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STUDIES OF DBCP IN SUBSOILS

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ABSTRACT

Studies of DBCP in subsoils at four locations in the San Joaquin Valley show that: 1) DBCP can be found in subsoils between the ground surface and the water table in parts per billion (of dry soil) amounts; 2) Clays and silts adsorb higher levels of DBCP and may not act as barriers to downward movement of DBCP; and 3) DBCP is persistent in soil, remaining in the top soil at one site six to seven years after a single application.

Water-run or shank injection application of DBCP to soil is a likely cause of DBCP contamination of groundwater in the study areas. The potential for contaminating groundwater as a result of sprinkler application of DBCP requires additional study.

BACKGROUND

DBCP (1,2-dibromo-3-chloropropane) was widely used in California until 1977 as a soil fumigant for nematode control. Subsequently, in 1979, extensive DBCP contamination of groundwater underlying DBCP use areas was discovered by California water pollution control, agricultural and health authorities. Testing by the California Department of Health Services (CDHS) has shown that water supplies for over 200,000 people have been affected, 50,000 of whom were continuously or intermittently consuming water exceeding the CDHS recommended level of one $\mu g/l$.

This contamination is a serious public health problem. It also questions the environmental safety of DBCP; and, indicates that soil may not be an effective barrier to movement of some organic chemicals. Because this testing did not establish how DBCP reached groundwater. CDHS conducted this study of DBCP in subsoil below four DBCP application sites.

SAMPLE SITES

Several factors were considered in selecting sites. The sites were located in or immediately adjacent to fields that were known to have been treated with DBCP. The fields were also in areas where DBCP contamination of groundwater had been identified and the depth to groundwater was no greater than about 15 m. Finally, sites were selected from three widely separated areas. The general locations of the sample sites are shown in Figure 1.

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Well sampling near site I has indicated DBCP levels range from not detectable (5 ng/l sensitivity) to 16 µg/l. A well 39 m NNW of the sample site has ranged from 8.3 to 11.0 µg/l DBCP.

Virtually all wells tested within 5 km of sites II and III show DBCP contamination, with levels ranging from about 0.02 µg/l to as high as 22 µg/l. Depth sampling of a well about 50 m from site IV revealed DBCP levels up to 4 µg/l as deep as 40 m below the groundwater surface.

Site I was an orchard; the other properties were vineyards. Available DBCP application data are summarized in Appendix A.

SAMPLING PROCEDURE AND ANALYTICAL TECHNIQUES

Soil samples were collected by advancing a 5.1 cm sampler ahead of a hollow stem auger. After collection, the soil samples were cooled to about 5^{o}C and delivered to CDHS laboratories by the following day. Sampling was conducted during April 1980.

DBCP was extracted from soil samples by distillation with ethyl acetate. The distillate was removed to a clean glass vial and traces of water removed using anhydrous sodium sulfate. The extract was presented to a gas-liquid chromatograph operated isothermally, and DBCP concentration was expressed as micrograms DBCP per kilogram of oven-dried soil (ppb DBCP). A Tracor MT-220 gas-liquid chromatograph equipped with a 1.8 m by 6.4 mm, i.d., glass column packed with 3% OV 101 and a ^{63}Ni electron capture detector was used. The column was maintained at 100C while injector and detector were maintained at 225 and 325C, respectively. Nitrogen, at a flow rate of 80 ml/minute was used as carrier gas.

Moisture content was determined by oven drying at 105C for four hours. Organic content was determined by ignition at 550C for 1 hour.

RESULTS AND DISCUSSION

Figures 2 and 3 summarize data on types of soil recovered, DBCP concentrations at various depths, and moisture and organic contents of the various strata. Note that the abscissa scales vary for each site.

At Site I the first meter of soil had DBCP. The soil was then had no detectable DBCP until clays and silts were encountered near 9 m. After reaching peak concentrations in these clays and silts, DBCP levels decreased until the water table was reached at about 16 m. Groundwater at the surface of the water table had 12 µg/l of DBCP.

At Site II, the top soil again contained DBCP, but below 1 m no DBCP could be detected. DBCP then appeared in a silt and sand at 2 m and again in silts and some sands below 4.5 m. Sample collection stopped when a perched water table with 0.54 µg/l of DBCP was intercepted at 7.6 m.

The first 2 m of silty top soil at Site III contained DBCP. Below 2 m, DBCP was found in trace amounts at 3 m and between 5.4 and 6.2 m. The subsoil at Del Rey was notably freer of silts and clays than the other sites. Groundwater at Del Rey contained 6.1 μg/l of DBCP.

DBCP was found only in the top 0.5 m of soil at the Lodi site even though the subsoil contained significant silts and clays. Groundwater at this site, at about 18 m, had 1.2 μg/l of DBCP.

Sites I, II, and III illustrate that DBCP has leached through soils in parts per billion amounts. Sites I and II also indicate that clays and silts can adsorb higher levels of DBCP and that clays and silts, while adsorbing some DBCP, may not necessarily act as DBCP barriers. It is possible that subsurface clay and silt deposits may act as DBCP "reservoirs" to release DBCP into downward percolating waters for years to come. DBCP presence also seems to correlate with soil organic and moisture contents.

The presence of DBCP in the top soil at each site testifies to the environmental persistence of DBCP. At Site II, the only DBCP use was a single application in 1973 or 1974, six to seven years earlier. At Site III, a single application was made in 1975, five years ago. The single Site IV application still persists after four years, as do the heavier applications at Site I.

Site IV at first seems anomalous in that DBCP does not appear to have leached downward through this soil. It is possible that not enough DBCP was applied to the soil to cause detectable leaching. As indicated in Appendix A, this site received only a single treatment. In addition, because DBCP is volatile, much of the DBCP could have dissipated into the atmosphere during or shortly after the sprinkler application. The more uniform distribution of DBCP on the soil resulting from sprinkler distribution could also reduce leaching. Finally, it is also possible that soil macropores directed DBCP leaching away from the exact coring site.

These results are consistent with the general nature of volatile aliphatic halocarbons. These compounds are generally not well adsorbed (1,2) and, according to various scales of chemical mobility in soils, are of intermediate to high mobilities. (3,4) Because they apparently also resist degradation, it is not surprising that they are common ground water contaminants.

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APPENDIX A-DBCP APPLICATION DATA (from Calif. Dept. of Food and Agr.)

<u>Site I, Winton</u>

1969-1972: Some areas Telone (470 l/ha) preplant. Some areas DBCP (30 ppm) post-plant. Use through 1972 depended on severity of nematode problems, annually in heavily infested areas.

1973: Entire field treated with DBCP (33 l/ha).

1974-1976: Treated spring and fall at same rate. Adjacent areas treated either spring or fall. Spring applications were shanked in; fall applications water-run.

1977: Spring applications only.

<u>Site II, Parlier</u>

1973 or 1974: Last application of DBCP.

<u>Site III, Del Rey</u>

1975: Water-run application made in spring.

1974: Water-run application in area south of soil sampling site.

1974 or 1975: Neighbor applied DBCP.

<u>Site IV, Lodi</u>

1976: Used in fall through sprinkler system.

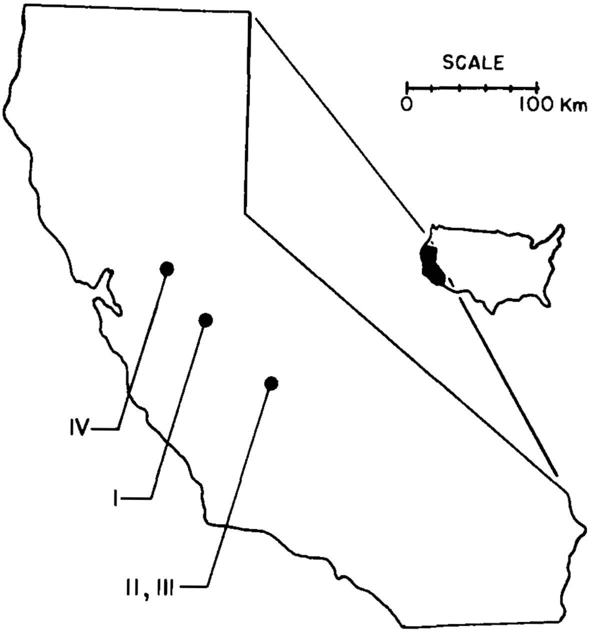

Figure 1. Locations of Sample Sites.

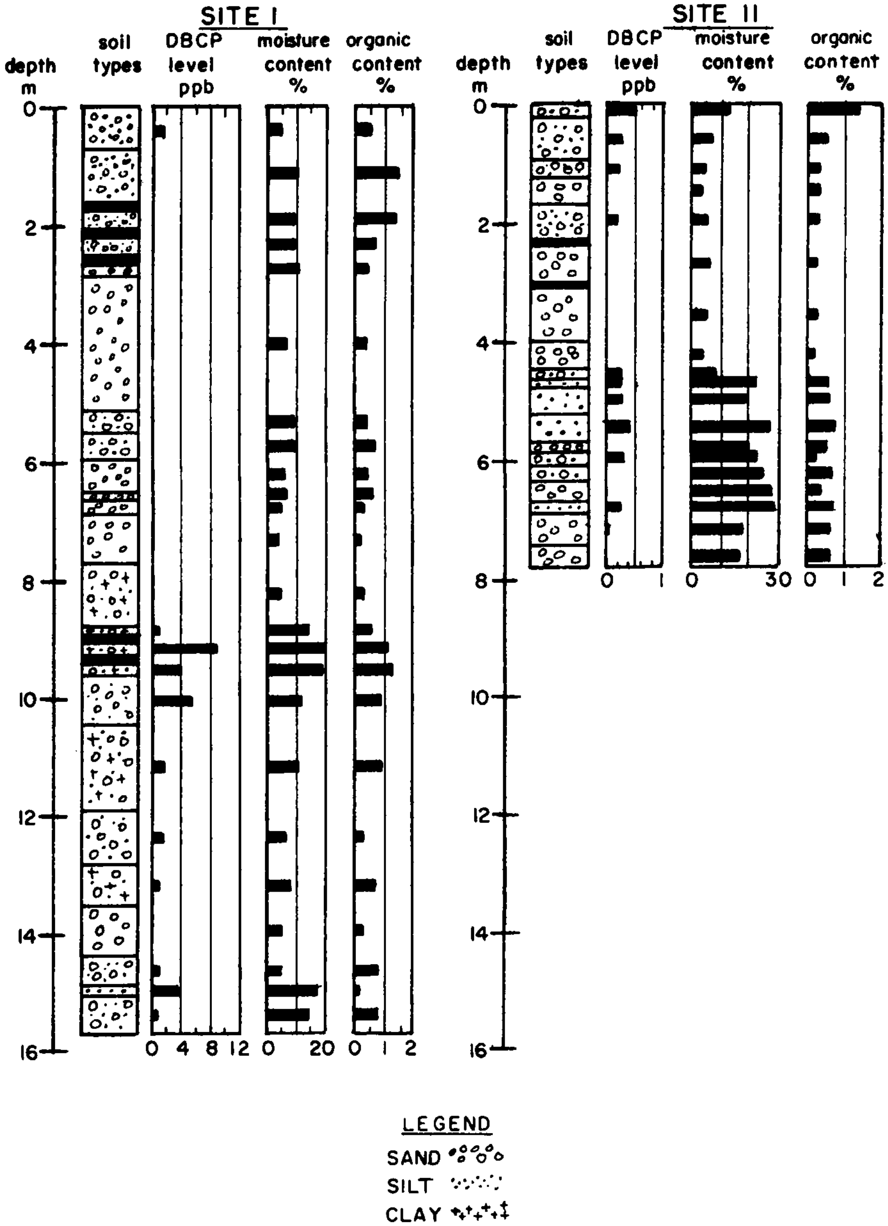

Figure 2. DBCP Soil Test Results From Sites I and II.

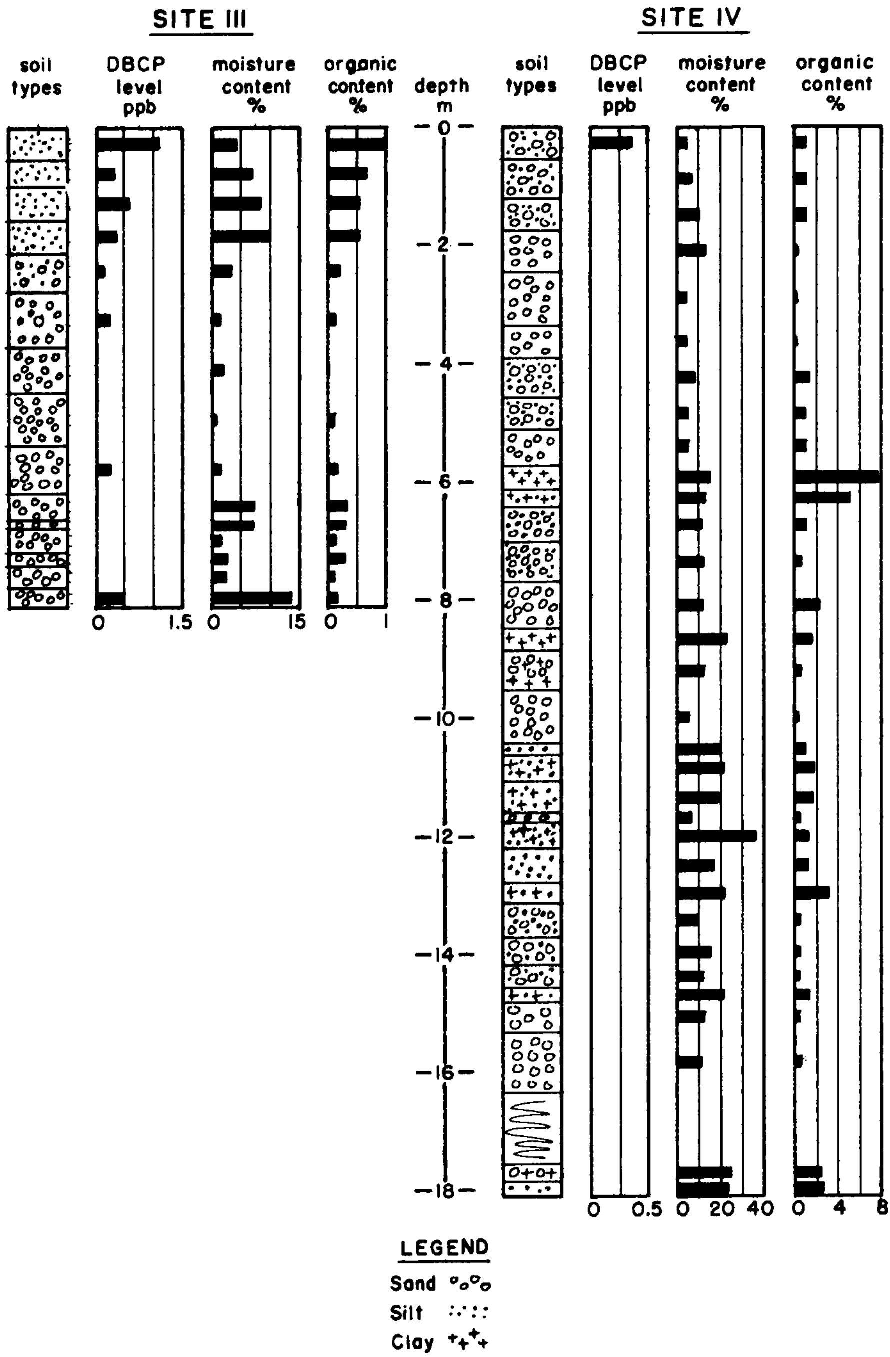

Figure 3. DBCP Soil Test Results From Sites III and IV.