RATES AND APPLICATION TIMING OF 1,3-DICHLOROPROPENE FOR THE MANAGEMENT OF *MELOIDOGYNE INCOGNITA* AND *ROTYLENCHULUS RENIFORMIS* ON COTTON[1]

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ABSTRACT

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Replicated fumigation field trials were conducted at separate sites in Florida. One site was naturally infested with *Meloidogyne incognita* and the other with *Rotylenchulus reniformis.* The fumigant, 1,3-dichloropropene (1,3-D), was applied at rates of 16, 32, and 48 kg a.i./ha at 92, 63, 36, and 2 days before planting (DBP) Delta Pine 458BR cotton at the *M. incognita* site and at 69, 37, 12, and 0 DBP at the *R. reniformis* site. All treatments were replicated six times. Yields in the non-treated controls at the *M. incognita* site averaged 349 kg/ha of cotton lint whereas those across rates and timing in the 1,3-D treatments averaged 504 kg/ha. All 1,3-D treatments significantly reduced post-harvest numbers of *M. incognita* (12 J2/100 cm^3 soil across rates and timing) compared with the non-treated controls (460 J2). At the *R. reniformis* site, the non-treated controls averaged 353 kg lint/ha while 1,3-D treatment across rates and timing averaged 450 kg/ha. Post-harvest *R. reniformis* soil population densities of all nematode stages were not influenced by treatment (3048/100 cm^3 soil from non-treated and 3040 in the 1,3-D treatments across rates and timing). Since there were no significant negative effects from timing of application, these studies indicate that profitable applications of 1,3-D may be accomplished earlier and later than the current application recommendation of 10-21 days before planting.

Key words: Cotton, 1,3-dichloropropene, *Gossypium hirsutum, Meloidogne incognita,* nematicide, reniform nematode, root-knot nematode, *Rotylenchulus reniformis,* Telone II, time of fumigation.

RESUMEN

Rich, J. R. y R. A. Kinloch. 2001. Dosis y momento de aplicación de 1,3-Dicloropropano para el control de *Meloidogyne incognita* y *Rotylenchulus reniformis* en algodón. Nematrópica 31:253-258.

Fumigaciones en ensayos de campo con repeticiones se llevaron a cabo en dos sitios diferentes en Florida. Se escogió un sitio con suelo naturalmente infectado con *Meloidogyne incognita* y el otro con *Rotylenchulus reniformis.* El fumigante, 1,3-dicloropropano (1,3-D) se aplicó en dosis de 16, 32 y 48 kg i.a./ha a los 92, 63, 36, y 2 días antes de la siembra (DAS) en suelos infectados con *M. incognita.* Suelos infectados con *Rotylenchulus reniformis* se fumigaron a los 69, 37, 12, y 0 DAS. En ambos sitios se sembró la variedad de algodón Delta Pine 458BR y todos los tratamientos se repitieron seis veces. Los redimientos de las plantas testigos en suelos infectados con *M. incognita* alcanzaron un promedio de 349 kg/ha de algodón en mota, mientras que el promedio correspondiente a todos los tratamientos con fumigación alcanzó 504 kg/ha Todos los tratamientos con 1,3-D redujeron significativamente las densidades poblacionales de *M. incognita* (12 J2/100 cm^3 de suelo para todas las dosis y momento de aplicación) en comparación con el testigo (460 J2) después de la cosecha. En el caso de *R. reniformis,*

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las plantas testigos produjeron en promedio 353 kg de algodón en mota/ ha, mientras que las tratadas con 1,3-D alcanzaron 450 kg/ha. Las densidades poblacionales en el suelo, de todos los estados de desarrollo, después de la cosecha no estuvieron afectadas por los tratamientos.(3048/100 cm^3 de suelo no tratado y 3040 en suelos tratados con 1,3-D para todas las dosis y momento de aplicación). Puesto que no hubo efecto negativo significativo debido al momento de aplicación, estos estudios indican que la rentabilidad en la aplicación de 1,3-D puede lograrse con fumigaciones más tardías o tempranas con respecto a los 10-21 días antes de la siembra que se recomienda actualmente.

Palabras claves: Algodón, 1,3-Dicloropropano, *Gossypium hirsutum*, *Meloidogne incognita*, momento de fumigación, nematodo reniforme, nematodo agallador de raíces, *Rotylenchulus reniformis*, Telone II.

INTRODUCTION

Upland cotton (*Gossypium hirsutum* L.) is a major agronomic crop in the northern tier of counties in Florida, U.S.A., with production in 1999 of 43 000 ha (Anonymous, 2000). The root-knot nematode, *Meloidogyne incognita* (Kofoid and White) Chitwood, and the reniform nematode, *Rotylenchulus reniformis* Linford and Oliveira, are widespread in cotton fields throughout this region (Kinloch and Sprenkel, 1994). Since resistant cultivars are not available, management of these nematodes is by rotation and use of nematicides. Peanut, commonly grown in northern Florida, is a non-host of both *M. incognita* and *R. reniformis* and is a useful crop in cotton rotation systems. Peanut, however, has a limited hectarage due to allotment constraints. Maize is a nonhost of *R. reniformis,* but plantings have been reduced in recent years because of low prices for this crop. Growers have tended to monoculture cotton due to relatively high prices for this commodity. Thus, growers have not been able to rotate adequately and nematode damage has increased on cotton. Without rotation, the remaining management option is the use of nematicides (Rich and Kinloch, 2000a). The most effective nematicide used to manage nematodes in Florida cotton is 1,3-dichloropropene (1,3-D). Label requirements for application, however, require a 10 to 21-day waiting period prior to planting. This time delay between treatment and planting presents logistical problems for growers during the normally rainy and busy planting period in north Florida. If growers could apply the product well in advance of planting or at planting, scheduling farm operations including 1,3-D application would be more flexible. The objectives of the following tests were to determine responses of cotton yield and post-harvest *M. incognita* and *R. reniformis* soil population densities to 1,3-D applied at varying application times relative to planting.

MATERIALS AND METHODS

Two north Florida fields, one naturally infested with *M. incognita* in Santa Rosa County and one infested with *R. reniformis* in Gadsden County, were used for replicated field trials. Soil at the *M. incognita*-infested site was a sandy loam (82% sand, 10% silt, 8% clay, pH 5.7, O.M. <2%), and the reniform nematode-infested site was also a sandy loam (80% sand, 8% silt, 12% clay, pH 5.9, O.M. <2%). The sites were prepared in late February by moldboard plowing then double-disking. Prior to treatment, all plots at the *M. incognita* site and control plots at the *R. reniformis* site were assayed for initial nematode populations by removing six soil cores (2.5-cm-diam and 24-cm-deep). Cores from individual plots were combined and a 100 cm^3 sub-sample from each plot was removed for nematode extraction using the modified centrifugation-sugar flotation technique (Jenkins, 1964). Initial population densities of *M. incognita* second stage juveniles (J2) averaged 327/100 cm^3 soil while all stages of *R. reniformis* averaged 1234/100 cm^3 soil.

The 1,3-D was placed 30-cm-deep with a single chisel beneath the row in all plots. It was applied at rates of 16, 32, and 48 kg a.i./ha at 92, 63, 36, and 2 days before planting (DBP) the Delta Pine 458BR cotton cultivar on 3 June at the *M. incognita* site and at 69, 37, 12, and 0 DBP on 13 May at the *R. reniformis* site. Individual plots were two rows wide and 7.6-m-long on 91-cm-wide centers. Treatments at the *M. incognita* site were stratified according to preplant soil densities, while those at the *R. reniformis* site were placed in a randomized complete block design. Treatments at both tests were replicated six times. Both sites were maintained using standard recommended practices (Sprenkel, 2000) and were not irrigated.

Plots were mechanically harvested on 29 October and 16 October at the *M. incognita* and *R. reniformis* sites, respectively. Seed cotton was harvested from entire plots and converted to lint yield by multiplying by 0.40. Nematode samples were collected within two weeks of harvest and processed as previously described.

Analysis of variance and, where appropriate, linear regression were performed on the factorial treatments (those treated with 1,3-D). Dunnet's test comparing all treatments against the control was used to evaluate the effect of 1,3-D treatment. Statistical analysis was done with Minitab version 11.21.

RESULTS

Pretreatment soil population densities of *M. incognita* infective juveniles (J2) were high and ranged from 308-363/100 cm^3 soil among treatments. There were no significant differences in nematode numbers among the plots assigned to different treatments. Thus, variation of pretreatment soil infestation levels was not considered a factor in influencing individual treatment yields. The greatest yield was produced in the 48 kg a.i./ha treatment applied two days before planting and lowest yield was produced in the non-treated control (Table 1). Factorial analysis of the yield data among the 1,3-D treatments alone indicated that effects of treatment date and dosage were not significant ($P > 0.05$) nor did they interact significantly. Therefore an optimal rate × time treatment could not be determined for yield. However, comparison of yield by Dunnet's test indicated that all rates of nematicide increased yield ($P = 0.05$) compared to the non-treated control plots.

All fumigant treatments regardless of rates and timing significantly reduced J2 soil population densities below that recovered from the non-treated control according to Dunnet's test ($P \leq 0.05$). Factorial analyses of the nematode data among the 1,3-D treatments alone did not indicate a significant effect of timing or an interaction, but the dosage effect was significant ($P \leq 0.005$). Linear regression of nematode numbers against fumigant rate for the 1,3-D treatments alone resulted in the equation $y = 245 - 3.85x$ ($r^2 = 0.12$, $P = 0.002$), where y = final nematode population density and x = fumigant rate. The mean numbers of J2/100 cm^3 soil (pooled by date) were 175.4, 138.8, and 52.3, for plots treated with 16, 32, and 48 kg ai./ha, respectively.

Initial population densities of *R. reniformis* were high and population densities were expected to cause damage. Dunnet's comparison of all treatments against the control revealed that all 1,3-D treatments, except 16 kg a.i./ha at 69 DBP, improved

Table 1. Cotton lint yield and post-harvest soil population densities of *Meloidogyne incognita* J2 in soil treated with 1,3-dichloropropene (1,3-D) at varying time intervals prior to planting, 1998.

Treatment kg a.i./ha[z]	Days prior to planting	Lint (kg/ha)	*M. incognita*/100 cm^3 soil
16	2	509	170
16	36	501	182
16	63	498	140
16	92	442	163
32	2	593	250
32	36	467	105
32	63	425	75
32	92	481	125
48	2	614	73
48	36	484	116
48	63	470	15
48	92	561	28
Not treated	—	349	460

[z]1,3-D was applied by single-chisel injection 30 cm below the row middle; Data are averages of six replicates.

yield over the control ($P \leq 0.05$) (Table 2). Factorial analysis of the yield data among the 1,3-D treatments alone revealed effects ($P \leq 0.05$) of both date and dose, with no interaction. Linear regression of cotton yield against fumigant rate for the 1,3-D treatments alone resulted in the equation y = 418 + 1.10x ($r^2 = 0.07$, $P = 0.03$), where y = lint weight (kg/ha) and x = fumigant rate. The difference in yield between the lowest and highest treatment rate was 7% (Table 3). The regression equation for cotton yield per hectare (y) against treatment date (x) was y = 466 - 0.489x ($r^2 = 0.06$, $P = 0.03$). Nevertheless, there was less than 4% variation in yield in all treated plots except those treated 69 days before planting (Table 3).

Dunnet's comparison of all treatments against the control failed to detect significant effects of any treatments on the post-harvest *R. reniformis* populations ($P > 0.05$). Factorial analyses of the nematode data among the 1,3-D treatments alone revealed a significant effect ($P = 0.05$) of time, but not of dose, nor was there an interaction. Linear regression of nematode population density against $\log_n$ application date (to linearize the relationship) for the 1,3-D treatments alone resulted in the equation y = 2171 + 303x ($r^2 = 0.11$, $P = 0.005$), where y = nematodes per 100 cm^3 soil and x = $\log_n$ (treatment date + 1). This trend was due primarily to post-harvest *R. reniformis* population densities that were lower for the 0 DBP treatment compared to the other treatment dates (Table 3).

DISCUSSION

For over two months after planting, the weather was unusually hot and dry at both sites. Thus, cotton yields were lower than normal in these tests. However, data from these two tests indicate that 1,3-D can be applied productively up to three months

Table 2. Cotton lint yield and post-harvest soil population densities of *Rotylenchulus reniformis* in soil treated with 1,3-dichloropropene (1,3-D) at varying time intervals prior to and at planting, 1998.

Treatment kg a.i./ha[z]	Days prior to planting	Lint (kg/ha)	*R. reniformis*/100 cm^3 soil
16	0	447	2 617
16	12	442	2 938
16	37	460	3 540
16	69	362	3 531
32	0	442	1 895
32	12	492	3 237
32	37	472	2 778
32	69	439	2 960
48	0	467	1 404
48	12	470	3 263
48	37	443	3 852
48	69	462	3 636
Not treated	—	353	3 048

[z]1,3-D was applied by single chisel injection 30 cm below the row middle; Data are averages of six replicates.

prior to planting cotton. Early applications and also those closer to planting (0 and 2 DBP) would allow growers more flexibility under conditions which would match farm operation schedules and appropriate moisture conditions. At-planting applications of 1,3-D are not presently labeled for use on cotton and caution is urged because phytotoxicity may occur in heavier soil types or under cooler soil temperatures than were present in these tests (Rich and Kinloch, 2000b).

Table 3. Lint yield and *Rotylenchulus reniformis* post-harvest soil population densities as influenced by date of application and rate of 1,3-dichloropropene in cotton, 1998.

Treatment	Lint (kg/ha)	Nematodes/ 100 cm^3 soil
Days before planting[y]		
69	420	3 431
37	458	3 557
12	469	3 202
0	450	1 972
Rate (kg a.i./ha)		
16 kg	428	3 239
32 kg	462	2 842
48 kg	458	3 040

Post-harvest population reductions of *M. incognita* J2 were found with the 1,3-D treatments. These data are consistent with observations by the present authors in other tests with 1,3-D in Florida (Kinloch and Rich, 1998). Conversely, post-harvest population reductions with 1,3-D treatment are seldom found with *R. reniformis* (Rich and Kinloch, 2000a). This is possibly due to a re-infestation of the fumigant-treated soil because of the high nematode soil population densities usually encountered in cotton fields infested with *R. reniformis*. Earlier soil sampling will be needed to more accurately determine effects of 1,3-D on population densities of this nematode.

The rates of 1,3-D used in these tests were effective and are in line with current recommendations of 32 to 48 kg a.i./ha. Data from these and other tests indicate the acceptability of 16 to 32 kg a.i./ha of 1,3-D to manage *R. reniformis* in Florida and higher rates of 32 to 64 kg a.i./ha to manage damaging populations of *M. incognita* encountered in the state.

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