Bull. Environ. Contam. Toxicol. (1994) 52:797–801

Environmental Contamination and Toxicology

HCH Residues in Rain Water from Hardwar, India

V. K. Dua,[1] C. S. Pant,[1] V. P. Sharma[2]

[1]Malaria Research Centre (Field Station), BHEL Complex, Ranipur Hardwar-249403, India
[2]Malaria Research Centre, 22-Sham Nath Marg, Delhi-110054, India

Received: 15 July 1993/Accepted: 1 November 1993

The organochlorine insecticides DDT and HCH have been extensively used in India in agriculture and public health programme (Gupta 1986). These two compounds account for about 77% of the total pesticides used for public health, out of which HCH contributes about 55% (Pesticide information 1984). The annual consumption of HCH is about 8250 metric tons. The use of these insecticides results in their release into atmosphere and aerial transport is the major route of contamination (Woodwell et al. 1972). Several studies from India have shown the occurrence of DDT and HCH in soil (Pillai 1986), water (Bakre et al. 1990), air (Kaushik et al. 1987), whole blood (Bhatanagar et al.1992) and bovine milk (Battu et al. 1989; Verma 1990). We report the occurrence of HCH in rain water collected from Hardwar. This insecticide was extensively used during "Ardh Kumbh" congregation (January to April 1992), an important festival of Hindus, in district Hardwar to control house flies and mosquitoes. About 6 metric tons of HCH (50% W.P.) was used in this congregation covering an area of 130 sq km besides its regular use of 5.6 metric tons for an area of 1962 sq km in antimalaria programme during monsoon season (July to September).

MATERIALS AND METHODS

Rain water samples were collected from Bharat Heavy Electricals Limited (BHEL) Township, Ranipur area adjoining Hardwar city, during 1992 whenever rainfall had occurred. All glassware were rinsed with acetone and dried before use. Samples were collected in wide mouth glass bottles equipped with 20 cm (i.d.) funnel. After each rainfall, water was collected, measured and brought to the laboratory for the analysis of organochlorine insecticide residues. The pH of rain water samples were about 6.5.

Correspondence to: V. V. Dua

n-Hexane (AR grade) was used for the extraction of organochlorine insecticide residues from rain water. One litre of rain water was exracted thrice with 50 ml n-hexane using separatory funnel. The hexane portion were pooled and concentrated to 5 ml by vortex evaporator. The concentrated sample was cleaned up using anhydrous sodium sulphate and silica column eluted with n-hexane : benzene (40:60). The eluant was evaporated to dryness using vortex evaporator and kept at 4°C till analysis.

The samples were analysed for organochlorine insecticide residues on Hewlett- Packard 5890A gas chromatograph fitted with Ni electron capture detector on 5% Silicone OV-17 coated on Gas Chrom Q. (80-100 mesh) packed glass column. Nitrogen (flow @ 120 ml/min) was used as carrier gas with injector 210°C, oven 190°C and detector 220°C temperatures.

The identification of HCH residue peaks were cross checked on another column 5% DEGS coated on Gas Chrom Q. (100-120 mesh) glass column (Kaushik et al. 1987). Samples were also fortified with HCH isomers to confirm their identity. The identity of HCH residues in rain water was further confirmed by Gas Chromatography - Mass spectrometry (GC-MS) on Shimadzu 34 QP-2000 instrument at 70 eV at 250°C using fused silica capillary column (0.25 mm x 50 m) ULBON (equivalent to OV-1).

RESULTS AND DISCUSSION

The percentage recoveries (mean $\pm$ SD) of α, β, γ and δ isomers of HCH and Aldrin (internal standard) were 93.6±2.8, 92.0±2.2, 98.2±1.4, 91.8±4.6 and 94.2±3.3 respectively. The retention times of α , β , γ , δ isomers and aldrin are 3.51, 5.74, 4.73, 6.83 and 7.63 min. respectively on 5% OV-17 column using nitrogen gas (flow 120 ml/min) as carrier gas. An analysis of technical sample of HCH used in district Hardwar contained 38% of α, 37% of γ and 24% of δ isomers. No β isomer was detected in technical sample. Rain water samples were analysed for organochlorine insecticide residues and it was found that HCH isomers were present in all rain water samples while DDT and its metabolites were absent from all rain water samples from this area. GC-MS analysis of rain water sample showed a prominent m/e 282 molecular ion for HBC (hexachlorobenzene) which confirms the presence of HCH residue (Ryan 1976).

Table 1 shows concentration profile of total HCH and its isomers determined in rain water during January to September 1992. Average HCH concentration

Table 1. Concentration of HCH in rain

Month	HCH Concentration (μg/L)			
	α-HCH	ϒ-HCH	δ-HCH	Total HCH
January	0.036	0.030	0.047	0.113
February	0.013	0.012	0.035	0.060
June	0.045	0.092	0.015	0.152
July	0.009	0.078	0.008	0.095
August	0.022	0.010	ND	0.032
September	0.002	0.002	0.004	0.008
Average	0.021	0.037	0.018	0.077

ND : Not detectable

was 0.077 μg/L (range 0.008 to 0.152) while average α , ϒ , and δ isomers were 0.021, 0.037 and 0.018 μg/L respectively. No ß HCH isomer was found in any rain water sample. The level of HCH isomers in rain water correspond to their proportion in technical HCH used. Figure 1 shows correlation of HCH with rainfall. It was noted that the first few showers contained higher HCH concentrations than subsequent ones and concentrations decreased when the interval between the two rainfall was less. Maximum HCH residues were found from the samples taken in the month of January and June.

Total HCH consumption during 1992 was 11.6 metric tons for district Hardwar out of which 52% HCH was used to control breeding of house flies and mosquitoes during the "Ardh Kumbh" congregation from January to April 1992. The remainder was used in the antimalaria programme. Therefore, it is clear that maximum HCH residues detected in rain water during January to June was accounted for the use in "Ardh Kumbh" congregation and that observed during July to September, was mainly due to its use in antimalaria programme. It is worth to noting that the amount of HCH /sq km in Ardh Kumbh was many fold greater than that used in malaria control. This resulted in higher HCH concentrations during January to June as compared to July to September. However, Agarwal et al.(1987) have reported maximum DDT and HCH residues in rain water samples in the month of September to December from Delhi and related it to their extensive use in antimalaria programme during monsoon season. Heavy rainfall in August and September diluted the atmospheric contamination and resulted lowest HCH value.

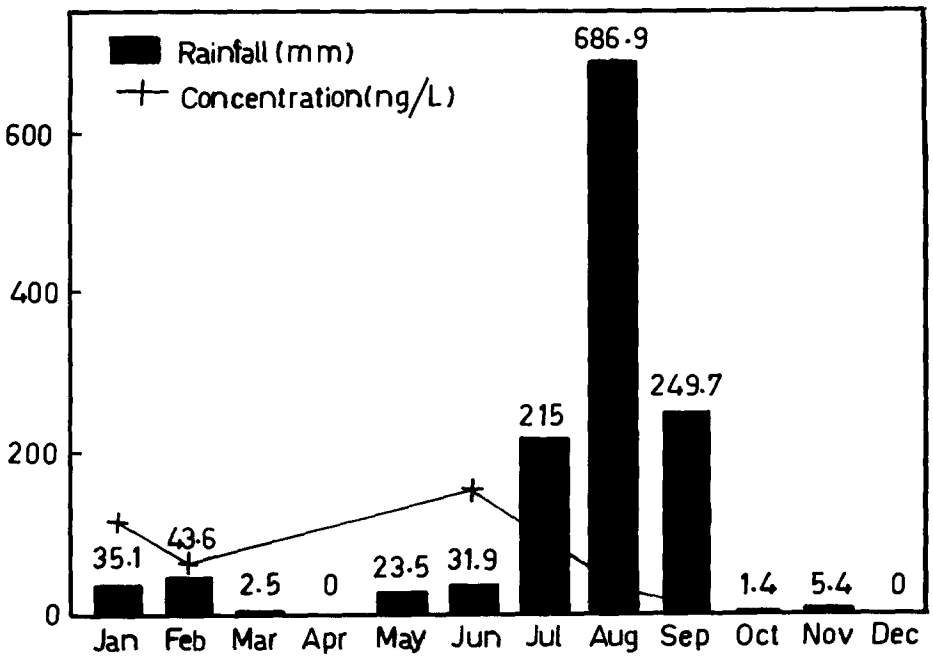

Figure 1. Total HCH residues and rainfall in Hardwar.

The Υ HCH isomer which is effective and safe, contibuted 48% of the total HCH present in the rain water samples whereas α and δ isomers which are harm ful due to their mammalian toxicity and not insecticidal, are of the level of 52%. The HCH was sprayed onto surfaces, plants, building, hutments,and soil etc. Therefore, the residues observed in rain water result from volatilization from the surfaces under the high ambient temperatures, movement through the air and washing out of the aerial residues by rain. If there were no rain the residues would presumably stay in the air moving with the wind. The present study clearly showes that the extensive use of HCH contaminate the whole environment. Although small amounts have been found in rain water, considering the total volume of rain water, a large quantity of HCH is comming back to the ground and contaminating almost every thing on the earth. Moreover HCH is not very effective insecticide as it results in rapid insect resistance. Therefore, there is an urgent need to minimize the use of insecticides like HCH and adopt an alternate strategy that would be environmentally sound for the mosquito control programme (Sharma 1991).

REFERENCES

Agarwal HC, Kaushik CP, Pillai MKK (1987) Organochlorine insecticide residues in rain water in Delhi, India. Wat Air Soil Pollut 32 : 293-302

Bakre PP, Misra V, Bhatanagar P (1990) Organochlorine residues in water from the Mahala water reservoir, Jaipur, India. Environ Pollut 63 : 275-281
Battu RS, Singh PP, Joia BS, Kalra RL (1989) Contamination of bovine (buffalo Babulis bubalis (L)) milk from indoor use of DDT and HCH in malaria con trol programmes. Sci Tot Environ 86 : 281-287
Bhatanagar VK, Patel JS, Bariya MR, Venkaiah R, Shah MP, Kashyap SK (1992) Levels of organochlorine insecticides in human blood from Ahmedabad (rural), India. Bull Environ Contam Toxicol 48 : 302-307
Gupta PK (1986) Pesticides in the Indian Environment. In: Bhatia B, Varshney CK (eds) Environmental Science Series, Interprint Publishers, New Delhi, India, p 12
Rayen JF (1976) Residue analysis by Mass Spectrometry. In : Gudzinomicz BJ, Gudzinomicz MJ, Martin HF (eds) Fundamentals of Integerated Gas Chromatography-Mass Spectrometry, M. Dekker, NewYork, USA, p 21
Kaushik CP, Pillai MKK, Raman A Agarwal HC (1987) Organochlorine insecticide residues in air in Delhi, India. Wat Air Soil Pollut 32 : 63-76
Anonymous (1984) Pesticide Information. 10 : 34
Pillai MKK (1986) Pesticide pollution of soil, water and air in Delhi area, India. Sci Tot Environ 55 : 321-327
Sharma VP (1991) Environmental management in malaria control in India. In : Targett GAT (ed) Malaria waiting for the vaccine, John Wiley & Sons, Chichester, England, p 49-63
Verma DK (1990) HCH residues in milk : gas chromatographic investigation. Int J Environ Anal Chem 42: 79-81
Woodwell GM, Wurster Jr CF, Isaacson PA (1972) Atmospheric circulation of DDT. Science 177 : 725