The Movement of 2,4-dichlorophenyl methanesulfonate ^{35}S in Plants

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Abstract: Movement of 2,4-dichlorophenyl methanesulfonate ^{35}S in plant roots was investigated using plastic containers which physically isolated portions of the plant root system. Results with bean and cotton plants showed that this compound can be absorbed in one part of the root system and distributed to other parts of the root system and also to the top of the plant. These tests confirm field observations of nematode control on roots outside a treated zone which indicated lateral movement of this compound in the roots. There was no evidence of its downward movement from treated leaves to stems or roots of cotton or beans. *Key Words:* 2,4-dichlorophenyl methanesulfonate, Systemic movement, Bean, Cotton.

The chemical, 2,4-dichlorophenyl methanesulfonate (Shell SD 7727) has been reported as a persistent, non-volatile nematicide, effective primarily against the root knot nematode, *Meloidogyne incognita* (Kofoid and White) Chitwood (2). Field tests have shown a carryover control of the root knot nematode for more than one season. The material is effective when applied to the soil surface either as a spray or as granules with incorporation, or in irrigation water by either flooding or sprinkling. Observations in the field have indicated the possibility of absorption and movement of this compound throughout the plant's root system. The investigations reported here summarize studies with ^{35}S-labeled 2,4-dichlorophenyl methanesulfonate showing the movement of this compound within bean and cotton plants.

MATERIALS AND METHODS

Labeled 2,4-dichlorophenyl methanesulfonate was synthesized from commercially available methanesulfonyl chloride ^{35}S reacted with 2,4-dichlorophenol in the presence of alkali (1). The crude product was isolated by solvent extraction and purified by recrystallization. The product, having a specific activity of 17.3 μc/mg, was characterized by gas liquid chromatography, thin-layer chromatography, infrared spectrophotometry and nuclear magnetic resonance analysis, as 2,4-dichlorophenyl methanesulfonate, having a chemical and radiochemical purity of greater than 99.5%.

A plastic side-arm flask was designed and fabricated to test the movement of this nematicide from one portion of a plant's root system to another (Fig. 1). The distal part of the plant's main root system was isolated in the side-arm and sealed from the main container with an eicosane dam. Eicosane, a non-phytotoxic inert n-C_{20} hydrocarbon (m.p. 38 C), readily available from most chemical supply companies, was found to be an ideal material to seal portions of plant root systems in different containers. A 1, 10 or 100 ppm aqueous solution of the ^{35}S-labeled compound was placed in the main container of the apparatus and water in the side-arm. There was no possibility of contaminating the untreated roots in the side-arm since the liquid in the flask was kept well below the outlet to the side-arm. After 7 days these plants were carefully removed and the separate portions of the root system rinsed with water. These plants were either placed on film for radioautograms or thoroughly ground, extracted with methylene chloride and the amount of 2,4-dichloro-

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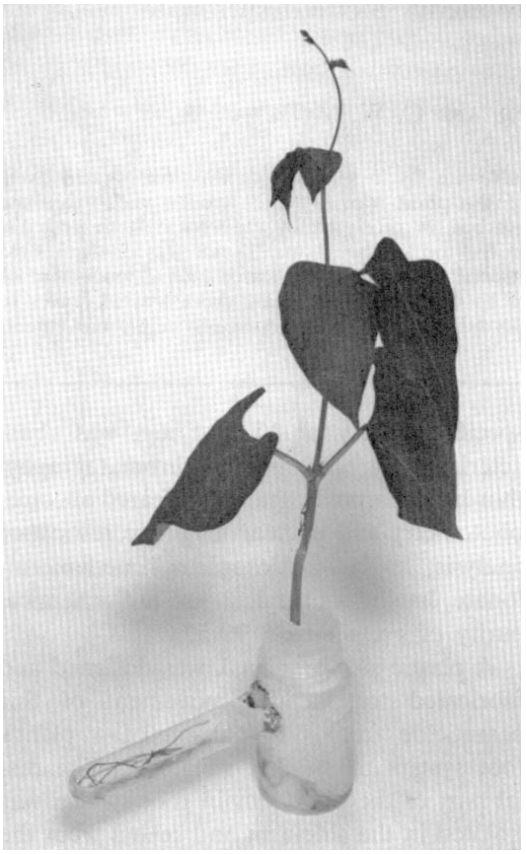

FIG. 1. Plastic side-arm flask for testing the movement of 2,4-dichlorophenyl methanesulfonate ^{35}S in root systems of plants.

phenyl methanesulfonate ^{35}S equivalents quantitated by conventional liquid scintillation counting procedures (3).

RESULTS

The amounts of ^{35}S equivalents in the root systems of bean plants which had been treated in these side-arm flasks for 7 days are given in Table 1.

These data show that this compound is translocated downward in the main portion of the root system where a certain amount of the material is exosmosed into the surrounding medium. The distal movement of this nematicide is clearly illustrated in the radioautogram (Fig. 2A, B). Likewise bean plants grown in soil treated with SD 7727 ^{35}S with a portion of the root system in a second pot containing untreated soil and isolated by an eicosane dam have shown a similar migration into the outer roots.

To make sure the downward movement of 2,4-dichlorophenyl methanesulfonate was not peculiar to bean plants, cotton plants were used in a similar series of experiments. At the end of 9 days the root systems and the solutions around them were analysed. These results are shown in Table 2.

These data likewise show a distal movement of 2,4-dichlorophenyl methanesulfonate ^{35}S in cotton roots and an exosmosis of the compound from these roots into the surrounding medium.

To establish the identity of the radiolabeled compound recovered from root extracts of treated plants aliquots were chromatographed and co-chromatographed with unlabeled 2,4-dichlorophenyl methanesulfonate in TLC systems. Since the translocated substance recovered from treated plants had the same R_f value when chromatographed separately or together with authentic SD 7727, it was considered to be the same compound.

In contrast to this ready movement in the roots and from the roots into the tops of the plants, topical applications of this compound on the leaves remained fixed. An application of 1 ml of a 500 μg/ml aqueous solution containing 5% isopropanol was painted on one of the cotylendonary leaves of a

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FIG. 2. Movement of 2,4-dichlorophenyl methanesulfonate ^{35}S (SD 7727) ^{35}S in plants. **A** and **B**. photograph and radioautograph of a bean plant showing upward and downward (root below arrow) movement of SD 7727 ^{35}S; **C** and **D**. photograph and radioautograph of a cotton plant showing no movement of SD 7727 ^{35}S from the treated leaf.

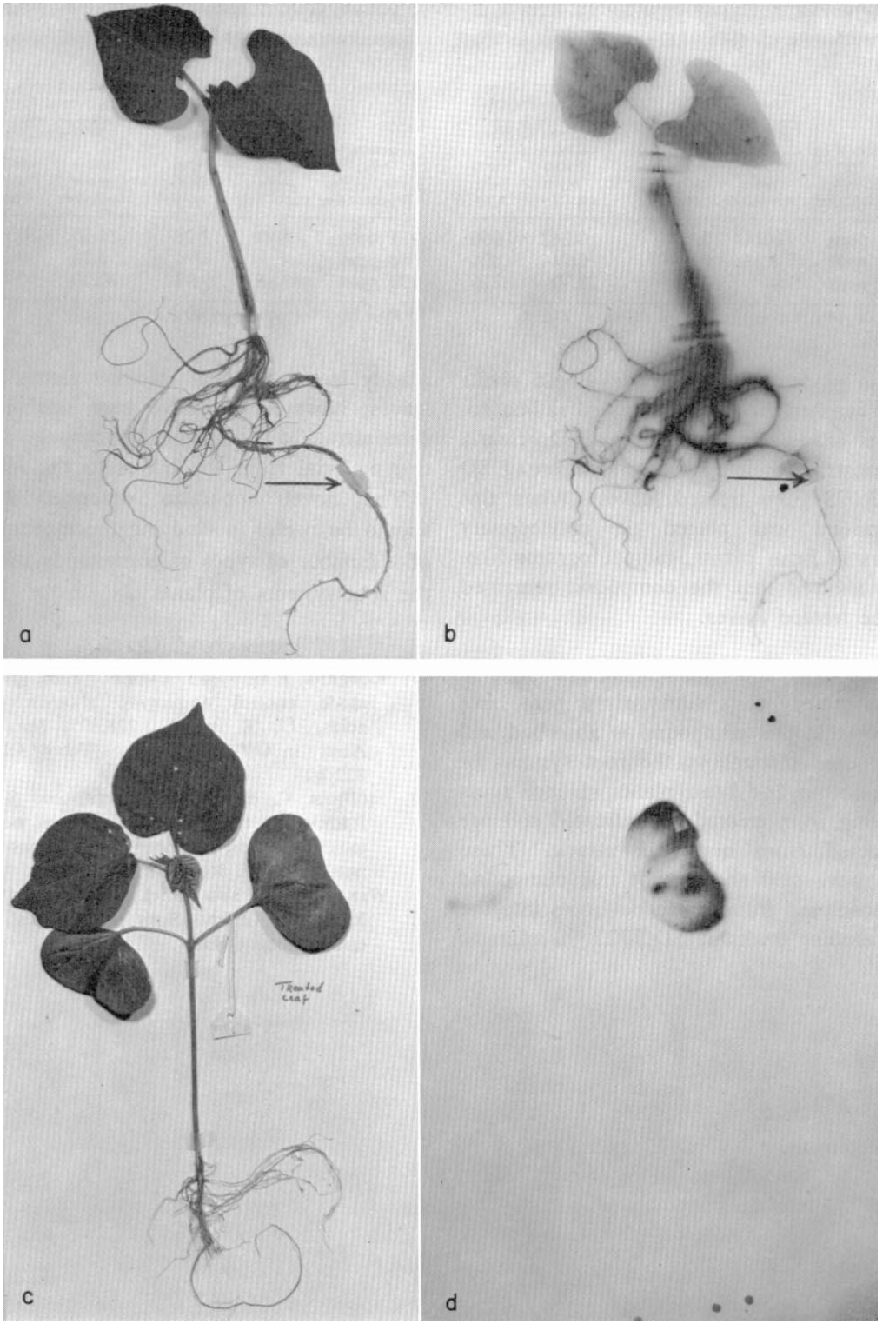
a
b
Treated leaf
c
d

TABLE 1. Movement of 2,4-dichlorophenyl methanesulfonate ^{35}S (SD 7727) equivalents in bean plants after 7 days exposure at 24 C.

Concentration of SD 7727 ^{35}S placed in the main container	Amount of SD 7727 ^{35}S recovered (ppm)			
	In the root tissue		In the solutions	
	From main container	From side-arm	From main container	From side-arm
1 ppm	0.144	0.177	0.262	0.050
10 ppm	4.23	0.325	0.744	0.024
100 ppm	–	–[a]	29.79	1.276

[a] Plant used for autoradiogram shown in Fig. 2.

TABLE 2. Movement of 2,4-dichlorophenyl methanesulfonate ^{35}S (SD 7727) equivalents in cotton plants after nine days exposure at 24 C.

Concentration of SD 7727 ^{35}S placed in the main container	Amount of SD 7727 ^{35}S recovered (ppm)			
	In the root tissue		In the solutions	
	From main container	From side-arm	From main container	From side-arm
1 ppm	6.01	2.25	1.20	0.32
10 ppm	–	–[a]	2.75	0.06
100 ppm	43.68	9.03	20.20	0.14

[a] Plant used for radioautogram.

cotton plant. After one week these plants were washed from the pots and radioautograms made. Figures 2C and D, clearly demonstrate there was no migration of SD 7727 ^{35}S from treated leaves. When this compound was placed on cotyledonary leaves of bean plants, radioautograms likewise showed that the compound remained in the treated leaves.

DISCUSSION

Laboratory tests summarized here have shown that this compound is absorbed and distributed throughout the root systems of both cotton and bean plants. Hence roots growing from treated to untreated soil are protected from nematode attack. These tests have also shown that this compound is exosmosed from the feeder roots into the surrounding medium. SD 7727 ^{35}S migrates readily from the roots into the stems and leaves; however, we have been unable to demonstrate any downward movement of this material from the leaves to the roots.

The novel apparatus described here should be useful in studying the movement of a number of types of compounds within the root systems of plants.

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