



No. 33: Pesticides and Cancer

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BACKGROUND

Many people have concerns about whether pesticides have the potential to induce tumors or to cause cancer. This publication defines the terms used in classifying carcinogens, explains regulatory options, and identifies pesticides currently classified as carcinogens. The evaluation of pesticides is an ongoing process, and classifications may change. The reader may wish to periodically check the web sites referred to in the text for updated information.

Substances that have the potential to cause tumors – benign or malignant – are termed *oncogenes*, while those that may cause malignant tumors are called *carcinogens*. Oncogenicity and carcinogenicity studies are conducted as part of the data base required by the U.S. Environmental Protection Agency (EPA), the federal body that regulates pesticides. Some pesticides, as well as many other synthetic and naturally-occurring substances, have been found to cause tumors under certain conditions. It is important to remember that both the substance's potency and the exposure level

to the substance are primary factors affecting the level of risk. Some substances, both natural and synthetic, are potent carcinogens, while others are considered weak carcinogens. It takes a much higher dose, or exposure, for cancer to develop from a weak carcinogen than from a potent one.

REGULATORY OPTIONS

When a pesticide is shown to be oncogenic or carcinogenic at levels expected to occur from normal use of the pesticide, EPA may choose from several options.

The Agency may cancel or suspend registration of the pesticide for some or all use; modify the use of the pesticide such as reducing the rate of application, increasing the preharvest interval, or limiting the number of times application can be made to a specified crop, commodity, or site within a given time; or require that more or different protective gear be worn while handling the pesticide. These measures reduce exposure, and thus the risk, for the pesticide applicator and for consumer.

Educating People to Help Themselves

Another option is to classify a pesticide for restricted use. Restricted use pesticides (RUP) can legally be used only by a trained, certified pesticide applicator, or an individual under his/her supervision. To become certified to apply these products, applicators must demonstrate competency by passing an exam.

SOURCES OF INFORMATION ON CARCINOGENICITY

There are many sources of information on pesticides and carcinogenicity. Two of the most readily available sources include a pesticide's label and Material Safety Data Sheet (MSDS). Pesticides classified as RUPs on the basis of oncogenicity or carcinogenicity will so state on the label. The designation will appear on the front of the label and may use language such as "Restricted Use Pesticide. This product has been shown to cause tumors in laboratory animals." The MSDS may contain a notation that the pesticide is a carcinogen. Another reliable source of information is the International Agency for Research on Cancer (IARC). IARC maintains a web site at www.iarc.fr.

CLASSIFICATION OF CARCINOGENS

EPA classifies carcinogens using a system adapted from one developed by IARC. Such a classification system helps scientists characterize and compare the carcinogenic hazard of various compounds, both synthetic and naturally occurring. Substances are classified on the basis of a variety of tests including types and diversity of tumors induced, structural relationship of a compound to other carcinogens, and whether positive results have been replicated. The basic classification system and EPA's definitions are described below.

Group A- Known human carcinogens

Substances in this group have sufficient evidence from epidemiologic data (studies on humans) to support a causal relationship between exposure to the agent and cancer. Examples of known human carcinogens include UV radiation, aflatoxins, arsenic, mineral oils, radon, tobacco, and some viruses. All uses of pesticides classified as Group A carcinogens have been canceled except (1) coal tar and chromium as wood preservatives and (2) ethylene oxide (EtO), which retains limited uses as a sterilant for medical and beekeeping equipment and in spice sterilization facilities

Group B - Probable human carcinogens

Examples of probable human carcinogens include anabolic steroids, phenacetin, and some viruses.

B1: Substances in this subgroup have sufficient evidence from animal studies, but only limited evidence from epidemiologic studies. All uses of pesticides classified as Group B1 carcinogens have been canceled except creosote as a wood preservative, and formaldehyde, In addition to being a component of some pesticides, formaldehyde is found in many personal care products and other commodities.

B2: Substances in this subgroup have sufficient evidence from animal studies, with inadequate or no evidence from epidemiologic studies. All or most uses of 28 pesticides classified as Group B2 carcinogens have been canceled or were never approved. Other pesticides classified as B2 continue to be allowed for use with appropriate mitigating measures to reduce risks to workers and consumers.

Group C - Possible human carcinogen

Substances in this group have limited evidence of carcinogenicity from animal studies, and no data from epidemiologic studies. Examples of possible human carcinogens include bracken fern, caffeic acid, carbon tetrachloride, lead, and phenytoin (an anticonvulsant medication). All or most uses of 15 pesticides classified as Group C carcinogens have been canceled or were never approved. Other pesticides classified as C have various food and other uses.

Group D - Not classifiable as to human carcinogenicity

Substances in this group have inadequate or no animal or human carcinogenicity data. Examples of unclassifiable substances include acrylic fibers, ampicillin, cimetidine, and saccharin.

Group E - Evidence of noncarcinogenicity for humans

Substances in this group have no evidence of carcinogenicity in at least two animal tests in different species in adequate animal and epidemiological studies. Caprolactam, used in the manufacture of nylon 6, is an example of a substance classified as probably noncarcinogenic to humans.

USE OF TABLES IN THIS PUBLICATION

The tables below identify pesticides classified by EPA and/or by other agencies

as probable and possible carcinogens. In most cases, only actual pesticide products are included in the table; intermediates in the production process are not generally included.

Food and non-food uses described in the tables are based on registration information. For convenience and brevity, uses in the tables have been condensed into broad categories such as vegetables, fruits, nuts, field crops, etc. In fact, pesticide products must be specifically registered for each type of fruit, vegetable, field crop, etc. for which the registrant is granted a registration. Some of the pesticides in the tables bear specific registrations on many crops within a particular category such as fruit or vegetables; others are registered on a much narrower variety. The reader should also be aware that, while a pesticide may retain a registration for a particular use, it may or may not be widely used in actual practice.

NOTE: The tables only include pesticides classified as carcinogens prior to 2003. Since that time, procedures have changed and data are no longer compiled in one place. More information can be found on EPA's pesticide reregistration web page at www.epa.gov/pesticides/reregistration/status.htm. Access the document(s) listed under "Decision" or Fact Sheets" for each active ingredient. However, be aware that EPA no longer updates the page and the apparent substitute (Pesticide Chemical Search) does not link to documents or provide description of decisions.

Group A Pesticides

Active Ingredient	Use Pattern	Regulatory Status
Arsenic, inorganic	Wood preservatives; food use; indoor/outdoor	Food uses voluntarily canceled 1993; remaining uses are ant baits and wood preservatives; RUP
Arsenic acid Arsenic pentoxide Arsenic, sodium	Desiccants, herbicides	Scheduled for reregistration eligibility decision, 2003
Benzene	Food use, animal use	Voluntary cancellation 1985
Chromium VI	Wood preservative	(See arsenic, inorganic)
Coal Tar (Coke Oven Emissions)	Indoor/outdoor use, wood/non-wood use	All uses canceled 1986 except wood use (label restrictions); RUP
Ethylene Oxide Group I (IARC, 1994) - see also under Group B1	Fumigant, sterilant; food use, non-food use	

Group B1 Pesticides

Active Ingredients	Use Pattern	Regulatory Status
Acrylonitrile	Fumigant; stored tobacco, food processing areas, termiticide	Canceled 1980
Cadmium	Fungicide; lawn / turf	Last product canceled 1986
Creosote	Wood preservative	RUP
Ethylene Oxide (OHEA, 1985) see also under Group A	Fumigant, sterilant; food use, non-food use	
Formaldehyde	Fumigant; germicide; food use	

Group B2 Pesticides

Active Ingredients	Use Pattern	Regulatory Status
Acetaldehyde		No current food uses; EPA is in the process of revoking food tolerances
Acetochlor	Herbicide; cabbage, citrus, coffee, peas, maize, onions, orchards, soybeans, sugarbeets, sunflowers, vineyards	Conditional registration allows for automatic cancellation in use of several alternative herbicides is not reduced; RUP for some uses
Acifluorfen, sodium salt	Herbicide; soybeans, peanuts, rice	

Aldrin	Insecticide; food and non-food uses	All uses canceled 1989
Amitrole	Herbicide; non-food outdoor uses	Reregistration Eligibility Document issued 1996; RUP for all uses except homeowner use
Aniline -- not registered as active ingredient but as an analog		
Aramite	Roses	All products canceled by 1984
Azobenzene	No uses	No records indicating registered or pending products
Bis(chloroethyl)ether (BCEE)	No uses	No records indicating registered or pending products
Cacodylic Acid	Herbicide; cotton, forestry	
Captafol	Fungicide; food use	All products voluntarily canceled 1987
Captan	Fungicide; food use	
Carbon tetrachloride	Fumigant; grain	Some uses voluntarily canceled 1985; other uses canceled 1988; RUP for museum use
Chlordane	Insecticide; vegetables, structures	All uses canceled by 1988
Chlordimeform	Insecticide/acaricide; food use (cotton only)	RUP
Chloroaniline	Seed treatment, foliar treatment	All uses canceled 1977
Chloroform	Fumigant; grain	Some uses canceled 1983
Cyproconazole (SAN 619F)	Fungicide; small grains, coffee, sugarbeets, stone and pome fruits, peanuts, turf	
Daminozide (Alar)	Plant growth regulator; ornamentals	Food use tolerances revocation 1990
Dibromochloropropane (DBCP)	Soil fumigant; food uses	Canceled 1988
DDT	Insecticide; food and non-food uses	Food uses canceled 1983; non-food uses canceled 1988
1,3-Dichloropropene (Telone)	Nematicide, soil fumigant; various food uses	Currently in Special Review for groundwater issues; RUP
Dicloromethane	Food and non-food uses, indoor/outdoor uses	Some uses canceled 1986
Dieldrin	Insecticide; food uses, termiticide use	All uses canceled by 1989
1,1-Dimethyl hydrazine	Food uses; non-food uses	

Di(2-ethylhexyl)phthalate		Canceled due to nonsupport of uses by the registrant
Dipropyl isocinchomeronate (MGK 326)	Non-food use (topical animal use)	No pending new uses
Epichlorohydrin	No uses	No records indicating registered or pending pesticide products
Ethylene dibromide (EDB)	Fumigant; food and non-food uses	All food uses canceled 1983 except mangoes (expired 1987) and papaya (voluntarily canceled 1987); remaining uses are vault fumigation and quarantine fumigation of nursery stock; RUP for some use
Ethylene dichloride	Fumigant	Product canceled 1985
Ethylene thiourea (ETU)	Metabolite of ethylene bisdithiocarbamate (EBDC) fungicides; food and non-food uses	Thiram (one of the EBDCs) is scheduled for reregistration eligibility decision, 2003. EBDC fungicides underwent Special Review; some products were canceled
Fenoxycarb	Insect growth regulator; fruits, tree nuts, citrus, pasture grasses, cucurbits, ornamentals, stored products, ant baits	
Folpet	Fungicide; seed and plant bed treatment for fruits, vegetables, ornamentals	
Furmecyclox	Wood preservative	No action from company since 1987
Haloxypop-methyl	Herbicide; no food uses	
Heptachlor and heptachlor epoxide	Insecticide; food and non-food uses, termiticide use	All uses canceled 1988 except fire ant use, for which a Reregistration Eligibility Document issued 1992; RUP
Hexachlorobenzene (HCB)	Seed protectant	Voluntarily canceled 1984
Hexachlorocyclohexane	Food uses	Some products canceled 1978; others reformulated to lindane
Lactofen	Herbicide; cotton, soybeans	
Lindane	Insecticide; pecans, avocados, livestock, forestry, Christmas trees, dog treatments, structures	Some uses classified RUP

Mancozeb	Fungicide; field crops, fruits, vegetables, nuts, commercial, sod, cotton, potatoes, corn, safflower, sorghum, peanuts, flax, cereal grains, sugar beets, ornamentals, golf courses	
Maneb	Fungicide; potatoes, field crops, tobacco, ground nuts, hops, sugar beets, fruits, vegetables, ornamentals	
Metam-sodium	Fungicide, herbicide, insecticide, nematocide, soil fumigant; food and non-food uses	Homeowner uses canceled by Metam-sodium Task Force. Agricultural labels are general use except small area uses which are classified RUP.
Methylene chloride (see dichloromethane)		
Metiram (see ethylene thiourea)	EBDC fungicide; food and non-food uses	Limited to use on apples, potatoes, and roses.
Methyl isothiocyanate	Fumigant	
Mirex	Insecticide	Canceled 1987
Orthophenylphenol	Fungicide; food use	
Orthophenylphenol and sodium salt	Fungicide	
Oxythioquinox	Insecticide/acaricide, fungicide; citrus, ornamentals	
Pentachlorophenol (PCP)	Wood preservative; no food uses	Wood uses canceled 1986; RUP
Polychlorinated biphenyls (PCBs)	Not registered as pesticides; considered contaminants	Elimination of all active and inert uses 1970
Procymidone	Fungicide; cereals, fruits, vegetables, industrial sites	
Pronamide	Herbicide; vegetables, fruits, ornamentals, turf, Christmas trees	RUP
Propargite	Acaricide; tree nuts, fruits, vegetables, field crops, ornamentals, Christmas trees	
β -Propiolactone	No uses	No records indicating any registered or pending pesticide products
Propoxur	Insecticide; greenhouse, indoor/outdoor structural pests; no food uses	

Propylene Oxide	Food use	
Terrazole	Fungicide; grains, field crops	
Tetrachloroethylene (perchloroethylene)	Non-food uses; indoor/outdoor uses	Canceled 1992 for non-support by registrant
Thiodicarb	Insecticide; vegetables, field crops	
Toxaphene	Insecticide; food uses	Canceled 1982
Trichloroethylene	Indoor/outdoor uses	Products canceled 1985
Trichlorophenol 2,4,6	Disinfectant	Canceled 1987
Triphenyltin hydroxide	Fungicide; vegetables, field crops, pecans, rice	RUP
UDMH	Contaminant of commercial daminozide and a metabolite of daminozide which is formed in the body, during food processing, or when spray mixes containing daminozide are left standing in the mixing tank. Non-food uses.	All food uses of daminozide were voluntarily canceled in 1989. Use on ornamentals and bedding plants remains.

Group C Pesticides

Active Ingredients	Use Pattern	Regulatory Status
Acephate	Insecticide; field, fruit, and vegetable crops; food handling establishments; ornamentals and turf; and home uses	Risk mitigation measures required for occupational exposures; dietary exposures not a concern; residential indoor and turf uses canceled 2001.
Acrolein	Insecticide, rodenticide; agricultural irrigation waters	RUP
Amitraz	Insecticide, acaricide; fruits, cotton, ornamentals	RUP for some uses
Asulam	Herbicide; sugarcane, Christmas trees, forestry, noncropland, turf, ornamentals	
Atrazine	Herbicide; field crops	RUP
Benomyl	Fungicide; fruits, nuts, vegetables, field crops, turf	
Bifenthrin	Insecticide/miticide; cotton, corn, fire ants, greenhouse ornamentals	RUP for emulsifiable concentrates
Bromacil	Herbicide; pineapple, citrus, noncrop areas	

Bromoxynil	Herbicide; field crops, cereal grains, mint, onions	
Calcium cyanamide	Herbicide, fungicide; food and non-food uses	Canceled 1984
Carbaryl	Insecticide; citrus, fruits, vegetables, forage crops, forests, field crops, lawns, nuts, ornamentals, rangeland, turf, shade trees, indoor/outdoor uses	
Clofentezine	Miticide; fruits, nuts, ornamentals	RUP
Cyanazine	Herbicide; corn and cotton	Sale and use of products will cease in 2002 with rate reductions each year prior; RUP
Cypermethrin	Insecticide; cotton, fruits, vegetables, structural pests, indoor/outdoor uses	RUP for all agricultural uses
Dacthal (DCPA)	Herbicide; vegetables, strawberries, field crops, turf, ornamentals	
Dichlobenil	Herbicide; orchards, vineyards, cranberries, ornamentals, nurseries, public green areas, noncrop industrial sites	
Dichlorvos (DDVP)	Insecticide; fruits, vegetables, greenhouse crops, household, public health, stored products	
Diclofop-methyl	Herbicide; barley, wheat	RUP
Dichloroethylene, 1,1	Fumigant	
Dicofol	Acaricide; fruits, vegetables, field crops, ornamentals	
Difenoconazole	Fungicide; wheat, sugar beets, peanuts, fruits, vegetables	
Dimethenamid	Herbicide; field crops	
Dimethipin	Plant growth regulator; cotton, rice, field crops	
Dimethoate	Insecticide, acaricide; fruits, vegetables, citrus, field crops, ornamentals, grains, structures	
Dinoseb	Herbicide	All uses canceled 1989
Ethalfuralin	Herbicide; field crops, cucurbits, non-food uses, indoor/outdoor uses	
Ethiozin		

Ethofenprox	Non-food uses	
Fenbuconazole	Fungicide; stone fruits	
Fipronil	Insecticide; corn, domestic animals, indoor bait stations	Corn use registered 11/14/97; other uses pending
Fluometuron	Herbicide; grapes, cotton	
Fomesafen	Herbicide; soybeans	
Hexachloroethane		No records indicating any registered or pending pesticide products
Hexaconazole	Fungicide; import use on bananas	
Hexythiazox	Miticide; food and non-food uses	
Hydramethylnon	Insecticide; ant control; food and non-food uses	
Hydrogen cyanamide	Plant growth regulator; grapes, kiwi	New uses under consideration; RUP on grapes
Imazalil	Fungicide; citrus, wheat, barley	
Isophorone	Food use	Company has submitted for review information rebutting carcinogen classification
Isoxaben	Herbicide; turf, ornamentals	
Linuron	Herbicide; noncrop sites	Tolerances revoked 1999; no food uses remain
Mercaptobenzothiazole	Fungicide; aquatic indoor uses	Products canceled due to maintenance fees and Data Call-In. Tolerances revocation by 2002.
Methidathion	Insecticide, acaricide; field crops, fruits, tree nuts, artichokes	RUP for all uses except nursery stock, safflower, and sunflower
Methyl 2-benzimidazole carbamate (MBC)	Sanitizer, algicide; no food uses. MBC is also a common breakdown product of ethyl and methyl thiophanate fungicides	
Methylphenol, 3-(m-cresol)	Wood preservative; food uses	
Metolachlor	Herbicide; field crops, woody ornamentals	Some uses RUP
MGK Repellent 326	Repellent	
MGK-264	Synergist ; non-food uses only	
Molinate	Herbicide; rice	
Nitrofen	Herbicide; food uses	Voluntary cancellation 1983

Norflurazon	Herbicide; tree nuts, vine crops, peanuts, cotton	
N-Octyl bicycloheptene dicarboximide (MGK-264)	Synergist for pyrethrins, allethrin, pyrethroids, and rotenone; often used with piperonyl butoxide in aerosols, household, and industrial sprays; food and non-food uses, indoor/outdoor use	
Oryzalin	Herbicide; fruit trees, tree nuts, vineyards, turf, ornamentals	
Oxadiazon	Herbicide; turf, ornamentals	
Oxadixyl	Fungicide; vineyards, vegetables, ornamentals, seed treatments	
Oxyfluorfen	Herbicide; fruits, vegetables, nuts, conifers, noncropland	
Paradichlorobenzene	Non-food uses, indoor/outdoor uses	
Parathion	Insecticide; field and grain crops, cotton	RUP
Pendimethalin	Herbicide; field crops, cereal grains, turf, ornamentals, industrial sites, ground maintenance	
Pentachloronitrobenzene	Soil fungicide; vegetables, field crops, ornamentals, turf	
Permethrin	Insecticide; fruits, vegetables, field crops, nuts, rangegrass, greenhouse, ornamentals, turf, lawns, wood treatment, structures	RUP for broadcast applications
Phosmet	Insecticide; vegetables, fruits, citrus, nuts, field crops, ornamental trees, Christmas trees	
Phosphamidon	Insecticide; food use	Products canceled 1984
Piperonyl butoxide	Synergist for pyrethrins, allethrin, pyrethroids, rotenone; food and non-food uses, greenhouse (indoor), household uses	
Prochloraz	Fungicide	Not registered in the U.S.; temporary tolerances expired 1989
Prodiamine (Rydex)	Herbicide; food uses, industrial sites	
Propazine	Herbicide; food uses, outdoor uses	

Propiconazole	Fungicide; cereal crops, grasses grown for seed, pecans, turf, ornamentals	
4-Pyridazine carboxylic acid, 2-(4-chlorophenyl)-3-ethyl-2,5-dihydro-5-oxo-, potassium salt (MON 21200)	Wheat	No new pending uses
Pyrimethanil	Fungicide; fruit, ornamentals, vegetables, and vines	
Pyriithiobac-sodium	Herbicide; cotton	
Simazine	Herbicide; fruits, citrus, nuts, field crops, ornamental and tree nursery stock, turf, industrial sites, lawns	RUP for uses on grapes and berries
TCMTB (Busan 72)		
Tebuconazole	Fungicide; peanuts, peaches, cherries, nectarines, bananas, seed treatment on grains	
Terbutryn	Herbicide; grain sorghum, fallow land	Canceled 1991
1,1,2-Tetrachloroethane	Non-food uses	Canceled 1987
Tetrachlorvinphos	Insecticide used on livestock and their premises	
Tetramethrin	Insecticide	
Thiazopyr	Herbicide	
2-(Thiocyanomethylthio) benzothiazole (TCMTB)	Fungicide, wood preservative; field and grain crops	
Triadimefon	Fungicide; fruits, wheat, grasses grown for seed, pines, sugar beets, cucurbits, Christmas trees, turf, ornamentals	
Triadimenol	Fungicide; seed treatment on wheat, barley, oats, rye, and corn	
Triallate	Herbicide; field and grain crops	
Tribenuron-methyl	Herbicide; wheat, barley	
1,1,1-Trichloroethane	Fumigant; on-food uses	Canceled 1992
1,1,2-Trichloroethane	Fumigant	
Tridiphane	Herbicide; food use	
Trifluralin	Herbicide; fruits, vegetables, field crops, citrus, nuts, grains	RUP for use on berries, grapes, citrus

Triflurosulfuron-methyl	Herbicide; sugar beets	
Uniconazole	Plant growth regulator; ornamentals	
Vinclozolin	Fungicide; apples, snap beans, grapes, lettuce, onions, raspberries, turf, ornamentals	Canceled for stone fruits, strawberries, tomatoes

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