2,4-D

general fact sheet

npic
NATIONAL PESTICIDE INFORMATION CENTER

What is 2,4-D?


photo credit: Martina, pixabay

2,4-D is an herbicide that kills plants by changing the way certain cells grow. 2,4-D comes in several chemical forms, including salts, esters, and an acid form. The toxicity of 2,4-D depends on its form. The form also affects what will happen to 2,4-D in the environment and what impacts it may have, especially on fish. 2,4-D is used in many products to control weeds, and it is often mixed with other herbicides in these products.

2,4-D was first used in the United States in the 1940s. Agent Orange, an herbicide used during the Vietnam War, contained both 2,4-D and 2,4,5-T. Dioxin, a by-product of 2,4,5-T, led to the ban of Agent Orange.

What are some products that contain 2,4-D?

Products containing 2,4-D may be liquids, dusts, or granules. The liquid forms may be concentrated or ready-to-use. There are over a thousand products with 2,4-D in them that are sold in the United States.

IMPORANT: Always ***follow label instructions*** and take steps to ***avoid exposure***. If any exposures occur, be sure to follow the First Aid instructions on the product label carefully. For additional treatment advice, contact the Poison Control Center at 800-222-1222. If you wish to discuss a ***pesticide problem***, please call 1-800-858-7378.

How does 2,4-D work?

2,4-D kills broadleaf weeds but not most grasses. 2,4-D kills plants by causing the cells in the tissues that carry water and nutrients to divide and grow without stopping. Herbicides that act this way are called auxin-type herbicides.

How might I be exposed to 2,4-D?

Products with 2,4-D may be used on farms, home lawns, roadsides, industrial areas, and pastures. You may be exposed if you are applying 2,4-D and you get it on your skin, breathe it in, or eat or smoke afterwards without washing your hands. You also may be exposed if you touch plants that are still wet with spray. You can limit exposure by following the label carefully if you are using products that contain 2,4-D. You can also stay away from grass or plants that have been treated until the leaves are dry.

What are some signs and symptoms from a brief exposure to 2,4-D?

Pure 2,4-D is low in toxicity if eaten, inhaled, or if it contacts the skin, and some forms are low in toxicity to the eyes. However, the acid and salt forms of 2,4-D can cause severe eye irritation. People who drank products containing 2,4-D vomited, had diarrhea, headaches, and were confused or aggressive. Some

people also had kidney failure and skeletal muscle damage. People who spilled 2,4-D on their skin developed skin irritation. Breathing 2,4-D vapors can cause coughing, a burning feeling in the airway, and dizziness.

Pets may be exposed to 2,4-D if they touch grass or other plants still wet from spraying and then groom their feet or fur, if they drink the pesticide, or possibly if they eat grass that has been treated with 2,4-D. Dogs may be more sensitive to 2,4-D than other animals. Dogs and cats that ate or drank products with 2,4-D in them developed vomiting, diarrhea, loss of appetite, lethargy, drooling, staggering, or convulsions. See the fact sheet about Pets and Pesticide Use for more information.

What happens to 2,4-D when it enters the body?

In humans, 2,4-D is not absorbed well through the skin or lungs, but it is absorbed into the body if swallowed. Sunscreen, insect repellents, and drinking alcohol may increase how much 2,4-D is absorbed through the skin. Once inside, 2,4-D moves throughout the body but does not build up in any tissues. The human body gets rid of most of the 2,4-D in the urine without changing it into anything else. More than 75% of the absorbed 2,4-D leaves the body in the first 4 days after exposure.

Is 2,4-D likely to contribute to the development of cancer?

Scientists have not found a clear link between 2,4-D and cancer in people. Because 2,4-D is often mixed with other herbicides, it is difficult to tell if 2,4-D or one of the other herbicides might be linked to cancer. Some studies have suggested that there may be links between non-Hodgkin's lymphoma and exposure to 2,4-D by itself, but other studies have not found any evidence of this.

In 2004, the EPA decided that 2,4-D could not be classified with regard to its ability to cause cancer because there was not enough data.

Has anyone studied non-cancer effects from long-term exposure to 2,4-D?

Animals fed high doses of 2,4-D for several weeks sometimes had fewer young or the young did not have normal skeletons. This only happened if the amount of 2,4-D fed to the mothers was enough to affect the mothers. 2,4-D has not been linked to health problems in human mothers or infants.

Are children more sensitive to 2,4-D than adults?

While children may be especially sensitive to pesticides compared to adults, there are currently no data to conclude that children have increased sensitivity specifically to 2,4-D.

What happens to 2,4-D in the environment?

2,4-D goes through different changes in the environment depending on its form. Most of the time, 2,4-D breaks down in soil so that half of the original amount is gone in 1-14 days. This breakdown time is called the "half-life" of the pesticide. One form of 2,4-D, the butoxyethyl ester, had a much longer half-life in aquatic sediment of 186 days.

2,4-D is broken down by bacteria in water and in soil. Water alone can also break down 2,4-D. 2,4-D has been found at low levels in shallow groundwater and streams in both rural and urban areas.

Can 2,4-D affect birds, fish, or other wildlife?

How 2,4-D affects animals and plants depends on the form of 2,4-D. Some of the ester forms of 2,4-D can be very toxic to fish and other aquatic life. The salt forms may be only slightly toxic to aquatic animals. Aquatic animals are more sensitive to 2,4-D as water temperature rises. 2,4-D may be moderately toxic to practically non-toxic to birds if they eat it. Eggs sprayed with 2,4-D still hatched and the chicks were normal. 2,4-D is practically non-toxic to honeybees. It is not expected to be a hazard to other beneficial insects.

Where can I get more information?

For more detailed information about 2,4-D please visit the list of referenced resources below, call NPIC between 8:00 AM and 12:00 PM Pacific Time (11:00 AM to 3:00 PM Eastern Time), Monday - Friday, at 800-858-7378, or visit us on the web at npic.orst.edu. NPIC provides objective, science-based answers to questions about pesticides.

Date Reviewed: March 2009

Cite as: Gervais, J.; Luukinen, B.; Buhl, K.; Stone, D. 2008. 2,4-D Technical Fact Sheet; National Pesticide Information Center, Oregon State University Extension Services. npic.orst.edu/factsheets/24Dgen.html

References:

1. Tomlin, C. D. S. The Pesticide Manual: A World Compendium, 14th ed.; British Crop Protection Council: Surrey, UK, 2006.
2. WHO. Environmental Health Criteria 84, Environmental Aspects - 2,4-Dichlorophenoxyacetic acid (2,4-D); International Programme on Chemical Safety, World Health Organization: Geneva, Switzerland, 1989.
3. Reregistration Eligibility Decision (RED) 2,4-D; EPA 738-R-05-002; U.S. Environmental Protection Agency, Office of Prevention, Pesticides and Toxic Substances, Office of Pesticide Programs, U.S. Government Printing Office: Washington, DC, 2005.
4. Charles, J. M.; Hanley, T. R.; Wilson, R. D.; Van Ravenzwaay, B.; Bus, J. S. Developmental Toxicity Studies in Rats and Rabbits on 2,4-Dichlorophenoxyacetic Acid and its Forms. Toxicol. Sci. 2001, 60, 121-131.
5. Carlo, G. L.; Cole, P.; MIller, A. B.; Munro, I. C.; Solomon, K. R.; Squire, R. A. Review of a Study Reporting an Association between 2,4-Dichlorophenoxyacetic Acid and Canine Malignant Lymphoma: Report of an Expert Panel. Regul. Toxicol. Pharmacol. 1992, 16, 245-252.
6. Kamrin, M. A. Pesticide Profiles: Toxicity, Environmental Impact, and Fate; Lewis Publishers: New York, 1997, p 306.

7. Munro, I. C.; Carlo, G. L.; Orr, J. C.; Sund, K. G.; Wilson, R. M.; Kennepohl, E.; Lynch, B. S.; Jablinske, M.; Lee, N. L. A Comprehensive, Integrated Review and Evaluation of the Scientific Evidence Relating to the Safety of the Herbicide 2,4-D. J. Am. Coll. Toxicol. 1992, 11, (5), 559-664.
8. FAO. Pesticide Residues in Food - Evaluations Part 1: Residues; FAO Plant Production and Protection Paper 152/1, Food and Agriculture Organization of the United Nations and World Health Organization: Rome, 1988; Vol. 1, pp 179-189.
9. Hazardous Substances Databank (HSDB), 2,4-D; U.S. Department of Health and Human Services, National Institutes of Health, National Library of Medicine. https://pubchem.ncbi.nlm.nih.gov/source/hsdb/202 (accessed June 2008), updated June 2005.
10. Pesticide Products. Pest-Bank [CD-ROM] 2007.
11. Label Review Manual; U.S. Environmental Protection Agency, Office of Prevention, Pesticides and Toxic Substances, Office of Pesticide Programs. https://www.epa.gov/sites/default/files/2018-04/documents/chap-07-mar-2018.pdf (accessed June 2008), updated Sept 2007.
12. Herbicide Handbook, 8th ed.; Vencill, W.K. Ed.; Weed Science Society of America: Lawrence, KS, 2002; pp 113-115.
13. Bradberry, S. M.; Proudfoot, A. T.; Vale, J. A. Poisoning Due to Chlorophenoxy Herbicides. Toxicol. Rev. 2004, 23 (2), 65-73.
14. Peterson, M. E.; Talcott, P. A. Small Animal Toxicology, 2nd ed.; Saunders Elsevier: St. Louis, 2006; pp 734-735.
15. Campbell, A.; Chapman, M. Handbook of Poisoning in Dogs and Cats; Blackwell Science Ltd.: Oxford, England, 2000; pp 220-221.
16. Arnold, E. K.; Lovell, R. A.; Beasley, V. R.; Parker, A. J.; Stedelin, J.R. 2,4-D Toxicosis III: An Attempt to Produce 2,4-D Toxicosis in Dogs on Treated Grass Plots. Vet. Hum. Toxicol. 1991, 33 (5), 457-461.
17. Paulino, C. A.; Guerra, J. L.; Oliveira, G. H.; Palmero-Neto, J. Acute, Subchronic and Chronic 2,4-Dichlorophenoxyacetic Acid (2,4-D) Intoxication in Rats. Vet. Hum. Toxicol. 1996, 38 (5), 348-352.
18. Reigart, J. R.; Roberts, J. R. Chlorophenoxy Herbicides. Recognition and Management of Pesticide Poisonings, 5th ed.; U.S. Environmental Protection Agency, Office of Prevention, Pesticides and Toxic Substances, Office of Pesticide Programs, U.S. Government Printing Office: Washington, DC, 1999; pp 94-96.
19. Charles, J. M.; Cunny, H. C.; Wilson, R. D.; Bus, J. S. Comparative Subchronic Studies on 2,4-Dichlorophenoxyacetic Acid, Amine, and Ester in Rats. Fundam. Appl. Toxicol. 1996, 33, 161-165.
20. Charles, J. M.; Bond, D. M.; Jeffries, T. K.; Yano, B. L.; Stott, W. T.; Johnson, K. A.; Cunny, H. C.; Wilson, R. D.; Bus, J. S. Chronic Dietary Toxicity/ Oncogenicity Studies on 2,4-Dichlorphenoxyacetic Acid in Rodents. Fundam. Appl. Toxicol. 1996, 33, 166-172.
21. Charles, J. M.; Dalgard, D. W.; Cunny, H. C.; Wilson, R. D.; Bus, J. S. Comparative Subchronic and Chronic Dietary Toxicity Studies on 2,4-Dichlorophenoxyacetic Acid, Amine, and Ester in the Dog. Fundam. Appl. Toxicol. 1996, 29, 78-85.

22. Hoppin, J. A.; Umbach, D. M.; London, S. J.; Alavanja, M. C. R.; Sandler, D. P. Chemical Predictors of Wheeze among Farmer Pesticide Applicators in the Agricultural Health Study. Am. J. Respir. Crit. Care Med. 2002, 165, 683-689.
23. Kamel, F.; Tanner, C. M.; Umbach, D. M.; Hoppin, J. A.; Alavanja, M. C. R.; Blair, A.; Comyns, K.; Goldman, S. M.; Korell, M.; Langston, J. W.; Ross, G. W.; Sandler, D. P. Pesticide Exposure and Self-reported Parkinson's Disease in the Agricultural Health Study. Am. J. Epidemiol. 2006, 165 (4), 364-374.
24. Draft List of Initial Pesticide Active Ingredients and Pesticide Inerts to be Considered for Screening Under the Federal Food, Drug, and Cosmetic Act. Fed. Regist. June 18, 2007, 72 (116), 33486-33503.
25. Hayes, H. M.; Tarone, R. E.; Cantor, K. P.; Jessen, C. R.; McCurnin, 25. D. M.; Richardson, R. C. Case-Control Study of Canine Malignant Lymphoma: Positive Association With Dog Owner's Use of 2,4-Dichlorphenoxyacetic Acid Herbicides. J. Natl. Cancer Inst. 1991, 83, 1226-1231.
26. Garabant, D. H.; Philbert, M. A. Review of 2,4-Dichlorophenoxyacetic Acid (2,4-D) Epidemiology and Toxicology. Crit. Rev. Toxicol. 2002, 32 (4), 233-257.
27. Gandhi, R.; Wandji, S.-A.; Snedeker, S. Critical Evaluation of Cancer Risks from 2,4-D. Rev. Environ. Contam. Toxicol. 2000, 167, 1-33.
28. Maire, M. A.; Rast, C.; Landkocz, Y.; Vasseur, P. 2,4-Dichlorophenoxyacetic Acid: Effects on Syrian Hamster Embryo (SHE) Cell Transformation, c-Myc Expression, DNA Damage, and Apoptosis. Mutat. Res. 2007, 631, 124-136.
29. IARC Monographs on the Evaluation of Carcinogenicity Risks to Humans. Overall Evaluations of Carcinogencity: An Updating of IARC Monographs, Volumes 1 to 42; International Agency for Research on Cancer: Lyon, France, 1987; Supplement 7.
30. Madrigal-Bujaidar, E.; Hernandez-Ceruelos, A.; Chamorro, G. Induction of sister chromatid exchanges by 2,4-dichlorophenoxyacetic acid in somatic and germ cells of mice exposed in vivo. Food Chem. Toxicol. 2001, 39, 941-946.
31. Collins, T. F. X.; Williams, C. H. Teratogenic Studies with 2,4,5-T and 2,4-D in the Hamster. Bull. Environ. Contam. Toxicol. 1971, 6 (6), 559-567.
32. Lerda, D.; Rizzi, R. Study of reproductive function in persons occupationally exposed to 2,4-dichlorophenoxyacetic acid (2,4-D). Mutat. Res. 1991, 6 (6), 1, 47-50.
33. Brand, R. M.; McMahon, L.; Jendrzejewski, J. L.; Charron, A. R. Transdermal absorption of the herbicide 2,4-dichlorphenoxyacetic acid is enhanced by both ethanol consumption and sunscreen application. Food Chem. Toxicol. 2007, 456, 93-97.
34. Brand, R. M.; Spaulding, M.; Mueller, C. Sunscreens Can Increase Dermal Penetration of 2,4-Dichlorphenoxyacetic Acid. J. Toxicol. Clin. Toxicol. 2002, 40 (7), 827-832.
35. Pont, A. R.; Charron, A. R.; Brand, R. M. Active ingredients in sunscreens act as topical penetration enhancers for the herbicide 2,4-dicholorphenoxyacetic acid. Toxicol. Appl. Pharmacol. 2004, 195, 348-354.
36. Kohli, J. D.; Khanna, R. N.; Gupta, B. N.; MDhar, M. M.; Tandon, J. S.; Sircar, K. P. Absorption and Excretion of 2,4-Dichlorophenoxyacetic Acid in Man. Xenobiotica 1974, 4 (2), 97-100.

37. Sauerhoff, M. W.; Braun, W. H.; Blau, G. E.; Gehring, P. J. The Fate of 2,4-Dichlorophenoxyacetic Acid (2,4-D) Following Oral Administration to Man. Toxicol. 1977, 8, 3-11.
38. Roberts, T. R. Metabolic Pathways of Agrochemicals - Part 1: Herbicides and Plant Growth Regulators; The Royal Society of Chemistry: Cambridge, UK, 1998; pp 66-74.
39. Van Ravenzwaay, B.; Hardwick, T. D.; Needham, D.; Pethen, S.; Lappin, G. J. Comparative metabolism of 2,4-dichlorophenoxyacetic acid (2,4-D) in rat and dog. Xenobiotica 2003, 33 (8), 805-821.
40. Arnold, E. K.; Beasley, V. R. The Pharmacokinetics of Chlorinated Phenoxy Acid Herbicides: A Literature Review. Vet. Hum. Toxicol. 1989, 31 (12), 121-125.
41. CDC. Third National Report on Human Exposure to Environmental Chemicals; U.S. Department of Health and Human Services, Centers for Disease Control and Prevention: Atlanta, 2005; pp 390-394.
42. Olsson, A. O.; Baker, S. E.; Nguyen, J. V.; Romanoff, L. C.; Udunka, S. O.; Walker, R. D.; Flemmen, K. L.; Barr, D. B. A liquid chromatographytandem mass spectrometry multiresidue method for quantification of specific metabolites of organophosphorus pesticides, synthetic pyrethroids, selected herbicides, and DEET in human urine. Anal. Chem. 2004, 76 (9), 2453-2461.
43. OSHA. Occupational Safety and Health Guideline for 2,4-D (Dichlorophenoxyacetic Acid); U.S. Department of Labor, Occupational Safety and Health Administration. https://www.osha.gov/chemicaldata/750 (accessed May 2008), updated April 1999.
44. Vogue, P.A.; Kerle, E.A.; Jenkins, J.J. OSU Extension Pesticide Properties Database; Oregon State University: Corvallis, OR, 2004.
45. Wilson, R. D.; Geronimo, J.; Armbruster, J. A. 2,4-D Dissipation in Field Soils After Applications of 2,4-Dimethylamine Salt and 2,4-D Ethylhexyl Ester. Environ. Toxicol. Chem. 1997, 16 (6), 1239-1246.
46. Boivin, A.; Amellal, S.; Schiavon, M.; van Genuchten, M. T. 2,4-dichlorophenoxyacetic acid (2,4-D) sorption an ddegradation dynamics in three agricultural soils. Environ. Pollut. 2005, 138, 92-99.
47. Pesticides in Surface and Groundwater of the United States: Summary of Results of the National Water Quality Assessment Program (NAWQA); U.S. Geological Survey: Reston, VA, 1998.
48. McPherson, A. K.; Moreland, R. S.; Atkins, J. B. Occurrence and Distribution of Nutrients, Suspended Sediment, and Pesticides in the Mobile River Basin, Alabama, Georgia, Mississippi, and Tennessee, 1999-2001; Water-Resources Investigations Report 03- 4203, U.S. Geological Survey: Montgomery, AL, 2003; pp 1-2, 44, 57.
49. Rice, C. P.; Chernyak, S. M.; McConnell, L. L. Henry's Law Constants for Pesticides Measured as a Function of Temperature and Salinity. J. Agric. Chem. 1997, 45, 2291-2298.
50. Torstensson, N. T. L.; Lundgren, L. N.; Stenstrom, J. Influence of Climatic and Edaphic Factors on Persistence of Glyphosate and 2,4-D in Forest Soils. Ecotoxicol. Environ. Saf. 1989, 18, 230-239.
51. Food and Drug Administration Pesticide Program Residue Monitoring 2003; U.S. Food and Drug Administration, Center for Food Safety and Applied Nutrition, Office of Plant and Dairy Foods: Washington, DC, 1993-2003.
52. Pesticide Data Program Annual Summary, Calendar Year 2006; U.S. Department of Agriculture, Agricultural Marketing Service: Washington, DC, 2007.

53. Relyea, R. A. The Impact of Insecticides and Herbicides on the Biodiversity and Productivity of Aquatic Communities. Ecolo. Appl. 2005, 15 (2), 618-627.
54. Intergrated Risk Information System, 2,4-Dichlorphenoxyacetic Acid (2,4-D) (CASRN 94-75-7); U.S. Environmental Protection Agency. https://epa.gov/ncea/iris/subst/0150.htm (assessed April 2008), updated Jan 2008.
55. ACGIH. TLVs and BEIs, Based on the Documentation of the Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices; American Conference of Governmental Industrial Hygienists Worldwide: Cincinnati, 2003; p 24.
56. Drinking Water Contaminants; U.S. Environmental Protection Agency. https://www.epa.gov/sdwa/drinking-water-regulations-and-contaminants (accessed May 2008), updated Feb 2008.