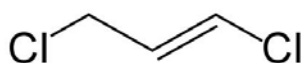


1,3-DICHLOROPROPENE
RISK CHARACTERIZATION DOCUMENT

Environmental Fate



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California Environmental Protection Agency**

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TABLE OF CONTENTS

Table of Contents	2
List of Figures	3
List of Tables	4
1. INTRODUCTION	5
2. CHEMICAL DESCRIPTION.....	5
3. REGULATION.....	6
4. USE PROFILE.....	7
4.1 Method of Application and Formulation.....	9
5. ENVIRONMENTAL FATE AND DEGRADATION IN SOIL	10
5.1. Adsorption.....	10
5.2. Diffusion/Leaching	10
5.3. Hydrolysis	10
5.4. Runoff	10
5.5. Microbial Degradation	11
5.6. Volatilization.....	11
5.7. Anaerobic Degradation	11
6. ENVIRONMENTAL FATE AND DEGRADATION IN WATER.....	12
6.1. Surface Water.....	12
6.2. Ground Water.....	13
6.3. Hydrolysis	13
6.4. Volatilization.....	13
6.5. Photolysis	13
7. ENVIRONMENTAL FATE AND DEGRADATION IN AIR	14
7.1. Photooxidation	14
7.2. Photolysis	14
8. ENVIRONMENTAL FATE AND DEGRADATION IN VEGETATION	15
9. NON-TARGET EFFECTS.....	15
9.1. Invertebrates.....	15
9.2. Vertebrates	16
10. ENVIRONMENTAL MONITORING.....	17
11. REFERENCES.....	20

LIST OF FIGURES

Figure 1. The geometric isomers of cis- and trans-1,3-Dichloropropene	6
Figure 2. Reported use of 1,3-Dichloropropene in California for the top 6 commodities in 2010	8
Figure 3. Environmental degradation pathway for 1,3-Dichloropropene.....	12
Figure 4. Photolysis pathway of trans-(E) and cis-(Z) 1,3-Dichloropropene with ozone (O ₃)	15
Figure 5. Highest 1,3-D one day (acute) concentrations detected among three monitoring locations in Parlier.....	18
Figure 6. Highest 1,3-D one day (acute) concentrations detected among three AMN monitoring locations for 2011	19

LIST OF TABLES

Table 1.	Physical and Chemical Properties for 1,3-Dichloropropene	5
Table 2.	Reported use of 1,3-Dicholoropropene in California, 1995-2010.....	7
Table 3.	Top 10 ranked counties with the most reported pesticide use of 1,3-Dicholoropropene for 2010	8
Table 4.	List of products containing 1,3-D currently registered in California	9
Table 5.	Application rates, methods, and re-entry restrictions based on crops as listed in the Telone II CA product label	9
Table 6.	Acute toxicity of 1,3-Dicholoropropene for freshwater and saltwater species	16
Table 7.	Acute toxicity of 1,3-Dicholoropropene for fish	17

1. INTRODUCTION

1,3-Dichloropropene, commonly known as Telone II or 1,3-D, is one of the most widely used fumigants in California (DPR, 2007). 1,3-D has been predominately used as a pre-plant fumigant to control soil-borne pests including nematodes, viruses, and bacteria (Anonymous, 1996). The combination of chloropicrin (CP) with 1,3-D has been shown to increase the mixture's herbicidal and fungicidal properties, and is currently considered to be a potential alternative pesticide to Methyl bromide (MBr). This report contains a review of the scientific literature concerning the environmental fate, physical and chemical properties, and specific uses and formulation of 1,3-D in California.

2. CHEMICAL DESCRIPTION

1,3-D is a colorless to straw-colored liquid with a sharp, sweet, penetrating, chloroform-like odor at room temperature. 1,3-D is a halogenated hydrocarbon that is used commercially in the agricultural industry as a pesticide, specifically, as a nematicide. It consists of two geometric isomers, *cis*-1,3-D and *trans*-1,3-D (Figure 1). It is soluble in most organic solvents and evaporates easily (U.S. EPA, 2006). The chemical properties of 1,3-D are presented in Table 1.

Table 1. Physical and chemical properties of 1,3-Dichloropropene

Property	Value
Chemical Name	1,3-Dichloropropene
Common Name	Telone II, 3-chloropropenyl chloride, alpha-chloroallyl chloride
CAS Registry Number	1,3-D: 542-75-6 <i>Cis</i> -Isomer: 010061-01-5 <i>Trans</i> -Isomer: 010061-02-6
Physical State	Liquid
Molecular Formula	C ₃ H ₄ Cl ₂
Molecular Weight	110.98 g/mole
Chemical Family	Chlorinated Hydrocarbon
Boiling Point	108 °C
Melting Point	-84 °C
Vapor Pressure	28.0 mmHg (20 °C) 34.3 mmHg (25 °C)
Water Solubility	2.18 x 10 ³ ppm (<i>cis</i> -) (25 °C) 2.32 x 10 ³ ppm (<i>trans</i> -) (25 °C)
Henry's Law Constant	3.55 x 10 ⁻³ atm·m ³ /mol
Log K _{ow}	1.82
Log K _{oc}	1.36 (<i>cis</i> -) 1.41 (<i>trans</i> -)
Density	1.22 g·cm ⁻³ (<i>cis</i> -) 1.22 g·cm ⁻³ (<i>trans</i> -)

Sources: U.S. Department of Health and Human Services, 1990; U.S. EPA, 1998, 2000, and 2006; Dow AgroSciences, LLC, 2007; Dow AgroSciences, LLC, 1998; Knuteson, 1996.

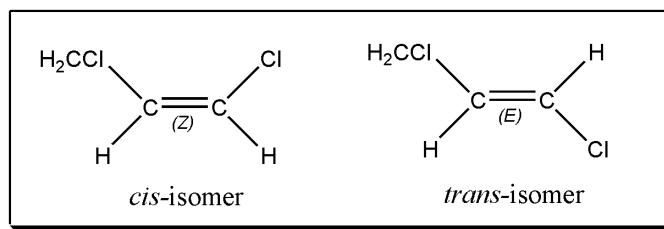


Figure 1. The geometric isomers of *cis*- and *trans*-1,3-Dichloropropene (Redrawn from WHO, 1993a).

3. REGULATION

All pesticides sold or distributed in the United States must be registered by the U.S. Environmental Protection Agency (EPA). Additionally, all pesticides sold or distributed in California must be registered with the California Department of Pesticide Regulation (DPR). 1,3-D was first registered as a pesticide in the U.S. in 1954 (U.S. EPA, 1998). However, current law requires that pesticides registered before November 1, 1984 be re-registered to meet today's more stringent standards. Thus, EPA issued a Registration Standard for 1,3-D in October 1986. At the same time, EPA released a Federal Register notice announcing a Special Review of 1,3-D for addressing the cancer concerns for workers and required additional data. In 1992 and 1996, the 1,3-D labels were modified to include new measures to minimize exposures to workers and residents who live near treated fields. Upon meeting EPA's requirements, 1,3-D was re-registered in 1998. 1,3-D was first registered in California in 1970. 1,3-D is included on California's Proposition 65 list of chemicals known to the State to cause cancer.

In April 1990, California Department of Food and Agriculture [state pesticide regulatory agency prior to the creation of DPR in 1991] suspended permits for the use of 1,3-D in California after California Air Resources Board monitoring stations in the Central Valley detected levels of concern in ambient air (DPR, 2002). Dow, which manufactures Telone (the most widely used 1,3-D product in California), responded to the ban with a four-year research program designed to develop application techniques to reduce residues in air and to validate methodology that would accurately predict 1,3-D emissions after fumigation. In 1994, Dow proposed a limited commercial reintroduction of Telone using modified use practices designed to minimize levels of 1,3-D in ambient air. DPR authorized the limited reintroduction of 1,3-D in 1995 with several strict control measures, including amended pesticide labels, reduced application rates, buffer zones, lengthened reentry intervals, and close control of distribution and use, in consultation with county agricultural commissioners. Additionally, DPR established a 90,250 pounds township cap on 1,3-D use (DPR, 2002). A township is defined as a 6 x 6 miles (36 square miles or 93.24 square kilometers) area divided into 36 equal sections, as specified by the Public Lands Survey System.

Greater 1,3-D use flexibility was requested by California agricultural commissioners, who needed to manage 1,3-D use demands, while maintaining a high standard of safety for the public and workers. Therefore, in 2001, DPR authorized an increase of 1,3-D use allocation in five California townships to accommodate high demand. Specifically, DPR allowed townships where needs exceed the current cap to use up to 180,500 pounds per

year. This new 180,500 pound 1,3-D use limit was only allowed if the accumulated unused 1,3-D pounds from previous years (since 1995) created an excess. In effect, annual township use less than 90,250 pounds added to a “bank” that could be tapped in high demand years (DPR, 2002). In a few townships, DPR has allowed use beyond the bank reserve.

4. USE PROFILE

1,3-D is widely used in agriculture as a pre-plant soil fumigant primarily for the control of nematodes, but also for plant diseases, insects, and weeds. 1,3-D is used for vegetables, fruit and nut crops, forage crops (grasses, legumes and other non-grass forage crops), fiber crops, and nursery crops (ornamental, non-bearing fruit/nut trees and forestry crops) (WHO, 1993a; Cox, 1992; U.S. EPA, 2006). In California, 1,3-D is normally applied to the soil as a mixture of *cis*- and *trans*-isomers at an application rate of 24 gallons per acre for tarped fumigation and 35 gallons for untarped fumigation at a depth of anywhere from one to 18 inches below the soil surface (U.S. EPA, 2006; Daughtry, 2004; Cox, 1992). California recommended permit conditions allow for a maximum application rate of 332 lbs. active ingredient per acre (DPR, 2011a). 1,3-D is typically applied by soil injection, but can also be applied through drip irrigation (U.S. EPA, 2006). An estimated 23 million pounds of active ingredient were used annually to treat approximately 372 thousand acres in the United States from 1990 to 1995 (U.S. EPA, 2006). Specifically, in California, a total of 93,413,759 pounds of 1,3-D were applied from 1995 to 2010 as listed in Table 2 (DPR, 2011b).

In 2010, 1,3-D was predominately used as a preplant fumigant in strawberry crops with 1949 thousand pounds applied (Figure 2). Almond and generic soil treatment followed strawberry in 1,3-D use with 942 and 830 thousand pounds applied, respectively. In 2010 Kern, Fresno, and Merced were the highest use counties with over 1 million pounds of 1,3-D applied (Table 3).

Table 2. Reported use (pounds of active ingredient) of 1,3-Dichloropropene in California, 1995-2010 (Daughtry, 2004; DPR, 2011b).

<i>Year</i>	<i>Use (lbs ai)</i>
1995	409,821
1996	1,956,846
1997	2,457,170
1998	3,011,057
1999	3,130,745
2000	4,446,910
2001	4,141,173
2002	5,359,193
2003	7,003,873
2004	8,945,145
2005	9,355,308
2006	8,733,270
2007	9,594,517
2008	9,704,804
2009	6,392,604
2010	8,771,323

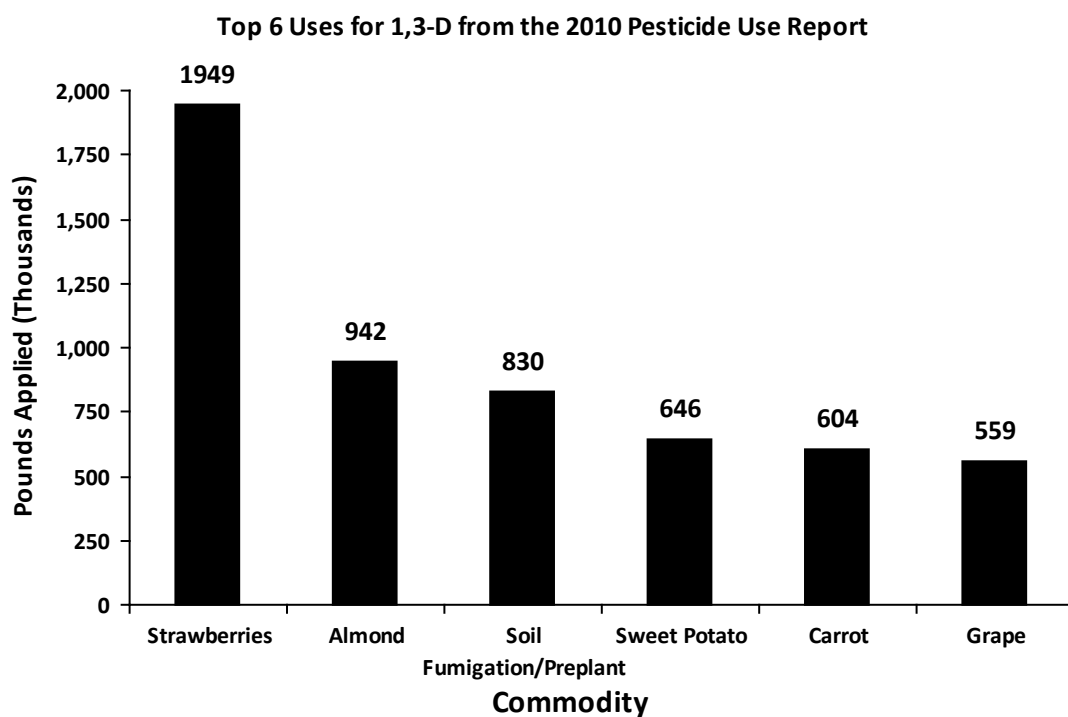


Figure 2. Reported use of 1,3-Dichloropropene in California for the top 6 commodities in 2010 (DPR, 2011b).

Table 3. Top 10 ranked counties with the most reported pesticide use of 1,3-Dichloropropene for 2010 (DPR, 2011b).

County	Pounds Applied (2010)	Rank
Kern	1,301,402	1
Fresno	1,100,282	2
Merced	1,036,899	3
Monterey	973,895	4
Stanislaus	787,699	5
Ventura	782,294	6
Tulare	600,008	7
Madera	332,112	8
San Joaquin	253,188	9
Santa Barbara	233,031	10

4.1. Method of Application & Formulations

1,3-Dichloropropene is formulated for soil fumigation as Telone II (Dow AgroSciences) for shank application and as an emulsifiable concentrate (Telone EC) for drip application. In a 2003 study, the effect of formulation type on the phase partitioning, transformation rate, and volatilization of 1,3-D isomers was examined. The study found that air-water partitioning coefficients were higher for Telone II compared to Telone EC, due to the higher water solubility of the EC formulation. The study also found that sorption of 1,3-D isomers in two soils was not affected by formulation and that formulation had no significant effect on the rate of 1,3-D transformation in water or soil (Kim et al., 2003a).

Table 4. List of products containing 1,3-D currently registered in California as of 4/30/2012.

<i>Product Name</i>	<i>Active Ingredients (%)</i>	<i>Weight/gallon</i>	<i>Method of application</i>
INLINE	1,3-D (60.8%), Chloropicrin (33.3%)	11.2 lbs	Drip
PIC-CLOR 15	1,3-D (79.9%), Chloropicrin (15.0%)	10.5 lbs	Shank Injection
PIC-CLOR 30	1,3-D (65.8%), Chloropicrin (30.0%)	11.0 lbs	Shank Injection
PIC-CLOR 60 EC	1,3-D (37.1%), Chloropicrin (56.7%)	11.8 lbs	Drip
PIC-CLOR-60	1,3-D (37.6%), Chloropicrin (60.0%)	12.1 lbs	Shank Injection
TELONE C-15	1,3-D (82.9%), Chloropicrin (14.8%)	10.5 lbs	Shank Injection
TELONE C-17	1,3-D (78.3%), Chloropicrin (16.5%)	10.6 lbs	Shank Injection
TELONE C-17 CA	1,3-D (78.3%), Chloropicrin (16.5%)	10.6 lbs	Shank Injection
TELONE C-35	1,3-D (61.1%), Chloropicrin (34.7%)	11.2 lbs	Shank Injection
TELONE C-35 CA	1,3-D (61.1%), Chloropicrin (34.7%)	11.2 lbs	Shank Injection
TELONE EC	1,3-D (93.6%)	10.1 lbs	Drip
TELONE II	1,3-D (97.5%)	10.2 lbs	Shank Injection
TELONE II CA	1,3-D (97.5%)	10.1 lbs	Shank Injection
TELONE TECHNICAL	1,3-D (97.5%)	10.1 lbs	Shank Injection
TRI-FORM 30	1,3-D (68.2%), Chloropicrin (29.7%)	11.0 lbs	Shank Injection
TRI-FORM 35	1,3-D (63.4%), Chloropicrin (34.6%)	11.2 lbs	Shank Injection
TRI-FORM 40/60	1,3-D (39.0%), Chloropicrin (59.4%)	12.1 lbs	Shank Injection

Table 5. Application rates, methods, and re-entry restrictions based on crops as listed in the Telone II CA product label.

Crop	Max Application Rate (gallons/acre)	Max Application Rate (lbs A.I./acre)	Method of Application	Re-entry Interval (days)
Carrot	25.0	246	Ground	7
Sweet Potato	25.0	246	Ground	7
Almond	33.7	332	Ground	7
Grape, Wine	33.7	332	Ground	7
Strawberry	33.7	332	Ground	7

5. ENVIRONMENTAL FATE AND DEGRADATION IN SOIL

1,3-D is mobile and persistent, with a reported half-life of up to 69 days, depending on the type of soil. The persistence of 1,3-D varies depending on environmental conditions, such as temperature and organic content of the soil, with higher temperatures and microbial activity being the largest contributors to 1,3-D degradation (U.S. EPA, 2006; Gan *et al.*, 1999). Figure 3 illustrates some environmental degradation pathways of 1,3-D.

5.1. Adsorption

1,3-D adsorbs more strongly to soil when it is in the vapor phase than when it is dissolved in water (U.S. EPA, 1998). The adsorption rate of 1,3-D increases with increasing organic content and decreasing temperature (U.S. EPA, 2006). A study that looked at the soil-water partitioning of 1,3-D in two California agricultural soils (Salinas clay loam and Arlington sandy loam) found relatively low K_d and K_{oc} values which suggested that 1,3-D is weakly adsorbed and highly mobile in these soils (Park *et al.*, 2004).

5.2. Diffusion/Leaching

Movement through soil is due mainly to diffusion rather than leaching. With a high Henry's law constant, the vapor phase dominates at soil temperatures (Table 1). Oliver (1987) found soil residues of 1,3-D reached a depth of 8.9 feet. Thomas *et al.*, (2003) looked at the influence of soil moisture and organic matter amendment on diffusion and emissions of (*Z*)- and (*E*)-1,3-D in sandy soils. They determined that upward diffusion of the two isomers in the soil was greatly influenced by the soil-water content; in air-dried soil both isomers rapidly volatilized into the atmosphere, whereas in near-water-saturated soils emissions were minimal. Additionally, presence of organic matter amendment greatly reduced diffusion of both 1,3-D isomers.

5.3. Hydrolysis

Once applied to the soil, 1,3-D is chemically hydrolyzed, resulting in the release of chlorine, and the formation of chloroallyl alcohol (van Dijk, 1974). 1,3-D hydrolyzes following pseudo first-order kinetics (Guo *et al.*, 2004). The hydrolysis rate constant increases with soil moisture content and decreases with initial 1,3-D concentration. Additionally, soil particle size and mineralogy has little effect on hydrolysis reaction rate while organic matter promotes 1,3-D degradation via direct substitution reactions. (Guo *et al.*, 2004)

5.4. Runoff

Because of its persistence in soil and high rate of hydrolysis, runoff of 1,3-D from soil to water has been determined to be, on average, very low (U.S. EPA, 2006). In a simulated rainfall study, where 12.8 cm of rain was applied to a fumigated field over the course of 10 hours, only 0.1% of the applied 1,3-D was found in the top 2 cm of soil, where it

would be potentially available for runoff. Calculated 1,3-D concentrations in runoff ranged from 0.649 to 7.97 ppb. The total mass of 1,3-D lost to runoff was equivalent to about 0.002% of the originally applied amount (Heim *et al.*, 2002).

5.5. Microbial Degradation

A *Pseudomonas* strain has been shown to further metabolize *cis*- and *trans*-3-chloroallyl alcohol to water and CO₂ (Berry *et al.*, 1980). 1,3-D half-lives of 1 to 3 days have been observed from biodegradation by *Pseudomonas* (NTP, 2011). Another study found that after 8 weeks of incubation, with repeated application of 1,3-D, volatilization fluxes were much lower for compost-amended soil than with the unamended soils, indicating accelerated degradation due to addition of compost, or development of new microbial populations with enhanced degradation capacity (Ibekwe *et al.*, 2001). This study also found that the strains *Pseudomonas* and *Actinomyces* were present in all soils to which compost was added indicating that they are involved in the degradation of 1,3-D.

5.6. Volatilization

Field volatility studies have shown that approximately 25-56% of 1,3-D volatilizes during the first two weeks after an application, with 80% of that emission occurring during the first four days (U.S. EPA., 1998; Kim *et al.*, 2003[a]; van Wesenbeeck, 1998; Knuteson *et al.*, 1992a; Kim *et al.*, 2003[b]).

5.7. Anaerobic Degradation

McCall (1986a) found that 1,3-D applied to soil in waterlogged, anaerobic conditions degrades rapidly, forming three main intermediate metabolites: 3-chloro-2-propene-1-ol, propionic acid, and an unidentified polar acid. The half-lives of 1,3-D under these conditions ranged from 2.4 to 9.1 days, depending on soil type and temperature. These results indicate that there is little potential for 1,3-D to accumulate under anaerobic conditions in the soil.

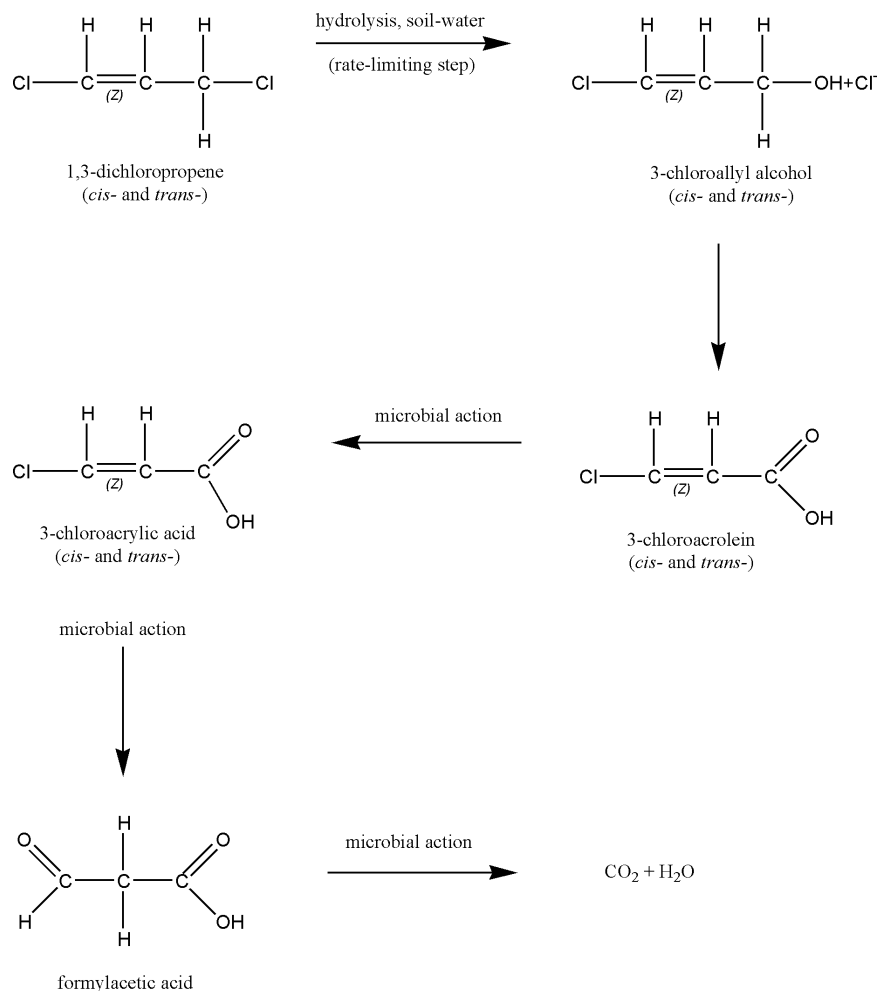


Figure 3. Environmental degradation pathway for 1,3-Dichloropropene (Redrawn from WHO, 1993a).

6. ENVIRONMENTAL FATE AND DEGRADATION IN WATER

6.1. Surface Water

A recent EPA document estimated the volatilization half-lives of 3.8 and 4.2 hours, respectively, for *cis*- and *trans*-1,3-D based on a model river 1 meter deep, flowing at a velocity of 1 m/sec with a wind velocity of 3 m/sec (U.S. EPA, 2006). One international study found between <0.02 and 0.02 µg/l of 1,3-D in surface waters in the Netherlands, where it is applied to counteract potato cyst nematodes (de Jong *et al.*, 2007; van Dijk, 1974).

1,3-D can be deposited into surface waters as a by-product from chlorination of organic material during water treatment (NTP, 2011). Treated waste water from paint and ink formulation processes can also release 1,3-D into surface waters (U.S. EPA, 2006).

6.2. Ground Water

1,3-D is more likely to be detected in surface water and “upper groundwater” (up to 2 meters below the surface) than in deep groundwater, and thus has very little potential to contaminate groundwater (WHO, 1993a; Oliver, 1987). Several studies have analyzed groundwater samples from wells in various locations in California, and have detected no traces of 1,3-D or the metabolite 3-chloroallyl alcohol (California SWRCB, 1983; Knuteson et al., 1992b; Maddy et al., 1982). Specifically, two ground water monitoring studies performed in Monterey and Merced Counties, looked at concentrations of 1,3-D in locations where Telone II had previously been applied. Both studies found no residue detections of 1,3-D (Knuteson et al., 1992b; Knuteson et al., 1992c). State law requires DPR to evaluate all pesticides for the potential to contaminate groundwater, based on physicochemical factors and method of application. 1,3-D does not meet the physicochemical criteria for inclusion on DPR’s groundwater protection list. Specifically, 1,3-D’s determined values for anaerobic soil metabolism and hydrolysis half-life do not exceed the Specific Numerical Values required for inclusion on the groundwater protection list (Johnson, 1989). A more detailed analysis by DPR confirmed the low potential for 1,3-D to contaminate groundwater (Dias et al., 2008)

6.3. Hydrolysis

One study estimated 1,3-D half-lives of 3.1 (± 0.1), 11.3 (± 0.5), and 51 (± 2.3) days at 30, 20, and 10° C, respectively, in sterile buffered water. Hydrolysis rates of 1,3-D are relatively independent of pH and are more influenced by temperature (McCall, 1986; Krijgsheld and van der Gen, 1986). However, another study found that the hydrolysis of 1,3-D in deionized water was pH dependent, with low pH inhibiting and high pH favoring the reaction (Guo et al., 2004). The same study found that other factors such as isomeric differences, photo irradiation, suspended particles, and small amounts of co-solutes has little effect on hydrolysis.

6.4. Volatilization

Due to its high Henry’s Law constant, 1,3-D tends to disappear rapidly in water, having a maximum estimated half-life of 50 hours (WHO, 1993a; U.S. EPA, 2006). In surface waters, volatilization of 1,3-D is a significant loss process that competes with biodegradation and hydrolysis. The relatively high water solubility of 1,3-D and low Koc suggests that it is more likely to remain in solution than become adsorbed to suspended aquatic materials and sediment (U.S. EPA., 2006).

6.5. Photolysis

One study determined the photolysis half-life of 1,3-D in sterile, tris buffer solution to be approximately 650 days; indicating that it is not a significant degradation pathway in water (Batzer et al., 1996).

7. ENVIRONMENTAL FATE AND DEGRADATION IN AIR

Due to its high volatility, and the methods involved in its use as a fumigant, a significant amount of 1,3-D finds its way into the atmosphere during application (Tuazon, *et al.*, 1984). Two separate studies have determined that approximately 40% of applied 1,3-D volatilizes into the air within 2-3 weeks after application (van Wesenbeeck, 1998; Knuteson *et al.*, 1997). Although 1,3-D is not a widely occurring atmospheric pollutant, most of the exposure to this compound appears to occur through air (U.S. EPA, 2006). In air, 1,3-D is degraded by photochemically produced hydroxyl radicals, with a half-life of 7 hours for the *trans*-isomer and 12 hours for the *cis*-isomer. 1,3-D is also degraded by reaction with ozone, with a half-life of 12 to 52 days (NTP, 2011).

7.1. Photooxidation

1,3-D isomers are photooxidized to form 3-chloropropionyl chloride, which is then rapidly hydrolyzed upon contact with condensed water to form 3-chloropropionic acid, and is removed from the atmosphere through rainfall. Because 1,3-D isomers are not degraded by UV radiation, reactions with ozone (O₃) and hydroxyl radicals (\cdot OH) (Figure 4) are assumed to be the main route for atmospheric degradation (Moilanen *et al.*, 1977; Tuazon *et al.*, 1984). Tuazon *et al.* (1984) determined the half-lives of *trans*- and *cis*-1,3-D with respect to reaction with O₃ to be 12 and 52 days, respectively.

7.2. Photolysis

The tropospheric half-lives under typical rural conditions of *trans*- and *cis*-1,3-D are approximately 30 and 50 hours, respectively, with *trans*-1,3-D being about 1.5 to 1.7 times more reactive than *cis*-1,3-D. Tuazon *et al.* (1984) suggested that the photodecomposition of 1,3-D may be enhanced by the presence of atmospheric particulates. Photodegradation of 1,3-D is greatly increased with increased light intensity and NO₂ concentration (Goersch and Dilling, 1979). The half-lives with respect to reaction with a simulated daytime concentration of \cdot OH radicals were determined to be 7 and 12 hours, respectively, for *trans*- and *cis*-1,3-D. Due to their short tropospheric half-lives, *trans*- and *cis*- 1,3-D are not expected to cause significant destruction of stratospheric ozone (Goersch and Dilling, 1979).

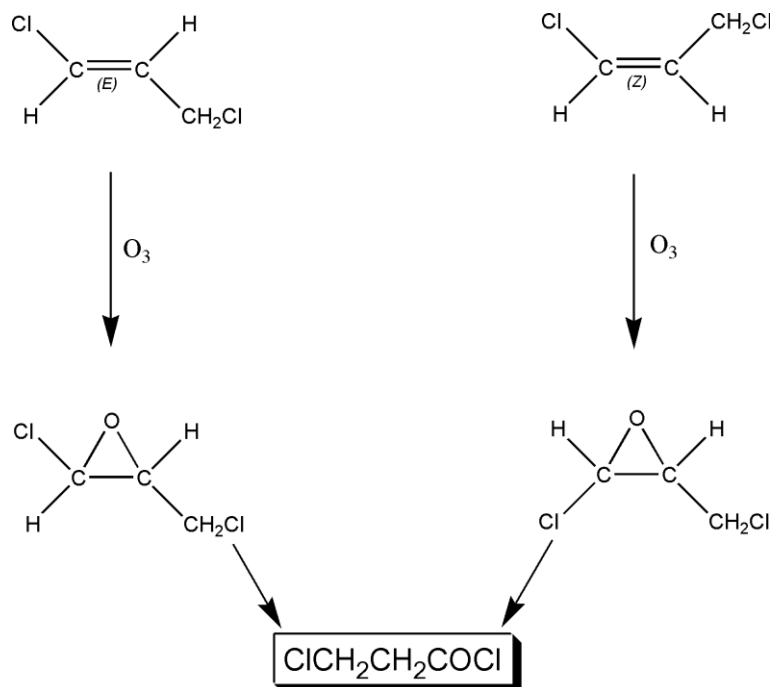


Figure 4. Diagram of trans- (E) and cis- (Z) 1,3-Dichloropropene reaction with ozone (O₃) (Redrawn from Moilanen, *et al.*, 1977).

8. ENVIRONMENTAL FATE AND DEGRADATION IN VEGETATION

Crops such as bush beans, carrots and tomatoes have been found to absorb 1,3-D from soil. 1,3-D is quickly absorbed and metabolized to 3-chloroallyl alcohol, which is subsequently absorbed by these plants and converted into normal plant products. Traces of 1,3-D were detected in plants 30 minutes after application, reached a maximum by 4 to 6 h and generally decreased to minimal levels by 24 to 36 h. The 1,3-D isomers and chloroallyl alcohol had short half-lives in the plants and were not detectable by 120 h after the initial administration. Due to its rapid metabolism in plants, and because most crops are not planted until most of the fumigant has dissipated, plant residues of 1,3-D appear to be of little consequence (Berry, *et al.*, 1980; WHO, 1993a).

9. NON-TARGET EFFECTS

Although 1,3-D is proven to be a good preplant alternative to methyl bromide for the removal of parasitic nematodes and other soil borne pests, non-target soil dwelling organisms have the potential to be exposed and adversely impacted by the introduction of 1,3-D. The acute oral toxicity of 1,3-D in animals is moderate to high, and the acute dermal exposure is moderately toxic (WHO, 1993b).

9.1. Invertebrates

1,3-D runoff from treated fields offers a potential source of contamination of water bodies and thus their aquatic invertebrate population. However, a US runoff study

showed less than 0.005% of the applied 1,3-D was in the runoff waters with concentrations of 20 ppb or less with such concentrations unlikely to be of major hazard to invertebrate species (NRA, 2001). In large concentrations, however, 1,3-D can be highly toxic to aquatic invertebrates.

In other invertebrate species 1,3-D's toxicity has been shown to be relatively low. A study found that 1,3-D is relatively nontoxic to honey bees and by utilizing a dusting technique, the researchers determined the 48-hr LD₅₀ to be 6.6 µg/bee (WHO, 1993b). Another study concluded that applications of 1,3-D do not adversely affect soil arthropods, but have an effect on earthworms and soil microflora. However, the effects observed were transient as full recovery was observed within six months of 1,3-D application for earthworms and 4.5 months for soil microflora (Small *et al.*, 2008).

Toxicity of 1,3-D to freshwater and saltwater algae and invertebrate species has been shown to be of moderate toxicity (Table 6). For example, the acute toxicity of 1,3-D in terms of the half maximal effective concentration after 48 hours to daphnia magna, a cladoceran freshwater water flea, has been shown to be 6,150 µg/L.

Table 6. Acute toxicity of 1,3-Dichloropropene for freshwater and saltwater species (U.S. EPA, 1980).

Species	48-hr EC ₅₀ (µg/L)	96-hr EC ₅₀ (µg/L)	96-hr LC ₅₀ (µg/L)
Freshwater			
<i>Selenastrum capricornutum</i>		4,950	
<i>Daphnia magna</i>	6,150		
Saltwater			
<i>Skeletonema costatum</i>		1,000	
<i>Mysidopsis bahia</i>			790

9.2. Vertebrates

The toxicity of 1,3-D is low to waterfowl and upland game birds, while 1,3-D is moderately toxic to cold water fish, and warm water fish as illustrated on Table 7 (NRA, 2001). Because of its application method, which reduces terrestrial exposure, and because of its relatively low toxicity to mammals, use of 1,3-D is not expected to result in large incidents of mortality in vertebrates (U.S. EPA, 1998). 1,3-D is rapidly absorbed, conjugated with glutathione (GSH) to form water-soluble mercapturic acids, and quickly excreted in the urine. 1,3-D does not bioaccumulate in target tissues, due to its high water solubility (U.S. EPA, 2000; WHO, 1993b). Acute and chronic toxicity to freshwater aquatic species occurs at concentrations as low as 6,060 and 244 µg/L, respectively. Acute toxicity to saltwater aquatic species can occur at concentrations as low as 790 µg/L (U.S. EPA, 1980). Birds are comparatively less sensitive to 1,3-D, with 8-day LC₅₀s of >10 g/kg reported for the Mallard duck and Bobwhite quail (WHO, 1993b).

In a 2006 peer reviewed report, the European Food Safety Authority stated that 1,3-D possess a high acute risk to earthworm eating and insectivorous birds and mammals and a long term risk to earthworm eating and insectivorous mammals (EFSA, 2006).

Table 7. Acute toxicity of 1,3-Dichloropropene for fish (WHO, 1993b).

Species	Test Type	Fish Size	Temp (°C)	96-hr LC ₅₀ (mg/litre)
Fathead minnow	static	0.9 g	18	3.39-4.97
Largemouth bass	static	1.0 g	18	3.52-3.78
Walleye	static	1.3 g	18	0.99-1.18
Golden orfe	-	2.8 g	20	8.0-11.0
Sheepshead minnow	static	8-15 mm	25-31	0.7-4.5
Rainbow trout	-	-	-	3.9
Bluegill	static	0.32-1.2 g	21-23	5.1-6.8
Guppy	semi-static	-	22	0.5
Goldfish	static	1.0 g	18	<7.5

10. ENVIRONMENTAL MONITORING

In 2000, the California Air Resources Board (ARB) conducted ambient air monitoring for 1,3-D in Kern County. The monitoring occurred from July to September to coincide with the use of 1,3-D as a preplant fumigant for roses and carrots. Of the 154 collected samples, 50 contained concentrations of 1,3-D above the Estimated Quantitation Limit (EQL) of 0.05 µg/m³, with 135 µg/m³ being the highest concentration detected (California Air Resources Board, 2000). Ambient air monitoring was also conducted by ARB in Monterey and Santa Cruz Counties from September 2001 to November 2001. Samples were collected every 24 hours for 8 weeks at 4 sites in Monterey County and 2 sites in Santa Cruz County. Of the 192 samples collected, 118 (61%) measured above the EQL of 0.108 µg/m³, with the highest concentration detected being 18.9 µg/m³. The highest average weekly concentration for the sampling period was 1.74 µg/m³. These detections were an increase from the previous year's measurements in Monterey and Santa Cruz Counties, when the highest detection recorded was 4.3 µg/m³, and the highest weekly average was 0.4 µg/m³ (California Air Resources Board, 2002).

In July, 2005, the California Department of Pesticide Regulation (DPR) monitored air concentrations of 1,3-D around an 8-acre application site in the Smith River Valley (Del Norte County). Air monitoring was conducted for 144 hours following the start of the application, which was made through shank injection at a depth of 18-20 inches. The highest detection of 1,3-D, 186 µg/m³, occurred during the last 24 hours of the monitoring phase. 1,3-D flux rates were higher during the day for the first 3 days of sampling and higher during the night for the second 3 days of sampling. The total amount of 1,3-D released from the application site during the monitoring phase was approximately 7.24% of the initial application amount (Wofford *et al.*, 2005).

In 2006, DPR conducted intensive air monitoring for 40 pesticides and pesticide breakdown products in the City of Parlier (Fresno County) as an environmental justice pilot project. A total of 71 samples collected were analyzed for VOCs, including 1,3-D, concentrations of 1,3-D above the Estimated Quantitation Limit (EQL) of 0.05 $\mu\text{g}/\text{m}^3$, with 23.6 $\mu\text{g}/\text{m}^3$ being the highest concentration detected (Wofford et al., 2009). The study established a one year average concentration for 1,3-D of 1.97 $\mu\text{g}/\text{m}^3$.

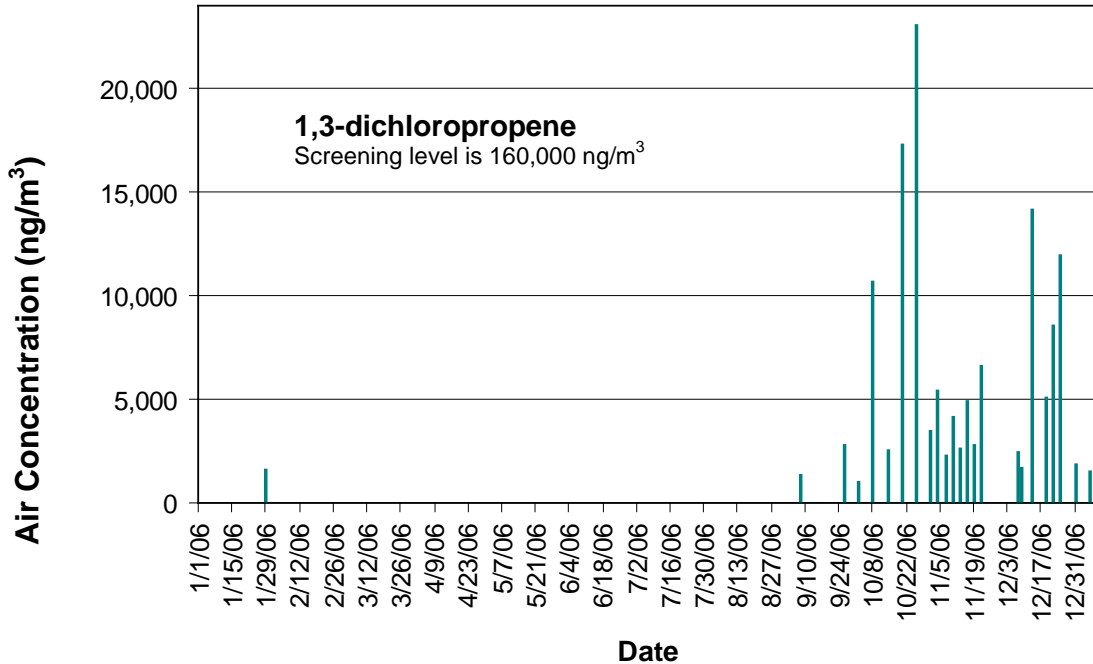


Figure 5. Highest 1,3-D one-day (acute) concentrations detected among three monitoring locations in Parlier. (Taken from Wofford et al., 2009).

ARB continuously monitors for 1,3-D as part of the Air Toxics "Hot Spots" Information and Assessment Act (AB 2588), which was enacted in 1987 and requires stationary sources to report to ARB the types and quantities of certain substances routinely released into the air. In 2010, A total of 473 VOC samples collected contained concentrations of both 1,3-D isomers. The highest concentration of 1,3-D detected was 1,361 ng/m^3 while the mean average for all 1,3-D observations was 226 ng/m^3 . (CARB, 2012).

On February 2011, DPR began monitoring for various pesticides and breakdown products, including 1,3-D, as part of the new intensive Air Monitoring Network (AMN). The AMN methodology was based on the Parlier monitoring project of 2009 with some alterations and was designed to sample ambient air for multiple pesticides in several communities in California on a regular weekly basis, over five years. A total of 141 VOC samples collected were analyzed for concentrations of 1,3-D. The highest concentration of 1,3-D detected was 12,249 ng/m^3 (both *cis*- and *trans*- 1,3-D isomers). First year results of the AMN study also included a highest 4-week rolling average of 798 ng/m^3 and a 1-year rolling average 1,3-D concentration from all sampling sites of 660 ng/m^3 for 2011 (Vidrio et al., 2012).

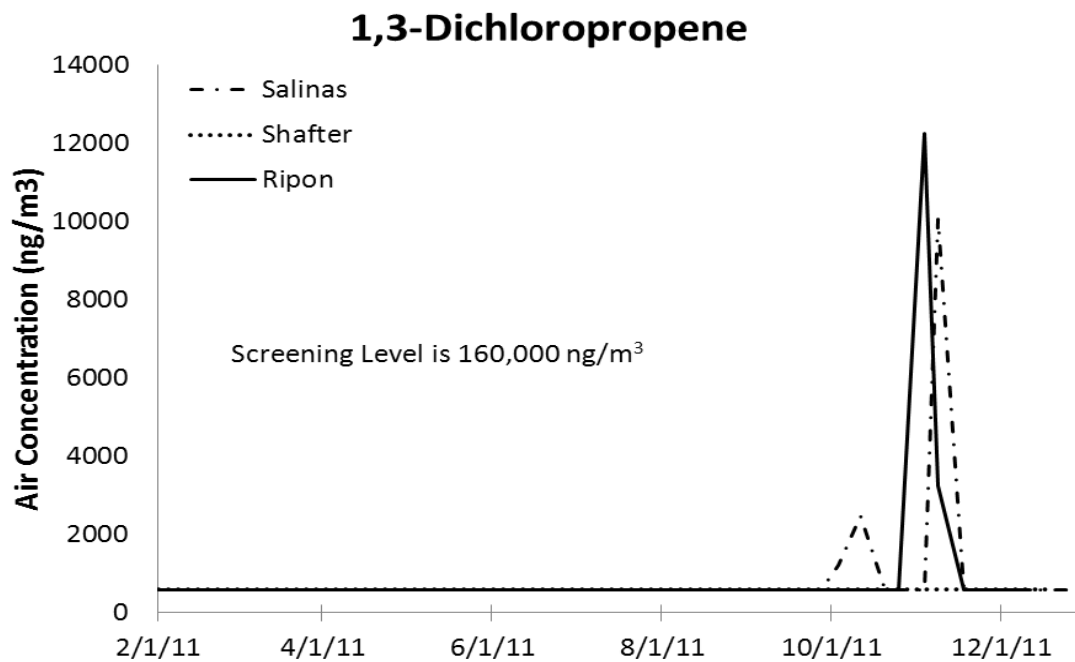


Figure 6. Highest 1,3-D one-day (acute) concentrations detected among three AMN monitoring locations for 2011. (Taken from Vidrio et al., 2012).

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