

US EPA ARCHIVE DOCUMENT

Date Out:

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ENVIRONMENTAL FATE AND MONITORING BRANCH

Review Action

To: Lois Rossi, Director, PM 03
Special Review and Reregistration Division (7508W)

From: Ibrahim Saheb, Agronomist
Environmental Fate & Monitoring Branch/EFED (7507C)

Thru: Betsy Behl, Chief
Environmental Fate & Monitoring Branch/EFED (7507C)

Attached, please find the EFED review of...

Common Name:	Dichlorvos (DDVP)	Trade name:	various
Company Name:	Amvac Chemical Corporation		
ID #:	084001		
Purpose:	Review environmental fate studies of to support reregistration of DDVP. Assess the environmental fate of DDVP and its impact on ground and surface water for the RED on this chemical.		

Type Product:	Action Code:	Review Time:
Insecticide	627	8 days

STATUS OF STUDIES

Guideline #	MRID	Status ¹	Data Requirement status ²
161-1	41723101	A	S
161-2	43326601	A	S
161-3	43642501	A	S
162-1	41723102	A	S
162-2	43835701	A	S
163-1	41723103	C	S
163-1	40034904	C	S
164-1	44297701	A	S
164-1	44386701	A	S

1Study Status Codes: A=Acceptable
2Data Requirement Status Codes:

U=Upgradeable C=Ancillary I=Invalid.
S=Satisfied P=Partially satisfied
N=Not satisfied R=Reserved W=Waived.



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1. CHEMICAL:

Common Name: Dichlorvos

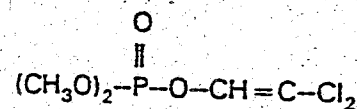
Trade Name: DDVP

Chemical Name: 2,2-Dichlorovinyl dimethyl phosphate

Chemical Abstract Registry No.: 62-73-7

Type of Product: Insecticide

Chemical Structure:



Dichlorvos (DDVP)

Physical/ Chemical Properties:

Molecular weight: 220.98

Boiling Point (at 20 °C): 140

Aqueous Solubility (at 25 °C): 10×10^3 ppm.

Vapor Pressure: 1.2×10^{-2} mmHg (at 20 °C)

Henry's Law Constant: 5.01×10^{-8} atm-m³/mol (measured).

K_{ow}: 23

2. TEST MATERIAL:

Refer to individual Data Evaluation Records (DERs)

3. STUDY/ACTION TYPE:

Review environmental fate studies of to support reregistration of DDVP. Assess the environmental fate of DDVP and its impact on ground and surface water for the RED on this chemical.

4. STUDY IDENTIFICATION:

(1)MRID No.41723101 (161-1)

R.V. Vithala. November 19, 1990. Hydrolysis of ¹⁴C-DDVP in aqueous solutions buffered at pH 5, 7, and 9. Performed by Center for Hazardous Materials Research. 320 William Pitt way Pittsburgh, PA 15238. Sponsored by Amvac Chemical Corporation 4100 East Washington Blvd. Los Angeles CA 90023. Laboratory Project ID No. 006/006/001/98.

(2)MRID NO. 43326601 (161-2)

Steven G. Mobley. July 27, 1994. Aqueous Photolysis of ¹⁴C-DDVP (Dichlorvos) in Artificial Light. Performed by PTRL East, Inc. 3945 Simpson Lane Richmond, KY 40475. Sponsored by Amvac Chemical Corporation 4100 East Washington Blvd. Los Angeles, CA 90023. Laboratory ID Agriseach Project No. 838.

(3)MRID No: 43642501 (161-3)

Bijay Misra. March 16, 1995. Photodegradation of ¹⁴C-DDVP (Dichlorvos) on a Sandy Loam Soil Under Artificial Sunlight Irradiation. Performed by Pittsburgh Environmental Research Laboratory, Inc. 3210 William Pitt Way Pittsburgh, PA 15238. Sponsored by Amvac Chemical Corporation 4100 East Washington Blvd Los Angeles CA 90023. Laboratory Project ID No. ME 9400184.

(4)MRID No: 41723102 (162-1)

Rama V. Vithala. November 26, 1990. DDVP- Aerobic Soil Metabolism of ¹⁴C-DDVP. Performed by Center for Hazardous Materials Research 320 William Pitt Way Pittsburgh, PA 15238. Sponsored by Amvac Chemical Corporation 4100 East Washington blvd. Los Angeles CA 90023. Laboratory ID Agriseach Project No. 006/006/004/89.

(5)MRID No: 43835701 (162-2)

Steven G. Mobley. October 26, 1995. Dichlorvos Anaerobic Soil Metabolism study. Performed by PTRL East, Inc. 3945 Simpson Lane, Richmond, KY 40475. Sponsored by Amvac Chemical Corporation 4100 East Washington Blvd Los Angeles CA 90023. Laboratory Project ID No. 882.

(6A)MRID No: 41723103 (163-1)

Rama V. Vithala. November 20, 1990. DDVP- Mobility of unaged DDVP using batch equilibrium technique. Performed by Center for Hazardous Materials Research 320 William Pitt Way Pittsburgh, PA 15238. Sponsored by Amvac Chemical Corporation 4100 East Washington blvd. Los Angeles CA 90023. Laboratory ID Agrisearch Project No. 006/006/008/89.

(6B)MRID No: 40034904 (163-1)

D. E. Pack. October 15, 1986. Freundlich Adsorption Isotherms of Dichloroacetic Acid. Performed by Chevron Chemical Company Lab. Sponsored by Amvac Chemical Corporation, Richmond CA. Laboratory ID Project No. 8614820.

(7A)MRID No: 44297701 (164-1)

Bruce C. Leppert. July 30, 1997. Dichlorvos terrestrial Dissipation study. Performed by Stewart Agricultural Research Services, Inc. P.O. box 509 Macon, MO 65202. Sponsored by Amvac Chemical Corporation 2110 Davie Ave City of Commerce CA 90040. Laboratory ID Agrisearch Project No. SARS-96-CA-72, Amvoc Protocol No. SARS-96-72.

(7B)MRID No: 44386701 (164-1)

Bruce C. Leppert. August 27, 1997. Dichlorvos: Terrestrial Field Dissipation of DDVP 2-E on Bareground Plot in Missouri. Performed by Stewart Agricultural Research Services, Inc. P o box 509 Macon, MO 65202. Sponsored by Amvac Chemical Corporation 2110 Davie Ave City of Commerce CA 90040. Laboratory ID Agrisearch Project No. CHW 6293-147, Amvac Protocol No. SARS-96-71.

5. REVIEWED BY:

Ibrahim Saheb, Agronomist
Fate and Monitoring Branch
Environmental Fate and Effect Division (EFED)

Date:

6. APPROVED BY:

Elizabeth Behl, Branch Chief
Fate and Monitoring Branch
Environmental Fate and Effect Division (EFED)

Date:

7. CONCLUSIONS:

All data requirements for the reregistration of the active ingredient DDVP can be considered satisfied.

Volatilization from soils is the major mode of dissipation of DDVP (vapor pressure = 1.2×10^{-2} mmHg) under field conditions. Acceptable laboratory studies also indicate rapid dissipation through volatilization. DDVP appears to degrade through aerobic soil metabolism and abiotic hydrolysis as well, but is secondary to volatilization. Hydrolysis is pH dependant where the half-lives were 11 days at pH 5, 5 days at pH 7 and 21 hours at pH 9. The major degradates were 2,2-dichloroacetic acid (DCA), 2,2-dichloroacetaldehyde (DAA), desmethyl DDVP, and glyoxylic acid. Aerobic soil metabolism data showed a half-life of 10 hours with the major metabolite being 2,2-dichloroacetic acid (62.8% of applied at 48 hours). Other metabolites present at less than 12% of applied were 2,2-dichloroacetaldehyde, and dichloroethanol. Extensive mineralization took place as CO_2 accounted for 60% of applied at 360 hours post-treatment. Due to rapid degradation of DDVP leaching/adsorption/desorption data were declared supplemental due to the inability to establish a soil/solution phase equilibrium. However, an acceptable soil TLC study (MRID #40279200) indicates that DDVP is moderately mobile (K_d 's ranging 0.3 to 1.2) based on the Heiling and Turner's mobility classification. The potential of DDVP to leach to ground water is mitigated by its rapid degradation. However, DDVP does have the potential to contaminate surface waters because of a low K_{oc} value and high water solubility (10×10^3 ppm). Substantial fractions of run-off will more than likely occur via dissolution in run-off water rather than adsorption to eroding soil. DDVP should not be persistent in any surface waters due to its susceptibility to rapid hydrolysis.

ENVIRONMENTAL FATE, SURFACE AND GROUND WATER ASSESSMENT:

Chemical hydrolysis and biodegradation are the major processes involved in the transformation of naled and its degradates in the environment. While direct photolysis in water is not a major degradative pathway for naled, indirect photolysis in the presence of photosensitizer may play an important role in the photodegradation of naled in aqueous media and soils. The degradate DDVP does not form under abiotic hydrolysis nor by direct photolysis in water, but forms by indirect photolysis in water and soils. In the presence of photosensitizer in water, as much as 20% of the applied dose of naled can be found as DDVP after 1 day, with rapid decline of DDVP residues afterwards. Under aerobic conditions, naled mineralizes rapidly to CO_2 and degrades to dichloroacetic acid and dichloroethanol, but DDVP is not detected. This is likely to be the result of the rapid degradation and mineralization of any DDVP that may form from naled. However, under anaerobic

aquatic conditions, DDVP can be as high as 15% of the applied naled dose after 1 day. The degradation of DDVP formed from naled under anaerobic conditions is slower (half-life 0.9 days) than under aerobic conditions.

DDVP is formed from trichlorfon in both soil and water by aerobic soil metabolism and hydrolysis. Environmental fate data indicate that trichlorfon degrades rapidly in aerobic soil ($t_{1/2}$ ~ 1.8 days) under non-sterile conditions; however, in a sterile soil, trichlorfon was stable ($t_{1/2}$ > 40 days). Abiotic hydrolysis studies indicate that trichlorfon degrades rapidly in aqueous media and that the rate of hydrolysis is pH dependent. The estimated hydrolysis half-life of trichlorfon is 31 minutes at pH 7, and 34 hours at pH 9, and 104 days at pH 5. This indicates the stability of trichlorfon to hydrolysis under acidic conditions. The maximum amount of DDVP formed from trichlorfon by aerobic aquatic metabolism is approximately 56 percent of the amount of trichlorfon originally applied at pH 8.5. This value was chosen because it maximizes the application rate for DDVP and provides a conservative estimate for potential groundwater contamination.

Screening models were used to determine estimated concentrations of DDVP in groundwater and surface water. Although these estimates are only for DDVP, there are several DDVP degradates that have been identified including desmethyl DDVP (Methyl O-(2,2-dichlorovinyl) phosphate), dichlorethanol, and dichloroacetic acid; this later degradate is very mobile.

The SCI-GROW screening model developed in EFED indicates that naled, trichlorfon, or DDVP will not be found in significant concentrations in groundwater. Concentrations of these compounds were calculated based on a maximum annual application rate of 9.375 lb a.i./acre for naled (the use rate on Cole crops), 8.17 lb a.i./acre for trichlorfon (turf), and 0.2 lb a.i./acre for DDVP (turf). The maximum amount of DDVP formed from naled is approximately 20 percent of the amount of naled originally applied. Therefore, a conservative DDVP use rate was selected as naled's use rate multiplied by 0.20. The application rate for DDVP formed from trichlorfon was estimated by multiplying trichlorfon's application rate (8.17 lb a.i./acre) by the maximum percent of DDVP (56%) formed as a trichlorfon degradate determined from the trichlorfon aerobic aquatic metabolism at pH 8.5. Since the groundwater concentrations were developed through a screening model and no monitoring data were used, we are only moderately confident of these estimates.

The groundwater concentrations estimated from the modeling do agree with limited existing groundwater monitoring data for these compounds. Monitoring data reviewed indicated that neither naled, DDVP, nor trichlorfon has been detected in groundwater. These data were not targeted to the pesticide use area.

The PRZM-EXAMS models were used to estimate surface water concentrations for naled, trichlorfon and DDVP. Turf was

used as the site of interest for trichlorfon. General outdoor uses (including turf) were used as the site of interest for DDVP. Eight crops were simulated for naled. The modeling results indicate that all these compounds have the potential to contaminate surface waters by runoff, for short periods of time especially in areas with large amounts of annual rainfall. However, based on its environmental fate characteristics, naled will degrade/dissipate rapidly ($t_{1/2} < 1$ day), trichlorfon and DDVP will persist slightly longer ($t_{1/2}$ 1.4 and ~ 5 days, respectively). Mitigation practices that reduce runoff could be effective in reduction of these chemicals transport into surface waters.

DDVP may reach surface water as a result of use of three pesticides: dichlorvos (DDVP), naled and trichlorfon. In the event that all of these pesticides are used in the same use area, then the contribution for each chemical should be incorporated in any risk assessment.

8. RECOMMENDATIONS:

Inform the registrant that the EFED has reviewed the submitted data and concluded that there are sufficient data to assess the environmental fate of Dichlorvos for reregistration of this active ingredient. In addition, the EFED has utilized SCI-GROW, GENNEC, and PRZM-EXAMS (2.3 and 3.1) models to estimate environmental concentrations of DDVP in ground and surface water. The EFED has also generated EECs for DDVP as a degradation product of naled and trichlorfon. See attached copy of water assessment.

9. DISCUSSION:

- a. See attached DERs.
- b. Executive Summary.

The submission of data required for the registration of DDVP is summarized below:

Satisfied:

- 161-1 Hydrolysis ; MRID# 41723101. Abiotic hydrolysis is an important, pH-dependent transformation mechanism for DDVP. The pseudo first order half-lives of DDVP are: 11.65 days

(279.60 hours) at pH 5; 5.19 days (124.62 hours) at pH 7, and 0.88 days (21.12 hours) at pH 9. Major hydrolytic degradates are 2,2-dichloroacetic acid (DCA), 2,2-dichloroacetaldehyde (DAA), desmethyl DDVP, and glyoxylic acid.

- 161-2 Photodegradation in Water; MRID# 43326601. Aqueous photolysis indicate DDVP dissipated with half-lives 10.2 days in the irradiated samples and 8.9 days in the dark control samples. Major degradates of DDVP in the Day 15 irradiated samples were 2,2-dichloroacetaldehyde (32.7%) and des-methyl DDVP (17.8%) of the applied radiocarbon. Under dark condition, major degradates were 2,2-dichloroacetaldehyde (42.0%) and des-methyl DDVP (16.3%).
- 161-3 Photodegradation on Soil; MRID #43642501. DDVP photodegraded with a half life of 15.5 hours on a sandy loam soil, and degraded with a half-life of 16.5 hours when incubated in darkness under similar conditions. After 72 hours of irradiation, 97% of the applied DDVP had dissipated from the soil by a combination of degradation and volatilization. Degradates identified in the irradiated soil were 2,2-dichloroacetic acid (26.6%), and 2,2-dichloroethanol (4.4%). The only degradation product formed under dark condition was 2,2-dichloroacetic acid of which 34% volatilized and 54.2% remained in soil.
- 162-1 Aerobic Soil Metabolism; MRID# 41723102. DDVP metabolized with a half-life of 10.18 hours in a sandy loam soil incubated in the dark at 25 °C under aerobic conditions. At 48 hours post-treatment, ¹⁴C-DDVP accounted for 6.39% of the initially-applied radioactivity (0.79 ppm). The major non-volatile metabolites formed during this aerobic metabolism were 2,2-dichloroacetaldehyde, dichloroethanol (each accounted for less than 12% of the initially applied radioactivity), and 2,2-dichloroacetic acid, which accounted for up to 62.8% of the initially applied radioactivity at 48 hours post-treatment. The only volatile metabolite was ¹⁴CO₂ which accounted for 60.8% of the initially applied radiocarbon after 360 hours post-treatment. This indicates that DDVP mineralizes readily in soils under aerobic conditions.
- 162-2 Anaerobic Soil Metabolism; MRID# 43835701. DDVP metabolized with a half-life of 6.3 days in sandy loam soil that was incubated anaerobically (flooding plus nitrogen atmosphere) in the dark at 25 °C and 75% of the FMC for 60 days. The major nonvolatile degradates in the water phase and soil extracts were 2,2-dichloroacetic acid, which accounted for up to 50.9% of the applied radioactivity at day 60; 2,2-dichloroacetaldehyde, which accounted for up to 23.2% of the applied radioactivity at day 1; and 2,2-dichloroethanol which accounted for up to 24.7% at day 60.

164-1 Terrestrial Field Dissipation A&B; MRID# 44297701 and MRID# 44386701, respectively. At the Missouri site, DDVP, at time 0 in the 0-inch soil layer was at 0.011 ppm, then was not detected in any of the later sampling intervals. A total of 13.4% of the applied DDVP was in the air and 90.6% of the applied DDVP was on the α -cellulose. The highest amount of DDVP residues in air filter (9 inch high) samples was 2.124 μg collected at 2 h after application. DCA residue in soil drop below LOD at the 28 days after application.

At the California site, DDVP, at time 0 in the 0-inch soil layer was at 0.005 ppm, then was not detected in any of the later sampling intervals. A total of 1.8% of the applied DDVP was in the air and 87.4% of the applied DDVP was on the α -cellulose. The highest amount of DDVP residues in air filter (9 inch high) samples was 2.063 μg collected at 2 h after application. DCA residue in soil drop below LOD at the 28 days after application.

At both sites, DDVP dissipated rapidly within application time and Time 0 sampling process.

Partially Satisfied:

- Leaching/Adsorption/Desorption (163-1)A; MRID# 41723103. Due to the rapid degradation of DDVP an equilibration time for DDVP between the soil and solution phases could not be established.

Supplemental:

- Leaching/Adsorption/Desorption (163-1)B; MRID# 40034904. For Dichloroacetic acid, the Freundlich constants (K_{ad}) values range from 0.15 to 0.46, and the corresponding (K_{oc}) values range from 9.38 to 24.2, indicating that dichloroacetic acid is weakly adsorbed.
- Soil TLC (Estimation of Soil Adsorption Coefficient of naled from (TLC Data), MRID#41354105. For DDVP, the K_d were (a) Blendon sandy loam soil 0.3 (pH 5.6; OM% 1.4); (b) Nicolett clay loam 0.8 (pH 7.0; OM% 0.7); © Oakley loamy sand 0.3 (pH 7.2; OM% 1.4); and (d) Stockton adobe clay 1.2 (pH 4.5; OM% 2.4).

Taking together, the partially satisfied (163-1 A) and the supplemental (163-1 B, and the soil TLC) studies, satisfy the 163-1 requirement.

10. BACKGROUND:

Dichlorvos is chlorinated organophosphate insecticide manufactured by Amvac Chemical Corporation for use in control of various insects.

Maximum application rates and reapplication intervals for: general outdoor areas including turf (0.2 lb ai/A, 1 day for commercial sites and 7 day for residential sites); manure piles (dry bait: 0.046 lb/1000 ft²; liquid spray: 0.046 lb/1000 ft²; 1 day reapplication interval); catch basins (1X80 g strip/1000 ft², usual control last 10 to 15 weeks); around structures (0.5 lb ai/A; 7 day for commercial and 30 day for residential sites); livestock/poultry (0.0013 lb ai/animal For livestock; 0.2 g/animal for poultry; 1 day interval).

11. COMPLETION OF ONE-LINER:

Attached.

12. CBI INDEX:

Not Applicable