SHORT COMMUNICATION

Conversion of DDT to DDD in flooded soil

Summary

Anaerobic conditions obtained by flooding the soil caused reductive dechlorination of \( p,p'\)-DDT and its conversion to \( p,p'\)-DDD was enhanced under water-logged conditions creating or favouring anaerobiosis. The DDT showed recalcitrance in the soil kept at 15\% moisture.

More \( o,p'\)-DDT was lost from the flooded soil. Similar amounts of \( p,p'\)-DDE were detected in all of the three levels of technical DDT treatments and the concentrations were not significantly different under both aerobic and anaerobic conditions.

Introduction

The mechanisms of disappearance of DDT from soil are still poorly understood; volatilization, codistillation, leaching, oxidation, hydrolysis, and microbial activity probably all contribute in the process. Climate, soil physical and chemical conditions as determined by texture, aeration, and drainage and moisture etc., may also affect the rate of breakdown. DDT residues in soils strongly resist microbial degradation, although dechlorination of DDT to DDD can occur in higher organisms. The dechlorination of DDT by microorganisms is possible. \textit{Proteus vulgaris} and baker’s yeast reductively dechlorinate DDT to DDD.

The efficiency of conversion by micro-organisms is inversely proportional to availability of oxygen in the system. When grown anaerobically or in an oxygen deficiency, the facultative anaerobes \textit{Serratia marcescens}, \textit{Escherichia coli} and an unidentified strain, could convert DDT almost completely to DDD. Dilute solutions of iron (II) porphyrin complexes are oxidised by DDT. Thus, it seemed likely that the microbial dechlorination of DDT might be explained as a process implicating the cytochromes of the respiratory chain, the absence of oxygen serving to keep the cytochromes in the reduced (FeII) state. In cell-free preparations of \textit{Aerobacter aerogenes}, the use of selective inhibitors indicated that the reduced Fe(II) cytochrome oxidase was responsible for DDT dechlorination. DDT labeled with carbon-14 was added to soil and the mixture was incubated anaerobically in an atmosphere of 20\% CO\(_2\) and 80\% N\(_2\) at 30\°C for 2 weeks and 4 weeks. DDT and six possible decomposition products were separated by thin-layer chromatography, and the radioactivity of materials from individual spots were determined by liquid scintillation. The DDT was dechlorinated by soil micro-organ-

isms to DDD, and only traces of other degradation products were detected. No degradation was detected in sterile soil. DDD is often detected as a residue in situations where only DDT has been used, and DDD appears to persist for unusually long periods 6.

**Materials and methods**

Soil samples (0–15 cm) representing the Arredondo fine sand were obtained from the University of Florida campus, Gainesville, Florida, U.S.A. The air-dried and sieved soil was thoroughly mixed with technical DDT to 10, 110, and 210 ppm concentrations of the insecticide. Four hundred grams of the treated soil were placed in a quart jar and covered with aluminium foil. The soil moisture was maintained at 15% for aerobic conditions while anaerobic conditions were obtained by flooding with 5 cm of distilled water over the soil surface. The experiment was conducted in an incubator at 37°C for 12 weeks. The jars were weighed weekly and the moisture lost due to evaporation was replaced.

After 12 weeks of incubation the DDT residues in the soil samples were extracted with 100 ml of hexane – acetone, 1:1. The extract was washed with three 100-ml portions of distilled water and the hexane layer retained. The hexane layer was passed through a small Buchner funnel containing a filter paper, 30 ml anhydrous sodium sulphate, 15-ml super cel and 15 ml Celite 545. After clean-up, the hexane layer was collected in a 50-ml glass-stoppered bottle and stored at 2°C prior to analysis.

The analysis of DDT residues and metabolites in the soil was done by a gas chromatograph equipped with the electroncapture detector.

Identification was based upon retention-time values, and the quantities of each material were calculated by relating the peak heights to those of standards analyzed on the same day.

**Results and discussion**

Results in Table 1 show that \( p,p' \)-DDT was dechlorinated to \( p,p' \)-DDD in the flooded soil. Analysis of the soil samples at the end of 12 weeks of incubation showed that in the flooded soil treated with 10 ppm of technical DDT \( p,p' \)-DDT content decreased from 8.83 ppm to 6.45 ppm, whereas, \( p,p' \)-DDD concentration rose from 0.50 ppm to 2.25 ppm.

Because the degree of aeration is inversely related to soil moisture, it is to be expected that under flooding with water oxygen will be a limiting factor. The observed dechlorination of \( p,p' \)-DDT and its conversion to \( p,p' \)-DDD was enhanced under water-logged conditions creating or favoring anaerobiosis.

In 110-ppm technical DDT treatments, anaerobic conditions obtained by flooding caused reductive dechlorination of \( p,p' \)-DDT to the extent that a concentration of 11.68 ppm of \( p,p' \)-DDD was recorded. The concentration of \( p,p' \)-DDD decreased from around 62.44 ppm to 26.89 ppm in the flooded soil only and no noticeable change occurred in the well-drained situation.

In 210-ppm technical DDT treatments, at the end of incubation, 27.18 ppm of \( p,p' \)-DDD was detected in the soil kept under water. Analysis of the