COMPARATIVE RESPONSES OF COTTON YIELD TO PREPLANT AND AT PLANT APPLICATIONS OF 1,3-DICHLOROPROPENE[††]

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ABSTRACT

Rich, J. R., and R. A. Kinloch. 2000. Comparative responses of cotton yield to preplant and at plant applications of 1,3-dichloropropene. Nematropica 30:223-229.

Four field trials were conducted in northern Florida to determine the feasibility of at plant applications of 1,3-dichloropropene (1,3-D) on cotton compared to the currently recommended preplant applications for management of *Rotylenchulus reniformis*. The 1,3-D was injected 30-cm-deep into a sandy loam soil with a single in-row chisel at rates of 16, 32, and 48 kg a.i./ha 7 to 13 days preplant or at cotton planting. In the absence of damaging initial populations of plant-parasitic nematodes, phytotoxicity in the cotton was not observed in the at plant 1,3-D treatments, and they caused only small reductions in plant stand, plant height, or yield compared with the preplant 1,3-D treatments or untreated controls. In two tests where high initial populations of *R. reniformis* were present, postharvest nematode population densities did not differ among any of the treatments. However, plant stands, heights and yields were increased by all rates and application timing of 1,3-D compared to control plots. Data from these tests indicate that 1,3-D may be applied at planting of cotton resulting in only limited phytotoxicity but producing comparable yields to the standard preplant treatment in *R. reniformis*-infested soil. Further tests are necessary under a wider range of soil types and environmental conditions before this method of application can be widely recommended.

Key words: cotton, 1,3-dichloropropene, *Gossypium hirsutum*, nematicide, reniform nematode, *Rotylenchulus reniformis*, soil fumigation.

RESUMEN

Rich, J. R., and R. A. Kinloch. 2000. Respuesta comparativa del rendimiento del algodón a las aplicaciones preplantío y durante el plantío de 1,3-dicloropropeno. Nematropica 30:223-229.

Cuatro pruebas fueron conducidas en el norte de la Florida, para determinar la factibilidad de las aplicaciones de 1,3-dicloropropeno (1,3-D) en el algodón, en relación a las recomendaciones actuales de aplicación preplantío para el manejo de *Rotylenchulus reniformis*. El 1,3-D, fue inyectado a 30 cm de profundidad en suelo fangoso a: 16, 32 y 48 kg a.i/ha, entre los 7 y 13 días del preplantío o durante el plantío del algodón. En ausencia de poblaciones iniciales de nematodos dañinos parasitadores de plantas, no se observó fitotoxicidad del algodón, en los tratamientos de plantío con 1,3-D. Solamente ocurrieron pequeñas reducciones en la altura, situación o rendimiento de la planta, en comparación con los tratamientos de 1,3-D preplantío o con los controles no tratados. En dos pruebas con altas poblaciones iniciales de *R. reniformis*, las densidades post-cosecha de las poblaciones de nematodos, no difirieron entre ninguno de los tratamientos. Sin embargo, la altura, situación y rendimiento de las

[††]Florida Agricultural Experiment Station Journal Series No. R-06934

plantas, se incrementaron con todos las concentraciones y tiempo de aplicación de 1,3-D, comparado con las parcelas control. Los datos de estas pruebas indican, que el 1,3-D, puede ser aplicado durante el plantío del algodón, resultando solamente en una toxicidad limitad, pero produciendo rendimientos comparables a los tratamientos usuales preplantío, para suelo infestado con *R. reniformis*. Más pruebas, bajo una mayor variedad de tipos de suelo y condiciones ambientales, serán necesarias antes que este método de aplicación pueda ser ampliamente recomendado.

Palabras claves: algodón, 1,3-dicloropropeno, *Gossypium hirsutum*, nematicida, nematodo reniforme, *Rotylenchulus reniformis*, fumigación del suelo.

INTRODUCTION

Cotton (*Gossypium hirsutum* L.) hectarage in northern Florida increased from 12 000 to 40 000 ha from 1987 to 1997 (Anonymous, 1997). Similar increases in cotton hectarage occurred during this period throughout the southeastern states of the U.S.A. Due to low market prices for alternative crops, cotton in this region has been monocultured in many areas resulting in increasing problems with the reniform nematode, *Rotylenchulus reniformis* (Gazaway, 1993). In Florida, the frequency of occurrence of this nematode likely has increased since being first recorded in 16% of Florida cotton fields (Kinloch and Sprenkel, 1994). Since plant resistance to the reniform nematode is currently not available in commercial cotton cultivars, nematicide use has become the only means to manage this pest in continuous cotton production systems. In Florida, a recommended practice is soil fumigation with 1,3-dichloropropene (1,3-D) 7 to 10 days before planting in order to allow for dispersion of the nematicide in soil and to avoid phytotoxicity (Kinloch and Rich, 2000). This delay between soil treatment and planting presents logistical problems for most growers during a normally rainy planting period in North Florida and provides opportunities for soil erosion and weed infestations in prepared fields. The use of 1,3-D in conjunction with the planting operation would allow savings of time and expense, thus resulting in greater use of the nematicide in Florida cotton. Four tests were conducted over 3 years to compare preplant and at plant applications and rates of 1,3-D on cotton phytotoxicity and lint yields.

MATERIALS AND METHODS

Four field trials were conducted on a sandy loam soil (80% sand, 8% silt, 12% clay, pH 6.0-6.2; < 2% O.M.) at the University of Florida, North Florida Research and Education Center, Quincy, Florida. Tests 1 (1996) and 2 (1997) were established following weed fallow in soil with no history of cotton production or presence of *Rotylenchulus reniformis*. These tests were established to measure possible phytotoxicity of 1,3-D as an at plant application. Tests 3 (1997) and 4 (1998) were initiated on sites with a history of cotton production and with known infestations of *R. reniformis* (1 234 and 1 423/100 cm^3 preplant soil, respectively). Soil at all sites was moldboard plowed in late March and double-disked in late April. Pre-plant 1,3-D applications were made with a single in-row chisel to 30-cm-deep on 9 May (Test 1), 6 May (Tests 2 and 3) and 1 May (Test 4). Chisel traces were sealed by pressing the soil surface with a rolling cultipacker. At plant treatments were applied similarly on 22 May in Test 1 and on 13 May in the remaining three tests. Seedbeds of all treatments were tilled to 7-cm-deep to provide uniformity before planting. Cotton cv.

ChemBrand 407 was planted in Test 1 and cv. Delta Pine 5415RR was used in the other three tests. Seed were placed 5 to 8 cm apart on 91-cm-wide centers, and individual plots in all tests were 2 rows wide × 7.6 m long. The experimental design was a randomized complete block with 6 replications in Tests 1, 2, and 4, and 12 replications in Test 3. Cotton was maintained according to standard recommended growing practices (Sprenkel, 1995). Tests 1, 2, and 4 were not irrigated, while Test 3 was irrigated as needed over the season.

Plants were monitored for phytotoxicity after emergence, and plant stands were recorded from 1.0 linear m of each plot row on 1 July (Test 1), 16 July (Tests 2 and 3), and 31 July (Test 4). Plant heights were measured on the same dates from 10 randomly selected plants in each plot. Cotton yields were not measured in Test 1. The other tests were mechanically harvested on 2 December (Tests 2 and 3) and 16 October (Test 4). Seed cotton yield was converted to lint yield by multiplying by a factor of 0.35. Soil samples for nematode assay were collected within two weeks after cotton harvest. Six soil cores (2.5-cm-diam., 25-cm-deep) were removed from each plot and composited. A 100 cm^3 subsample was processed with a modified centrifugation-sugar flotation method (Jenkins, 1964), and reniform nematodes were counted.

Data were analysed by standard analysis of variance procedures and means separated by the least significant difference test ($P \leq 0.05$).

RESULTS

Test 1: No visual phytotoxicity or plant stand reductions were observed in the at plant 1,3-D applications compared to the preplant 1,3-D treatments or the control (Table 1). Plant height was only reduced ($P \leq 0.05$) in the 48 kg a.i./ha 1,3-D at plant treatment compared to the same preplant rate. Postharvest plant-parasitic nematode population densities were very low and not included in these data.

Table 1. Plant stand and height of cotton cv. Chembrand 407 grown in soil fumigated with preplant (PP) and at plant (AP) applications of 1,3-dichloropropene in north Florida (Test 1—1996).

Timing and kg a.i./ha	No. plants in 1.0 m row[z]	Mean height (cm) 10 plants[z]
PP 16	12.8	28.9
PP 32	11.5	27.9
PP 48	12.8	29.7
AP 16	12.3	28.7
AP 32	11.3	27.2
AP 48	11.7	26.2
Control	12.8	26.9
LSD ($P \leq 0.05$)	1.9	2.3

[z]Data were collected 41 days after planting and are means of 6 replications.

Test 2: Phytotoxicity to cotton was not observed among any of the 1,3-D treatments. With the exception of one preplant 1,3-D treatment (16 kg a.i./ha) plant stand counts in the remaining chemical treatments did not differ ($P \leq 0.05$) from each other or the control (Table 2). No differences in plant heights or cotton lint yields were observed among 1,3-D treatments or the control. Postharvest plant-parasitic nematode populations were very low and not included in these data.

Test 3: Phytotoxicity was not observed in any of the 1,3-D treatments, and plant stand did not differ among treatments (Table 3). Plant heights were increased ($P \leq 0.05$) by all 1,3-D treatments compared to the control. Plants in plots treated with 1,3-D preplant at 16 kg a.i./ha were taller than those in the two at plant 1,3-D treatments. Cotton lint yields were higher ($P \leq 0.05$) in all the 1,3-D treatments compared

Table 2. Plant stand, height and yield of cotton cv. Delta Pine 5415RR grown in soil fumigated with preplant (PP) and at plant (AP) applications of 1,3-dichloropropene in north Florida (Test 2-1997).

Timing and kg a.i./ha	No. plants in 1.0 m row[z]	Mean height (cm) 10 plants[z]	Lint yield in kg/ha
PP 16	11.6	85.5	596
PP 32	10.6	87.3	636
PP 48	10.9	85.2	663
AP 16	10.3	85.5	591
AP 32	10.1	84.8	614
AP 48	10.2	82.3	583
Control	10.5	83.2	589
LSD ($P \leq 0.05$)	1.3	5.3	78

[z]Plant stand counts and heights were taken 63 days after planting and are means of 6 replications.

to the control. Comparable rates of 1,3-D at plant or preplant resulted in similar lint yields. Postharvest population densities of *R. reniformis* were not different among 1,3-D treatments or the control.

Test 4: As in the previous three tests, phytotoxicity was not observed in any treatment. Plant stands were greater ($P \leq 0.05$) in five of the six 1,3-D treatments compared to the control, while plant heights in four of the 1,3-D treatments were greater than the control (Table 4). The preplant application of 1,3-D at 32 kg a.i./ha resulted in a higher yield ($P \leq 0.05$) than the at plant application of the same rate, but no other differences in yield were found among 1,3-D treatments and rates. Postharvest *R. reniformis* population densities were lower ($P \leq 0.05$) in the at plant treatment of 48 kg a.i./ha 1,3-D compared to the control and the three preplant treatments.

Comparisons of preplant and at plant

Table 3. Plant stand, height, and yield of cotton cv. Delta Pine 5415RR and post-harvest population densities of *Rotylenchulus reniformis* in soil fumigated with preplant (PP) and at plant (AP) applications of 1,3-dichloropropene in north Florida (Test 3 -1997).

Timing and kg a.i./ha	No. plants in 1.0 m row[z]	Mean height (cm) 10 plants[z]	Lint yield kg/ha	*R. reniformis*/ 100 cm^3 soil
PP 16	14.9	82.0	1 137	2 963
PP 32	14.8	81.0	1 103	3 419
AP 16	14.4	75.8	1 112	3 224
AP 32	14.3	75.4	1 093	3 524
Control	14.0	61.0	895	3 366
LSD ($P \leq 0.05$)	2.0	5.6	128	1 349

[z]Plant stand and height were measured 63 days after planting and are means of 12 replications.

Table 4. Plant stand, height, and yield of cotton Delta Pine 5415RR and post-harvest population densities of *Rotylenchulus reniformis* in soil fumigated with preplant (PP) and at plant (AP) applications of 1,3-D in north Florida (Test 4 -1998).

Timing and kg a.i./ha	No. plants in 1.0 m row[z]	Mean height (cm) 10 plants[z]	Lint yield kg/ha	*R. reniformis* /100 cm^3 soil
PP 16	11.6	59.8	442	2 938
PP 32	11.9	60.6	492	3 237
PP 48	11.4	61.2	470	3 263
AP 16	11.7	57.1	447	2 617
AP 32	9.2	62.2	442	1 895
AP 48	12.2	64.8	467	1 404
Control	10.0	56.3	353	3 048
LSD (P ≤ 0.05)	1.4	4.5	46	1 267

[z]Plant stand and height were measured 78 days after planting and are means of 6 replications.

applications were made across rates of 1,3-D used in these tests (Table 5). Plant stand was reduced ($P \leq 0.05$) by the at plant treatments in three of the four tests. Similarly, plant heights were reduced by at plant treatment in two of the four trials. Cotton lint yields in the 1,3-D at plant treatments were not reduced from those of the preplant treatments. Postharvest *R. reniformis* population densities were reduced ($P \leq 0.05$) by at plant applications of 1,3-D in one of the two tests where populations were measured.

DISCUSSION

In the two tests where initial population densities of plant-parasitic nematodes were low, the at plant applications of 1,3-D did not result in visual phytotoxicity, reduction in plant stand, plant height or yield over the control. In the absence of nematodes as a compounding factor, these data indicated the feasibility of at plant treatment with 1,3-D in cotton. Results from Tests 3 and 4 confirmed this observation where population densities of *R. reniformis* were high and showed that at plant treatment with 1,3-D was comparable to standard preplant applications to increase cotton yield. The major cotton yield differences among these tests are attributed to presence or absence of damaging *R. reniformis* population densities rather than to effects of timing of the 1,3-D application.

Regardless of application timing, the 16 to 48 kg a.i./ha rates of 1,3-D improved cotton lint yield over the controls. These rates were found effective to increase cotton yield in *R. reniformis*-infested soil in Florida (Rich and Kinloch, 2000) and are similar to those recommended for control of this nematode in Georgia and South Carolina (Baird, 1997; Mueller, 1994). Cotton lint yield varied little among 1,3-D treatment rates, indicating that the lowest rate tested (16 kg a.i./ha) adequately managed early season population densities of *R. reniformis* encountered in these tests (Rich and Kinloch, 2000). These data are unlike the continuous yield increases obtained with increasing rates of 1,3-D from 0 to 64 kg a.i./ha in tests to manage *Meloidogyne incognita* in Florida cotton fields (Kinloch and Rich, 1998).

Table 5. Comparison of preplant (PP) and at plant (AP) soil applications of 1,3-dichloropropene on cotton growth and postharvest soil population densities of *Rotylenchulus reniformis* in combined evaluations in north Florida.[yz]

Treatment timing	No. plants in 1.0 m row	Mean height (cm) 10 plants	Lint yield in kg/ha	*R. reniformis* /100 cm^3 soil
		Test 1		
PP	12.4*	28.8*	—	—
AP	11.8	27.4	—	—
		Test 2		
PP	11.0*	86.0	632	—
AP	10.1	84.2	596	—
		Test 3		
PP	14.9	81.5*	1 120	3 191
AP	14.4	75.6	1 103	3 445
		Test 4		
PP	11.6*	60.5	468	3 146*
AP	10.8	61.4	452	1 972

[y]Data are averages of 6 replications in Tests 1, 2, and 4 and 12 replications in Test 3.
[z]Mean comparisons are from across 1,3-D treatments of 16, 32, and 48 kg a.i./ha.
*Represents significant reduction (t-test) across treatments within each test at $P \leq 0.05$.

Data from present tests indicate the possibility of applying 1,3-D in conjunction with the cotton planting operation. This approach could reduce separate trips across fields and allow fewer delays in planting due to adverse weather conditions. However, these tests were conducted under optimal conditions in sandy loam soil that provided rapid 1,3-D dissipation and cotton seedling emergence. Under less favorable environmental conditions such as cool, wet soils or heavier soil types, results of at plant application could be more adverse through slower fumigant dispersion (Lembright, 1990) and delayed seed germination. At plant treatments are not currently labeled for use in the U.S.A., and growers should await proper labeling of the 1,3-D (Telone II). Even then, they should initially treat and plant only a few hectares to determine any phytotoxicity from at plant 1,3-D application and to determine suitability of this practice in their cotton production systems.

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Received: *8.VIII.2000*

Recibido:

Accepted for publication: *12.IX.2000*

Aceptado para publicación:

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