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Fate and Interconversion of α-, β-, γ-, and δ-HCH on Gram (*Cicer arietinum* Linn.) Plants under Subtropical Field Conditions at Ludhiana, India

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Technical HCH (1,2,3,4,5,6-hexachlorocyclohexane) an organochlorine insecticide commonly known as BHC, is chiefly a mixture of α-(55 to 70%), β-(5 to 14%), γ-(10 to 18%) and δ-(6 to 8 %) steroisomers (Brooks, 1974). Due to its highly persistent nature, the use of technical HCH has been restricted or replaced with lindane (purified γ-HCH) in most of the developed countries. However, large amounts of technical HCH are still used in several Third World nations because of its low cost (FAO, 1990). Various studies conducted in different parts of the world reveal that the major problems of environmental contamination and human exposure from the use of technical HCH arise from its non-insecticidal α-, β- and δ-isomers, while the insecticidal γ-isomer does not seem to constitute any hazard (Kalra and Chawla, 1985; Mehrotra, 1986; Biegel, 1988).

Some reports have suggested that the interconversion of various HCH isomers, as observed in aquatic sediments (Newland et al., 1969; Benzet and Matsumura, 1973) and grass samples (Steinwandter, 1976 and 1978; Steinwandter and Schlutor, 1978) under laboratory conditions, might be contributing to be preponderance of β- and δ-HCH in the substrates treated with technical HCH. As these isomers possess significant chronic mammalian toxicity but serve no function in terms of pest control, the possibility of interconversion of HCH isomers is quite important from the standpoint of environmental toxicology (Deo et al., 1982; Biegel, 1988). Various supervised trials have shown that the crops treated with technical HCH are contaminated with excessive residues of β- and δ-isomers (Kalra and Chawla, 1985; Mehrotra, 1986). Thus, there is a need to ascertain whether the high proportion of β- and δ-isomers in harvest time residues in crops treated with technical HCH is due to their high persistence or because of their formation from α- and γ-

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isomers present in the technical HCH. The present investigations were, therefore, conducted to study the fate of various HCH isomers on gram, a major pulse crop, under the sub-tropical field conditions at Ludhiana, India by treating it with individual HCH isomers separately.

MATERIALS AND METHODS

α-, β-, γ- and δ-HCH used in this study were of greater than 98, 99, 99 and 95 % purity, respectively and were obtained from Environmental Protection Agency, Research Triangle Park, North Carolina, USA. One hundred and thirty mg of each compound were dissolved separately in 5 ml. xylene and, after adding 2 ml of Triton X--100 (Romali, Bombay, India) as emulsifier to each solution, the volumes were made to 100 ml. with distilled water to obtain aqueous emulsions of 0.13% concentration. Using a kitchen garden sprayer, the emulsions thus obtained were sprayed up to the point of run off on gram crop (Cicer arietinum Linn., variety GL 769) raised in four plots measuring 2 x 2 m each. In addition, gram crop sown in a similar manner was treated with emulsion prepared only from xylene and emulsifer to serve as control. All the treatments were carried out in duplicate and gram leaves were collected 0(2 hours), 7, 21 and 35 days after the application of these chemicals.

HCH residues were extracted from the gram leaves collected at various intervals with acetonitrile, partitioned into n-hexane, cleaned up by treatment with concentrated sulfuric acid and estimated on GLC using electron capture detector (Singh and Chawla, 1982). The identity of the residues was confirmed by micro-alkali derivatization (EPA, 1980). The recoveries determined by fortifying the gram leaves with different HCH isomers at 0.2 and 1 mg/kg ranged from 85.5 to 94.6% and the residues values have not been corrected for recovery. The suitability of all the solvents and reagents for residue analysis was ensured by conducting the reagent blanks.

RESULTS AND DISCUSSION

The residues of α-, β-, γ- and δ-HCH in the samples of gram leaves from the control treatments were below the limit of detection (0.01 mg/kg) throughout the study. In each treatment with a HCH isomer, levels of isomers other than that applied were also below the limit of detection at all the sampling intervals, thus indicating no interconversion of these compounds.

The mean initial deposits of α-, β-, γ- and δ-isomers on gram plants were 16.9, 38.0, 12.4 and 19.2 mg/kg of which about 99, 22, 97 and 83 per cent, respectively, dissipated in 7 days (Table 1). At the end of 35 days the residues of α- and γ-isomers were almost non-detect

able, while those of β- and δ-HCH were stil present in significant amounts. The rapid loss of α- and γ-HCH is attributed to their volatilization due to high vapour pressure. The findings are in agreement with those of Selenka (1982), who also reported that α- and γ-isomers are readily given up to the atmosphere from contaminated surfaces where β- and δ-HCH tends to persist. A similar trend was also indicated in a report on the fate of individual HCH isomers on rice plants (Anonymous, 1986).

Table 1. Residues (mg/kg) of different HCH isomers on gram plants treated separately with these compounds

Days after treatment	Treatment/residues*			
	α-HCH	β-HCH	γ-HCH	δ- HCH
0(2 hours)	16.91	38.00	12.40	19.20
7	0.21	29.52	0.43	3.24
	(98.80)	(22.40)	(96.50)	(83.10)
21	0.19	10.48	0.06	2.24
	(98.90)	(72.40)	(99.50)	(88.30)
35	0.03	1.12	BDL	0.81
	(99.80)	(97.10)		(95.80)

*Mean

Figures in parentheses indicate per cent degradation
BDL= Below detection limit of 0.01 mg/kg

Thus the results indicate that the higher persistence of β- and δ-isomers, and not the transformation of other isomers into these compounds, is responsible for their relatively high residues in gram plants treated with technical HCH. As the insecticidal γ-isomers does not seem to constitute any residue nazards, it is, therefore, desirable to replace the use of technical HCH with lindane i.e. purified γ-HCH so as to minimize the contamination of the foodstuffs and environment.

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