

## ENVIRONMENTAL FATE OF PROPARGITE

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Propargite, 2-[4-(1,1-Dimethylethyl)phenoxy]cyclohexyl 2-propynyl sulfite, is a non-systemic acaricide for controlling a variety of phytophagous mites on many crops including cotton, vines, fruit trees, vegetables, hops and nuts, etc. (Royal Society of Chemistry, 1987). This document reviews the environmental fate of propargite.

### Overall Environmental Fate

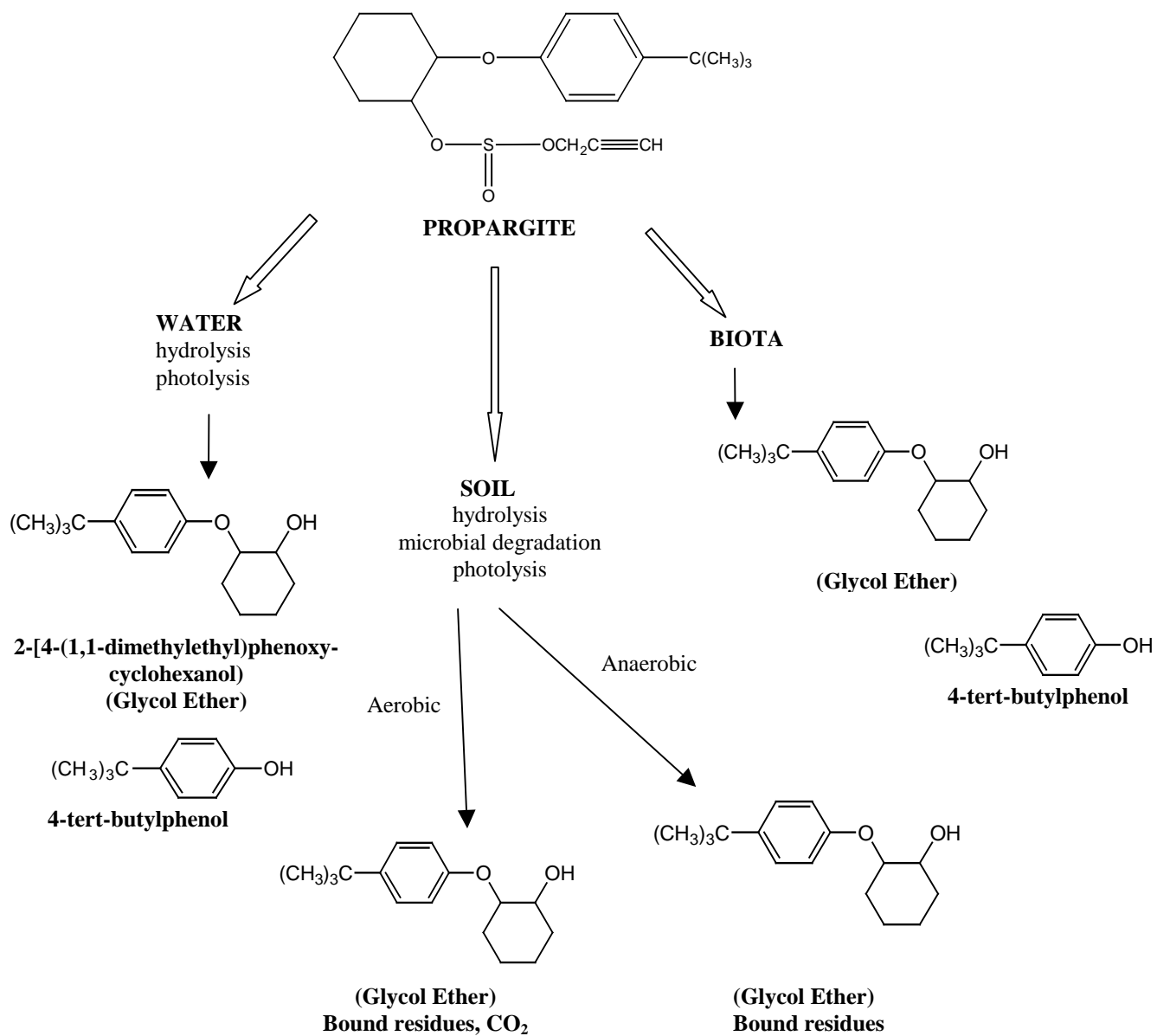
**Air:** Propargite has very negligible vapor pressure ( $3.89 \times 10^{-8}$  mmHg); therefore, it is not readily volatilized into the atmosphere. The low Henry's law constant,  $<9.43 \times 10^{-9}$  atm- $\text{m}^3\text{g}\cdot\text{mol}^{-1}$  at  $25^{\circ}\text{C}$ , indicates that propargite is unlikely to volatilize into air from an aqueous solution (Lyman, et al., 1982). Aside from drift that is generated by spray applications, propargite is not expected to be found in air over a large area.

**Water:** Propargite is a hydrophobic compound with very low water solubility, 0.5 ppm at  $25^{\circ}\text{C}$  (Agrochemical Handbook, 1992). Its organic adsorption coefficient values ( $K_{oc}$ ) varied from 4128 to 8553  $\text{cm}^3/\text{g}$ , increasing with higher organic matter content in soil. The data indicate that propargite moderately binds to soils with low organic matter and strongly binds to soils with high organic matter. It also has a high octanol/water partition coefficient ( $\log K_{ow} = 3.66$ ), suggesting that this compound readily binds to soils and other suspended matter in water. Therefore, propargite has a low potential to leach in soil and reach ground water. In California, 405 wells were sampled to test for propargite residues from 1984 through 1991 and no residues were detected. Propargite is a possible contaminant for surface water; 32 detections among 330 samples were reported in California during a period from 1993 to 1998.

Propargite hydrolyzes slowly in water at pH 7 and below; it hydrolyzes more rapidly at pH 9. The aqueous hydrolysis half-lives of propargite in aqueous buffer were 120-702 days, 48-78 days and 2-3 days at pH 5, 7 and 9, respectively. The half-lives for propargite in light and in darkness are almost identical, indicating that aqueous photolysis plays a negligible role in the degradation of propargite in water. The major degradation products of propargite in water are 2-[4-(1,1-dimethylethyl)phenoxy]-cyclohexanol (propargite glycol ether) and p-tert-butylphenol.

**Soil:** The fate of propargite in soil can be affected by many factors including its physico-chemical properties, application rate, soil type, moisture content, climate and runoff. The organic adsorption coefficient values of propargite, 4128 – 8553 cm<sup>3</sup>/g, suggest that propargite moderately binds to soil particles and strongly to soils with high organic contents. The photodegradation half-life of propargite on a sandy loam soil is approximately 75 days and the only identified degradation product is propargite glycol ether. The anaerobic metabolism half-lives for propargite at 1 and 10 ppm are 4.5 months and 12 months, respectively. Under aerobic conditions, the half-life is 40 days.

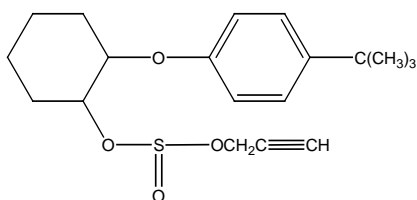
Field dissipation tests have been conducted for propargite in a wide variety of soils and conditions. No residues over detection level of 0.10 ppm was found below 6 inches and the estimated half-lives ranged from 64 to 122 days, meaning that propargite is moderately persistent in soil.

**DEGRADATION PATHWAY OF PROPARGITE**

**A. PHYSICAL AND CHEMICAL PROPERTIES**

1. Common Name: Propargite
2. Chemical Name: 2-(4-(1,1-Dimethylethyl)phenoxy)cyclohexyl 2-propynyl sulfite
3. Trade Names: Omite<sup>®</sup>, D-014<sup>®</sup>, BPPS<sup>®</sup>, Comite<sup>®</sup>
4. CAS Registry No.: 2312-35-8

5. Structural Formula:



6. Empirical Formula:  $C_{19}H_{26}O_4S$
7. Molecular Weight: 350
8. Specific Gravity: 1.085 – 1.115 g/ml
9. Solubility:
  - Water at 25 C:
  - 0.5 - 2 ppm
  - Organic Solvents at 25<sup>0</sup>C
  - Acetone:  $> 10^6$  ppm
10. Vapor Pressure:  $3.89 \times 10^{-8}$  mmHg
11. Octanol/Water Partition Coefficient: 5313 (  $\log K_{ow} = 3.66$ ) at 25C
12. Henry's Law Constant:  $< 9.43 \times 10^{-9}$  atm m<sup>3</sup>g.mol)<sup>-1</sup> at 25 <sup>0</sup>C

## B. ENVIRONMENTAL FATE

### Hydrolysis

The hydrolysis half-lives of propargite are pH dependent. Experiments were conducted at concentrations of 0.6-0.7 ppm at 25<sup>0</sup>C (Uniroyal, 1987a). The half-lives at pH 5, 7 and 9 were 120, 78 and 3 days, respectively, when the concentration of tetra-n-butylammonim phosphate buffer was 0.5 M. When the buffer concentration was 0.005M, the half-lives at pH 5, 7 and 9 were 702, 48, and 2 days, respectively. The only identified hydrolysis product was 2-[4-(1,1-dimethylethyl)phenoxy]-cyclohexanol (Glycol Ether)

### Photolysis

Aqueous photolysis studies on propargite were performed at 0.97 ppm and pH 5, which was the most stable pH for hydrolysis (Uniroyal, 1987b). Samples were exposed to natural sunlight for 12 hours every day. The observed photolysis half-life was approximately 134-140 days. This result was almost identical to the result obtained from an aqueous dark control, meaning that hydrolysis is the major degradation pathway for propargite in water as opposed to photolytic degradation. The identified degradation products were glycol ether and p-t-butylphenol.

Soil photolysis of propargite was investigated on a sterilized sandy loam soil using a Xenon arc burner over 15 days (Uniroyal, 1990). The estimated soil photolysis half-life for propargite was 75 days and the only identified degradate was glycol ether.

### Soil Metabolism

The aerobic soil metabolism of 4.9 ppm <sup>14</sup>C-propargite was investigated on sandy clay loam in darkness at 25<sup>0</sup>C (Uniroyal, 1987c). After 90 days, 31% of the applied radioactive was extractable from the soil, of which 77% was unreacted propargite. Thirty percent of the original radioactive was found to be bound residues and another 31% was converted to carbon dioxide. The estimated half-life of Omite® (propargite product) under aerobic conditions was 40 days.

Anaerobic soil metabolism of  $^{14}\text{C}$ -propargite was studied at concentrations of 1 and 10 ppm on sandy loam soil (Uniroyal, 1987d). The half-lives of 1 ppm and 10 ppm Omite® were approximately 4-5 months and 12 months, respectively. The major degradation product was glycol ether. Large amounts of bound residues were also found in the study.

### Soil Adsorption

A batch soil adsorption/desorption study on propargite was conducted on four soils: a Wisconsin Potato soil (OM 0.71%, pH 6.7), a California sand (OM 0.30%, pH 7.7), a Hesperia sandy loam (OM 1.70%, pH 6.9) and a clay loam (OM 5.36%, pH 6.3) (Uniroyal, 1987e). The 48-hour  $K_d$  value was experimentally obtained via  $^{14}\text{C}$  measurements. The soil adsorption coefficient  $K_d$  values were 17, 11, 55 and 266 for the potato, sand, sandy loam and clay loam soils, respectively. Their corresponding organic adsorption coefficient values ( $K_{oc}$ ) were 4128, 6322, 5578 and 8553  $\text{cm}^3/\text{g}$ , respectively. These data show that propargite moderately binds to soils with low organic matter and strongly binds to soils with high organic matter content (Linda, 1994).

### Soil Dissipation

Field dissipation tests have been performed for propargite in many locations and conditions. Results revealed no movement or migration of propargite and glycol ether residues to below 6 inches in tested sites (Uniroyal 1987f&e). Comite® was applied at a rate of 4.1 lbs active ingredient per acre in a cotton field situated in Kerman, California (Uniroyal 1987f). The soil type was a sandy loam (OM 0.7%, pH 7.9) and the total rainfall during this period was 49 inches. After 1, 4, 7, and 14 days and 1, 2, 3, 4, 6, 9, and 12 months of application, soil was sampled for analysis. The propargite residues in the top 6 inches ranged from 0.22 ppm to 0.54 ppm during the first 4 months of study. After 6 months, residues in all soil samples were below minimum detection level of 0.10 ppm and no residues were found below 6 inches.

In another experiment, propargite was applied to two unplanted sites in California to investigate the dissipation of propargite and its metabolite glycol ether in soils

(Uniroyal, 1990b). The total rainfall was 8-9 inches during the study and the application rate was 4.5 lb active ingredient per acre. The monitoring period was 375 days. Propargite was only found in the top 6 inches of soil on both sites with residues ranging from 5.35 to 0.14 ppm on the first site and 2.23 to 0.14 ppm on the second site. The estimated half-lives at the first and second site were 64-100 and 83-122 days, respectively. Propargite glycol ether was only detected in the top 6 inches with the concentrations from 0 to 0.35 ppm and from 0 to 0.30 ppm at the first and second sites, respectively.

### Plant Degradation

The degradation of propargite on plants has been studied on a large number of crops including cotton, orange, corn and potato, etc. Smith (1991) reported an application of propargite (Omite® 30W) on nectarine foliage at 10.7 pounds per 100 gallons of water per acre. Samples were randomly selected and analysis started after 13 to 35 days of application. The half-lives of propargite on the crop varied from 11 to 53 days.

In another field experiment, propargite was applied on tomatoes at a maximum recommended rate of 60 and at 120 g of ai per 100 L of water (Aplada-Sarlis et al., 1994). Samples were analyzed at 0, 1, 2, 3, 6, 13, 20, 27, and 34 days after application. The residues for propargite ranged from a high of 0.95 ppm at day 0 to a low of 0.42 ppm at 34 days at the 60 g dose. At the 120 g dose, the residue concentrations varied from 2.13 to 1.05 ppm at day 0 and 34 days, respectively.

The residue of propargite on cotton was investigated in Tulare County, California. In this case, Comite® was applied to cotton foliage at rates of one or two pounds of Comite® in 25 gallons water per acre (Uniroyal, 1976). Samples were analyzed at 0, 14, 28, and 42 days after application and the average residues for propargite were 55, 9.25, 0.40 and 0.10 ppm, respectively. The estimated half-life was 3.69 days on cotton. No research was performed to identify the metabolites of propargite on or in crops. All studies indicate that the degradation half-life of propargite heavily related to crop types, application locations and rates.

### Surface Water Monitoring

Although propargite has low water solubility (0.5 ppm at 25 °C) and medium to high soil adsorption, its relatively long soil dissipation half-lives, 64 – 122 days, make it a possible contaminant for surface water. From January 1993 through August 1998, of 330 samples tested and analyzed for propargite in California, 32 had detections ranging from 0.005 to 20 ppb (Miller, 2000).

### Groundwater Monitoring

Propargite has low water solubility, 0.5 ppm at 25°C, and medium to high soil adsorption ( $K_{oc} \approx 4128 - 8553$ ), therefore it has low potential to leach through soil and contaminate groundwater (Ney, 1995; Linda, 1994). Of 405 wells sampled for propargite in California during 1984 through 1991, no detections were reported at minimum detection levels that varied from 0 to 80 ppb (CalEPA., 2000).

### **References:**

- Aplada-Sarlis, P., K.S. Liapis and G.E. Miliadis. 1994. Study of procymidone and propargite residue levels resulting from application to greenhouse tomatoes. J. Agric. Food Chem., 42, 1575-1577.
- CALEPA. 2000. Well inventory database. Department of Pesticide Regulation, Sacramento, CA. Available at <http://scalos.cdpr.ca.gov:8001>.
- Linda, C.D. 1994. Physico-Chemical Properties and Environmental Fate of Pesticides. Department of Pesticide Regulation, Sacramento, CA.
- Lyman, W.J., W.F. Reehl and D.H. Rosenblatt. 1982. Handbook of Chemical Property Estimation Methods. McGraw-Hill, Inc., New York, 15-15.



- Miller, C. 2000. Personal Communication, Department of Pesticide Regulation, Sacramento, CA.
- Ney, R.E., Jr. 1995. Fate and Transport of Organic Chemicals in the Environment, a practice guide, 2<sup>nd</sup> ed., Government Institutes, Inc., Rochville, Maryland.
- Royal Society of Chemistry. 1987. The agrochemicals handbook, propargite, Royal Society of Chemistry, Nottingham, England.
- Smith, C.R. 1991. Dissipation of dislodgeable propargite residues on Nectarine Foliage. Bull. Environ. Contam. Toxicol., 46, 507-511.
- Uniroyal Chemical Co. 1976. Co-mite residue studies on cotton. DPR. Vol. 259-013 #946044, Department of Pesticide Regulation, Sacramento, CA.
- Uniroyal Chemical Co. 1987a. Omite hydrolysis. DPR. Vol. 259-062 #61969, Department of Pesticide Regulation, Sacramento, CA.
- Uniroyal Chemical Co. 1987b. Aqueous and soil photolysis of [14C]Omite. DPR. Vol. 259-062 #61968, Department of Pesticide Regulation, Sacramento, CA.
- Uniroyal Chemical Co. 1987c. Omite aerobic soil metabolism. DPR. Vol. 259-097, 72532, Department of Pesticide Regulation, Sacramento, CA.
- Uniroyal Chemical Co. 1987d. Anaerobic soil metabolism of Omite at 1 and 10 ppm. DPR. Vol. 259-049 #48132, Department of Pesticide Regulation, Sacramento, CA.
- Uniroyal Chemical Co. 1987e. Adsorption/desorption of propargite. DPR. Vol. 259-078 #71849, Department of Pesticide Regulation, Sacramento, CA.

Uniroyal Chemical Co. 1987f. Propargite terrestrial field dissipation on cotton, DPR.  
Vol. 259-108 #85713, Department of Pesticide Regulation, Sacramento, CA.

Uniroyal Chemical Co. 1990a. Soil photolysis study. DPR. Vol. 259-119 #95253,  
Department of Pesticide Regulation, Sacramento, CA.

Uniroyal Chemical Co. 1990b. Field dissipation of propargite on two sites in  
California. DPR. Vol. 259-124 #95674&95675, Department of Pesticide  
Regulation, Sacramento, CA.