrence and McLean, 1996, 1997; Lawrence *et al.*, 1995). Consequently, three treatments (i) aldicarb (0.59 kg a.i./ha) alone applied at planting; (ii) disulfoton (Di-Syston 8E Bayer CropScience, Kansas City, MO) (0.85 kg a.i./ha), an insecticide with no nematicidal activity, applied at planting; and (iii) an untreated control were included as controls for comparison. Aldicarb was applied in the seed furrow using a tractor-mounted granular chemical applicator. Disulfoton was applied in the seed furrow using a single 8002 flat fan nozzle positioned behind the seed furrow opening disk with a $CO_2$-charged system calibrated to apply a total volume of 95 liters/ha. Oxamyl was applied as a foliar spray 34 days after planting (DAP) in a total volume of 95 liter/ha when the cotton plants had reached the sixth true leaf physiological growth stage. A second oxamyl treatment was applied at the same rates 14 days after the first application. Oxamyl was applied with a $CO_2$-charged backpack field plot spray system. All treatments that did not receive oxamyl were treated with acephate (Orthene 90S, Valent USA, Walnut Creek, CA) (0.28 kg/ha) to reduce variation between treatments due to possible insect control effects from oxamyl.

The experimental design was a randomized complete block with five replications. Plots consisted of four 12.7-m-long rows spaced 0.97 m apart. Replications were separated by a 4.6-m alley. Each row was planted with DES 119 cotton seeds that were commercially treated with captan, carboxin (Vitavax) plus metalaxyl (Apron), and acephate.

Cotton seedling stand (number of live plants/12.7 m of row) was measured 39 DAP. Cotton plant height was measured at 14, 21, and 92 (Test 1) and 81 (Test 2) days after the second oxamyl application. Plots were irrigated as needed.

Population densities of *M. incognita* (life stage J2) in the soil were determined at the time of planting and at monthly intervals for the duration of the test. Ten soil cores, 2-cm-diam. × 20-cm-deep, were collected from each plot and thoroughly mixed, and a 250-$cm^3$ subsample was removed. Nematodes were extracted using gravity screening, and the fraction collected on a 38-um-pore sieve was further processed by centrifugal flotation (sucrose sp. gr. = 1.13) (Jenkins, 1964).

Cotton plants were collected from 1 m of row at harvest and the number of bolls produced on a plant, the respective fruiting position of the bolls, and boll weights were recorded. Plots were hand-harvested 148 and 142 DAP in Test 1 and Test 2, respectively. All nematode population levels and harvest data were subjected to analysis of variance and means were compared using Fisher's protected least significant difference (FLSD) test ($P \leq 0.05$).

## RESULTS

*Test 1:*

*Meloidogyne incognita* population densities ranged from 206 to 541 second stage juveniles (J2)/250 $cm^3$ soil at planting (Table 1). In June (35 DAP) nematode densities decreased an average of 15% from at-plant densities. In July (65 DAP) nematode numbers had increased in all plots. This July sample represented the first nematode sample after the plots received the two foliar applications of oxamyl (21 and 7 days after treatment for the first and second applications, respectively). Although not significantly different ($P \leq 0.05$) from aldicarb alone, nematode population densities were 19 and 14% lower in oxamyl applied 0.14 and 0.27 kg a.i./ha plus aldicarb. A second sample, collected in July at 79 DAP, showed fewer *M. incognita* (J2) in all treatments that included oxamyl in combination with aldicarb than with aldicarb alone, disulfoton, or the untreated control plots. In August, 107 DAP, *M. incognita* populations were lower ($P \leq 0.05$) in plots that received two foliar application of oxamyl at 0.27 and 0.53 kg a.i./ha plus aldicarb than in disulfoton or the untreated control. Nematode population densities were 33 to 50% lower in all treatments which included oxamyl in combination with aldicarb than with aldicarb alone.

*Meloidogyne incognita* population levels ranged from 489 to 1,279 nematodes/250 $cm^3$ soil at harvest (Table 1). Fewer *M. incognita* (J2) ($P \leq 0.05$) were recovered in all treatments that included oxamyl in combination with aldicarb than in the disulfoton control plots. Nematode numbers were 41% lower where oxamyl was applied than in plots that received aldicarb alone. Nematode population densities averaged across all sampling dates were lower after treatment with oxamyl applied at 0.14 and 0.27 kg a.i./ha in combination with aldicarb than for either the aldicarb alone, disulfoton, or the untreated control plots (Table 3).

At 62 DAP, cotton plants were taller ($P \leq 0.05$) in all plots that received the oxamyl plus aldicarb combinations and aldicarb alone compared with disulfoton and the untreated control (Table 4). Plants treated with two foliar sprays of oxamyl at 0.27 and 0.53 kg a.i./ha in addition to aldicarb were taller ($P \leq 0.05$) than plants treated with aldicarb alone. At 76 days, cotton plants that received oxamyl at 0.53 kg a.i./ha plus aldicarb were taller ($P \leq 0.05$) than those that received aldicarb alone, disulfoton, or were untreated. Plants were 4.1, 4.4, and 7.2 cm taller where oxamyl was applied at 0.14, 0.27, and 0.53 kg a.i./ha, respectively, in combination with aldicarb than where aldicarb was applied alone. By 140 DAP,

Table 1. Foliar applications of oxamyl and population development of *Meloidogyne incognita* on DES 119 cotton, Test 1.

| | | *Meloidogyne incognita*/250 cm$^3$ soil (days after planting) | | | | | |
|---|---|---|---|---|---|---|---|
| Treatment[z] | Rate kg a.i./ha | 0 | 35 | 65 | 79 | 107 | 148 |
| Oxamyl + Aldicarb | 0.14 + 0.59 | 206 | 258 b | 876 | 1306 | 773 | 670 |
| Oxamyl + Aldicarb | 0.27 + 0.59 | 232 | 232 | 927 | 1391 | 604 | 670 |
| Oxamyl + Aldicarb | 0.53 + 0.59 | 386 | 360 | 1133 | 1751 | 580 | 489 |
| Aldicarb | 0.59 | 412 | 332 | 1082 | 2740 | 1159 | 1030 |
| Disulfoton | 0.85 | 464 | 258 | 1262 | 3039 | 1365 | 1288 |
| Control | — | 541 | 464 | 800 | 2421 | 1313 | 876 |
| FLSD ($P \leq 0.05$) | | NS | 207 | NS | 293 | 649 | 560 |

Data are means of five replications. Means compared using Fisher's protected least significant difference (FLSD) test. All oxamyl treatments received aldicarb at 0.59 kg a.i./ha in the seed furrow at planting.
[z]Oxamyl was applied at the sixth true leaf stage (35 DAP) and 14 days later.

cotton plants treated with oxamyl at all rates plus aldicarb and aldicarb alone were significantly taller than those treated with disulfoton or were untreated. Plant height was increased 5.3, 7.1, and 6.6 cm, respectively, over aldicarb alone where two applications of oxamyl were applied at 0.14, 0.27, and 0.53 kg a.i./ha in combination with aldicarb (Table 4).

A trend toward a greater number of bolls retained and greater open boll weights was apparent on the plants that received oxamyl in combination with aldicarb and aldicarb alone compared with disulfoton or the untreated control ($P \leq 0.05$) (Table 5). The first open bolls were produced and retained on a lower main stem node ($P \leq 0.05$) in all treatments that included an at-plant application of aldicarb than in disulfoton and the untreated control.

Cotton yields were higher ($P \leq 0.05$) in the oxamyl (0.53 kg a.i./ha) plus aldicarb combinations than all other treatments. All treatments that included aldicarb increased yield higher than the untreated control (Table 6). Plots that received a foliar application of oxamyl (0.53 kg a.i./ha) at the sixth true leaf stage and 14 days later produced the highest yield of 4,530.2 kg/ha.

*Test 2:*

Population development trends for *M. incognita* in Test 2 were similar to those in Test 1. Population densities did not differ among treatments until 63 DAP (10 days after the last oxamyl application) (Table 2). At 63 and 72 DAP, fewer ($P \leq 0.05$) *M. incognita* were found in all oxamyl plus aldicarb combinations than the untreated control. At 106 DAP, fewer ($P \leq 0.05$) *M. incognita* were recovered from all oxamyl plus aldicarb combination compared with disulfoton. *Meloidogyne incognita* population levels ranged from 1,101 to 2,318 nematodes/250 cm$^3$ soil at harvest 142 DAP (Table 2). Fewer *M. incognita* were recovered in oxamyl (0.53 kg a.i./ha) in combination with aldicarb, aldicarb alone, disulfoton or the untreated control; however, differences were not significant.

Table 2. Foliar applications of oxamyl and population development of *Meloidogyne incognita* on DES 119 cotton, Test 2.

| Treatment[z] | Rate kg a.i./ha | *Meloidogyne incognita*/250 $cm^3$ soil (days after planting) | | | | | |
|---|---|---|---|---|---|---|---|
| | | 0 | 40 | 63 | 72 | 106 | 142 |
| Oxamyl + Aldicarb | 0.14 + 0.59 | 142 | 509 | 423 | 760 | 979 | 2208 |
| Oxamyl + Aldicarb | 0.27 + 0.59 | 187 | 251 | 624 | 1352 | 1017 | 1828 |
| Oxamyl + Aldicarb | 0.53 + 0.59 | 148 | 174 | 560 | 779 | 843 | 1101 |
| Aldicarb | 0.59 | 103 | 212 | 1313 | 2137 | 1545 | 1783 |
| Disulfoton | 0.85 | 187 | 792 | 1242 | 1867 | 2124 | 2318 |
| Control | — | 129 | 431 | 2060 | 3225 | 1532 | 2092 |
| FLSD ($P \leq 0.05$) | | 105 | 606 | 1197 | 1386 | 775 | 1294 |

Data are means of five replications. Means compared using Fisher's protected least significant difference (FLSD) test. All oxamyl treatments received aldicarb at 0.59 kg a.i./ha in the seed furrow at planting.
[z]Oxamyl was applied at the sixth true leaf stage (39 DAP) and 14 days later.

The lowest nematode population densities ($P \leq 0.05$) in Test 2, averaged across all sampling dates, were following the oxamyl 0.53 kg a.i./ha plus aldicarb treatment (Table 3). Fewer nematodes ($P \leq 0.05$) were found in this treatment than with aldicarb alone, disulfoton, or the untreated control.

Table 3. Foliar applications of oxamyl and mean *Meloidogyne incognita* population development on DES 119 cotton.

| Treatment[z] | Rate kg a.i./ha | *Meloidogyne incognita*/250 $cm^3$ soil[y] | | |
|---|---|---|---|---|
| | | Test 1 | Test 2 | Mean |
| Oxamyl + Aldicarb | 0.14 + 0.59 | 681.5 | 837 | 760 |
| Oxamyl + Aldicarb | 0.27 + 0.59 | 676 | 877 | 777 |
| Oxamyl + Aldicarb | 0.53 + 0.59 | 783.2 | 601 | 692 |
| Aldicarb | 0.59 | 1119.5 | 1182 | 7151 |
| Disulfoton | 0.85 | 1279 | 1422 | 1351 |
| Control | — | 1069 | 1578 | 1324 |
| FLSD ($P \leq 0.05$) | | 335 | 506 | 406 |

Data are means of five replications. Means compared using Fisher's protected least significant difference (FLSD) test. All oxamyl treatments received aldicarb at 0.59 kg a.i./ha in the seed furrow at planting.
[z]Oxamyl was applied at the sixth true leaf stage (35 and 39 days after planting, Test 1 and Test 2, respectively) and 14 days later.
[y]Mean *M. incognita* populations across 2 years data with five replications each year.

Table 4. Foliar application of oxamyl and the height of DES 119 cotton in soil naturally infested with *Meloidogyne incognita.*

| | | Days after planting/plant height (cm) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Test 1 | | | | Test 2 | | | |
| Treatment[z] | Rate kg a.i./ha | 62 | 76 | 140 | Mean[y] | 62 | 76 | 141 | Mean[y] |
| Oxamyl + Aldicarb | 0.14 + 0.59 | 60.7 | 89.4 | 120.4 | 90.2 | 74.0 | 93.2 | 101.5 | 89.6 |
| Oxamyl + Aldicarb | 0.27 + 0.59 | 64.5 | 89.9 | 122.2 | 85.1 | 77.4 | 95.4 | 103.1 | 92.0 |
| Oxamyl + Aldicarb | 0.53 + 0.59 | 68.6 | 92.5 | 121.7 | 94.3 | 78.7 | 96.9 | 113.0 | 96.2 |
| Aldicarb | 0.59 | 58.9 | 85.3 | 115.1 | 86.4 | 72.1 | 93.6 | 108.4 | 91.4 |
| Disulfoton | 0.85 | 53.6 | 80.3 | 104.6 | 79.5 | 67.2 | 88.2 | 94.7 | 88.4 |
| Control | — | 51.1 | 76.2 | 106.9 | 78.1 | 67.4 | 86.1 | 89.4 | 81.0 |
| FLSD ($P \leq 0.05$) | | 4.3 | 4.8 | 7.4 | 6.9 | 4.8 | 4.3 | 8.4 | 5.6 |

Data are means of five replications. Means compared using Fisher's protected least significant difference (FLSD) test. All oxamyl treatments received aldicarb at 0.59 kg a.i./ha in the seed furrow at planting.
[z]Oxamyl was applied at the sixth true leaf stage (35 and 39 days after planting, Test 1 and Test 2, respectively) and 14 days later.
[y]Mean plant height across each sample date.

Plants in Test 2 were taller ($P \leq 0.05$) in oxamyl (0.27 and 0.53 kg a.i./ha) plus aldicarb at 62 DAP. At 76 DAP, all oxamyl plus aldicarb and aldicarb alone treatments were taller than disulfoton and the untreated control. At harvest, plants in the oxamyl plus aldicarb combinations and aldicarb alone were taller than those in the untreated control.

There were more ($P \leq 0.05$) open bolls per cotton plant and higher open boll weights in the oxamyl 0.53 kg a.i./ha plus aldicarb treatment compared with all treatments (Table 5). All treatments that included an at-plant application of aldicarb produced and retained the first open boll at a lower main stem node as in Test 1.

In Test 2, all oxamyl and aldicarb combination treatments resulted in higher yields than aldicarb alone, disulfoton and the untreated control (Table 6). Plots that received foliar applications of oxamyl (0.53 kg a.i./ha) in combination with aldicarb produced the highest yield of 4,258 kg/ha.

Combined analysis over the two tests for seed cotton yield (Steel and Torrie, 1980) indicated that seed cotton yields were improved ($P \leq 0.05$) with the addition of oxamyl at 0.53 kg a.i./ha in combination with aldicarb in comparison with aldicarb alone, disulfoton or the untreated control (Table 6).

## DISCUSSION

Oxamyl applied as a foliar spray at the sixth true leaf stage followed by a second application 14 days later, in combination with an at-plant application of aldicarb, reduced the population density of *M. incognita* at specific sample dates in each test. This was accompanied by an improvement in cotton plant development and seed cotton yield. The temporal population development trends for *M. incognita* in our study were similar to nematode development observed previously (Lawrence and McLean, 1996, 1997, 2000; Lawrence *et al.*, 1995). At

Table 5. Foliar applications of oxamyl and number of open bolls, open bolls weight, and node of first fruiting branch on DES 119 cotton in soil naturally infested with *Meloidogyne incognita*.

| | | Test 1 | | | Test 2 | | |
|---|---|---|---|---|---|---|---|
| Treatment[z] | Rate kg a.i./ha | Open bolls | Boll weight | Node of first boll | Open bolls | Boll weight | Node of first boll |
| Oxamyl + Aldicarb | 0.14 + 0.59 | 50.7 | 202.6 | 4.1 | 49.6 | 240.3 | 4.1 |
| Oxamyl + Aldicarb | 0.27 + 0.59 | 61.3 | 249.9 | 4.5 | 56.4 | 289.9 | 4.1 |
| Oxamyl + Aldicarb | 0.53 + 0.59 | 54.3 | 205.1 | 3.9 | 68.6 | 345.2 | 3.7 |
| Aldicarb | 0.59 | 54.7 | 202.3 | 3.5 | 54.0 | 269.9 | 4.1 |
| Disulfoton | 0.85 | 38.3 | 132.2 | 6.5 | 28.2 | 134.4 | 5.6 |
| Control | — | 40.0 | 124.7 | 7.6 | 19.8 | 115.9 | 5.8 |
| FLSD ($P \leq 0.05$) | | 16.7 | 67.8 | 2.0 | 7.5 | 39.8 | 1.0 |

Data are means of five replications. Means compared using Fisher's protected least significant difference (FLSD) test. All oxamyl treatments received aldicarb at 0.59 kg a.i./ha in the seed furrow at planting.
[z]Oxamyl was applied at the sixth true leaf stage (35 and 39 days after planting, Test 1 and Test 2, respectively) and 14 days later.

the first sample after planting, nematode population densities averaged 18 and 53% lower in the aldicarb treatments compared with the control in Test 1 and 2, respectively.

Oxamyl was applied as a foliar spray at the sixth true-leaf stage and a second application 14 days later, therefore, a trend toward numerically fewer nematodes was

Table 6. Foliar applications of oxamyl and seed cotton yield of DES 119 in soil naturally infested with *Meloidogyne incognita*.

| | | Seed cotton yield (kg/ha) | | |
|---|---|---|---|---|
| Treatment[z] | Rate kg a.i./ha | Test 1 | Test 2 | Mean[y] |
| Oxamyl + Aldicarb | 0.14 + 0.59 | 3728.1 | 3954.3 | 3841.2 |
| Oxamyl + Aldicarb | 0.27 + 0.59 | 3761.5 | 4063.6 | 3912.6 |
| Oxamyl + Aldicarb | 0.53 + 0.59 | 4530.2 | 4258.2 | 4394.2 |
| Aldicarb | 0.59 | 3633.1 | 3547.9 | 3590.5 |
| Disulfoton | 0.85 | 3208.2 | 3209.8 | 3209.0 |
| Control | — | 2877.5 | 3097.9 | 2987.7 |
| FLSD ($P \leq 0.05$) | | 545.6 | 378.2 | 403.5 |

Data are means of five replications. Means compared using Fisher's protected least significant difference (FLSD) test. All oxamyl treatments received aldicarb at 0.59 kg a.i./ha in the seed furrow at planting.
[z]Oxamyl was applied at the sixth true leaf stage (35 and 39 days after planting, Test 1 and Test 2, respectively) and 14 days later.
[y]Mean seed cotton yield across 2 years.

recorded on the 3rd sample date in the oxamyl-treated plots. Fewer nematodes were recovered in plots that received the two foliar applications of oxamyl starting at 63 and 65 DAP and the remainder of the season. At each sample date the percentage of *M. incognita* juveniles recovered from the oxamyl plus aldicarb combinations was lower than aldicarb alone, disulfoton and the untreated control. Population densities of *M. incognita* in the oxamyl treatments were also lower ($P \leq 0.05$) when averaged across the season for both tests, indicating that the cotton plants were subjected to less stress from nematode parasitism in these treatments during the growing season.

The foliar applications of oxamyl in combination with aldicarb at planting produced a positive effect on cotton plant development and boll production. During the growing season, the three rates of oxamyl varied as to increasing plant height ($P \leq 0.05$). However, at each sample date, plants in all oxamyl plus aldicarb plots were numerically taller than plants in the three controls. Larger and more vigorously growing plants generally support a larger boll load and subsequently produce higher yields at harvest (Jenkins *et al.*, 1990).

In mid-south cotton production, the primary position for harvestable cotton bolls occurs at the first three flowering positions along the sympodial branches (Mauney, 1986). Tests conducted by Jenkins *et al.*, (1990) in Mississippi have determined that 77% of the total lint is produced from the first fruiting position. The second fruiting position produces an average of 20% with the third position producing the remainder of the total yield. The largest number of open bolls in these two tests were produced on the first fruiting position, which produced the highest percentage of the total yield. An additional 30.6% of the yield resulted from bolls on the third fruiting position from plants that received oxamyl plus aldicarb. This additional boll weight in each fruiting position may be in part the reason higher total yields were recovered from oxamyl and aldicarb combination plots compared with the other treatments.

*Meloidogyne incognita* also has an effect on the height of the first fruiting node. This is the lowest main stem node above the cotylendonary node from which a sympodial branch develops (Oosterhuis *et al.*, 1996). In mid-south cotton, the first fruiting node generally occurs at main-stem nodes 5 to 7, however, this is influenced by environmental conditions and cultural practices (Oosterhuis *et al.*, 1996). A desirable character in cotton production is a lower first fruiting position while a higher position indicates delayed plant development. This study supports other studies where the first fruiting node was produced lower on the main stem on plants that received aldicarb at planting. Lawrence and McLean (2000) reported similar effects on cotton with the reniform nematode *Rotylenchulus reniformis*. Foliar application of oxamyl did not have an effect of the first fruiting node position because applications were made after first-square initiation.

In summary, oxamyl as a foliar spray in combination with an at-planting application of aldicarb can provide cotton growers an additional means for management of *M. incognita* after plant establishment. Many Mississippi cotton growers routinely use aldicarb (0.59 kg a.i./ha) for early season insect control. A knowledge that oxamyl will provide *M. incognita* management in addition to insect control would allow the grower to choose a pest management program that would optimize the use of multiple-activity pesticides. Foliar applications of oxamyl may also serve as a treatment in a situation where nematode population levels were not known until after the crop was established.

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