(Terr-O-Cide 72-27) para combatir *Meloidogyne arenaria, M. hapla,* y la raza tres de *Heterodera glycines* fue comparada con la de DBCP en soya. Resultados de experimentos de campo en tres localidades de Alabama demostraron que las dos preparaciones de BDE fueron tan efectivas como DBCP en el combate de los parásitos y en ragg y Ransom. No se observaron efectos fitotóxicos como resultado de la inyección en la siembra de las dos preparaciones de BDE a niveles de 37.41 o menos L/ha. *Claves: nematodos noduladores y de quiste de la soya, Glycine max, hidrocarburos halogenados.*

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EFFICACY OF PLANTING-TIME APPLICATIONS OF 1,3-DICHLOROPROPENE FOR CONTROL OF NEMATODES ON SOYBEANS [EFECTIVIDAD DE TRATAMIENTOS DURANTE LA SIEMBRA CON 1,3-DICLOROPROPENO PARA EL COMBATE DE NEMATODOS EN SOYA]

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Accepted:
26.II.1979
Aceptado:

ABSTRACT

Two formulations (DD® and Telone II®) of 1,3-dichloropropene were applied at planting time to soybeans *(Glycine max* (L.) Merr.) to determine their efficacy in controlling root knot and cyst nematodes and the tolerance of the crop to the fumigant. Applications of the two formulations at rates of 18.7 to 84.2 L/ha were not phytotoxic to soybeans. DD or Telone II were not as effective for degree of nematode control or in yield response as the standard treatment of DBCP 86 EC (1,2-dibromo-3-chloropropane) at 9.4 L/ha.
Key Words: chemical control, methods of application, halogenated hydrocarbons, Heterodera glycines, Meloidogyne arenaria.

INTRODUCTION

Mixtures of dichloropropane and dichloropropene are among the oldest fumigant nematicides available for field use (3,8). The nematicidal activity of these mixtures was shown very early to depend on their content of 1,3-dichloropropene (2). Because of high phytotoxicity field use of 1,3-dichloropropene has been limited to preplant applications or to orchards during dormancy (13). The fumigant has been particularly useful for control of nematodes in crops such as potatoes or sweet potatoes that cannot tolerate brominated hydrocarbons (13). Development of DBCP, a more efficient fumigant nematicide than 1,3-dichloropropene (6), virtually stopped all studies on the use of 1,3-dichloropropene on row crops. The low cost of commercial formulations of DBCP promoted its use on low cash crops such as soybeans on which it became the standard nematicide. Recent actions by the U.S. Environmental Protection Agency and the consequent decisions by producers to stop manufacturing DBCP have virtually eliminated use of this nematicide from soybeans and other crops. Although other nonfumigant compounds have been reported effective for control of plant parasitic nematodes in soybeans (5,7,11) their use has been limited because of the high cost of nematicidal dosages or because they are not as effective as halogenated hydrocarbons. Since 1,3-dichloropropene is relatively inexpensive we thought that it could be used as a substitute for DBCP on soybeans. This article presents results on planting time use of commercial formulations of 1,3-dicholoropropene for control of typical parasitic nematodes on soybeans in Alabama.

MATERIALS AND METHODS

Formulations of 1,3-dichloropropene used in the tests were DD® (1,3-dichloropropene plus 1,3-dichloropropane) and Telone II® (1,3-dichloropropene) which contain 55 and 92% (w/w) of the compound, respectively; DBCP was applied as the Fumazone® 86 EC formulation. All fumigants were injected at planting using two chisels per row set to penetrate to a depth of 20 cms and separated 30 cms apart. DBCP applied at 9.4 L/ha was included in every test for comparative purposes.

Soil samples for nematode extraction were collected in the first week of September to coincide with maximal population development (4). A total of 20 2.5-cm diam soil cores were taken from every plot from the root zone to a depth of 15 to 20 cms using a standard soil probe. The cores from each plot were composited and a 50 cm^3 subsample was taken from each sample from the cyst nematode test to extract cysts using a semiautomatic elutriator (1). To extract the cysts the elutriator was allowed to function for five min with air bubbling through the cones, the overflow was passed through a single 180 micron stainless steel sieve to collect the cysts. All material in the sieve was washed into a standard Petri dish and the number of whole pale yellow to golden cysts was determined by observation with a stereoscope.

The general appearance of plots was assessed during the fourth week of July using a subjective scale where a value of one represented plots with stunted, chlorotic plants and a value of five corresponded to plots with healthy green plants with excellent growth and 0.9 to 1.2 meters tall. Yield was obtained from the entire plot at maturity of the beans.

Two experiments were established in Baldwin county in southern Alabama. At the Gulf Coast substation near Fairhope a test was conducted in a field with a Norfolk sandy loam heavily infested with *Meloidogyne arenaria* (Neal) Chitwood as the principal parasite and *Helicotylenchus dihystera* (Cobb) Sher and *Trichodorus christiei* Allen in lesser numbers. DD and Telone II were applied at rates of 0, 18.7, 28.0, 37.4, 46.8, 56.1,

and 84.2 L/ha. The field was planted with Bragg soybeans immediately after treatment on May 25, 1978.

The second test was established in a field with a Dothan loamy sand heavily infested with race 3 of the soybean cyst nematode *(Heterodera glycines* Ichinohe) and smaller numbers of *M. arenaria, H. dihystera,* and *T. christiei.* The field was located in the vicinity of Summerdale at the Engel farm. Telone II and DD were applied at the same rates as for the Fairhope test except that the 84.2 L/ha treatment was omitted and a 65.5-L rate was added. The field was planted with Ransom soybeans immediately after treatment on May 26, 1978.

Plots in each experiment were two-row-(96 cms)-wide and six meters long. Each treatment was represented by eight plots (replications) arranged in a randomized complete block design.

All data were statistically analyzed following standard procedures for analyses of variance (12). Values for the least significant difference were also calculated by standard procedures. Unless otherwise stated all differences mentioned in the text were significant at a probability level of 5% or lower.

RESULTS AND DISCUSSION

DD, Telone II, or DBCP did not affect numbers of *T. christiei* at the Fairhope test (Table 1). Numbers of *H. dihystera* were significantly reduced only by the DBCP treatment and by the 84.2 L rate of the other two fumigants. Larvae of *M. arenaria* were significantly lower than those in control plots only with the 84.2 L treatment of Telone II. However, at the 10% level of probability (LSD : 37) DD treatments of 56.1 and 84.2 L/ha also significantly reduced numbers of the larvae. These results indicate that both dichloropropene formulations are not sufficiently effective to lower populations of plant parasitic nematodes to significant levels with an economically acceptable dosage of the fumigant (18.7-37.4 L/ha). Results also suggest that Telone II may be somewhat more effective than DD in controlling *M. arenaria* which may be expected because of its greater concentration of dichloropropene. DD and Telone II gave significant yield responses for rates of 37.4 L/ha or higher. The 28.0-L rate of Telone II and the DBCP treatment also resulted in significantly higher yields than the control. Yield responses equivalent to that from the DBCP treatment were obtained with DD and Telone II at rates of 56.1 and 84.1 L/ha; other DD or Telone II treatments resulted in significantly lower yields than those from DBCP-treated plots. The only treatment resulting in statistically higher yields than that from DBCP application was 84.2 L/ha of DD.

The three fumigants did not affect population levels of *T. christiei* and *H. dihystera* in the Summerdale test, (Table 2) nor did they reduce larval populations of *M. arenaria* or *H. glycines* or the number of yellow *H. glycines* cysts in the soil. Numbers of *H. glycines* larvae in plots treated with the 18.7, 28.0, and 65.5 L rates of DD or the 18.7 and 28.0 L rates of Telone II were higher than in control plots. The 65.5 L rate of DD or Telone II and the 28.0 L rate of Telone II resulted in higher numbers of yellow cysts than the control. Subjective appearance of soybeans was improved in all plots that received DD at rates of 37.4 L or greater and for Telone II at rates of 28.0 L/ha or greater. DD or Telone II at 46.8 and 65.5 L/ha resulted in improved appearance over that obtained with DBCP treatments. Yield was significantly increased in only the plots that received the 65.5 L rate of Telone II. These results suggest that DD or Telone II did not reduce initial populations of the nematodes to levels sufficiently low to avoid development of damaging populations later in the season. This is supported by the fact that early improvement in plant appearance that probably resulted from early season control did not develop into positive yield responses. Higher numbers of larvae and

Table 1. Effect of planting time applications of two formulations of 1,3-dichloropropene (DD® and Telone® II) on nematode control and yield of Bragg soybeans in a field at Fairhope, Ala., heavily infested with *Meloidogyne arenaria* and other plant parasitic nematodes.

Treatment	Liters per hectare	Nematodes per 50 cm³ soil *M. arenaria* larvae	*Helicotylenchus dihystera*	*Trichodorus christiei*	Yield (Kgs/ha)
Control		104	39	5	779
DD	18.7	110	28	4	929
DD	28.0	77	32	8	929
DD	37.4	100	27	8	1068
DD	46.8	85	32	5	1136
DD	56.1	66	27	7	1256
DD	84.2	66	16	7	1631
Telone II	18.7	84	22	7	836
Telone II	28.0	88	34	9	1025
Telone II	37.4	69	32	8	1010
Telone II	46.8	87	27	4	1052
Telone II	56.1	99	39	6	1507
Telone II	84.2	31	17	8	1484
DBCP 86 EC	9.4	78	17	6	1411
	LSD (P:0.05):	43	15	4	212
	LSD (P:0.01):	57	21	5	281

*Figures for each variable are averages of eight plot replications.

Table 2. Effects of planting time applications of two formulations of 1,3-dichloropropene (DD® and Telone® II) on nematode control plant appearance, and yield of Ransom soybeans, in a field in the vicinity of Summerdale, Ala., infested with race 3 of *Heterodera glycines, Meloidogyne arenaria,* and other plant parasitic nematodes.

Treatment	Liters per hectare	Nematodes per 50 cm³ of soil					Plant** Appearance	Yield (Kgs/ha
		yellow cysts	*H. glycines* larvae	*M. arenaria* larvae	*Helicotylenchus dihysteria*	*Trichodorus christiei*		
Control		18	7	37	23	15	2.68	656
DD	18.7	25	13	44	17	16	2.87	694
DD	28.0	19	16	32	22	14	2.93	771
DD	37.4	21	16	27	24	14	3.50	848
DD	46.8	22	10	15	12	9	3.62	809
DD	56.1	22	17	33	15	18	3.50	925
DD	65.5	30	16	13	12	14	3.62	847
Telone II	18.7	26	18	31	18	11	3.00	809
Telone II	28.0	28	17	12	21	13	3.31	771
Telone II	37.4	21	13	33	23	15	3.56	732
Telone II	46.8	20	10	64	22	20	3.62	694
Telone II	56.1	20	12	19	12	15	3.43	848
Telone II	65.5	33	12	18	16	13	3.87	1079
DBCP 86 EC	9.4	23	12	18	15	19	3.12	847
LSD (P:0.05):		10	9	29	13	9	0.47	273
LSD (P:0.01):		13	12	39	17	12	0.63	364

*Figures for variables are average of eight plot replications.
**Appearance based on an index scale where 1 represented plots with very poor plant growth and 5 excellent plant growth.

cysts of *H. glycines* in some chemical treatments than in controls are interpreted as a being a consequence of greater destruction of root systems in control plots than in treated plots thus reducing feeding sites and reproduction.

These results differ with those obtained by the authors with ethylene dibromide applied to the same soybean cultivars under similar conditions in the same fields (9). Ethylene dibromide was equal or superior to DBCP for control of *M. arenaria* or *H. glycines* and yield responses.

The data obtained generally corroborate earlier information on preplant use of DD on other crops in which DD was found to be 8 to 16 times less effective than DBCP (6). Our results indicate that soybeans tolerate high dosages of 1,3-dicholoropropene applied at planting time. No lasting phytotoxic effect from the use of the fumigant was detected. It is possible that with better formulations and methods of application the effectiveness of 1,3-dichloropropene could be improved to a degree where its use could be economical.

RESUMEN

Dos preparaciones de 1,3-dicloropropeno (DD® y Telone II®) se inyectaron durante la siembra para determinar la eficacia del fumigante en el combate de los nematodos de quiste de la soya y noduladores así como la tolerancia de la soya *(Glycine max* (L.) Merr.) al dicloropropeno. Tratamientos con las dos preparaciones a concentraciones de 18.7 a 84.2 L/ha no fueron fitotóxicos para la soya. DD o Telone II no fueron tan efectivos para el combate de nematodos o en el rendimiento de la soya como el tratamiento usual de DBCP 86 EC (1,2-dibromo-3-cloropropano) a 9.4 L/ha.
Claves: combate de nematodos, métodos de aplicación, hidrocarburos halogenados, Heterodera glycines, Meloidogyne arenaria.

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