WATER QUALITY ADVISORY

ALACHLOR

Criteria and Standards Division

Office of Water Regulations and Standards

United States

Environmental Protection Agency

MARCH 1986

WATER QUALITY ADVISORY
Number 1 .

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Office of Water Regulations and Standards
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The advisory concentration for Alachlor in ambient water for the protection of freshwater aquatic life is estimated to be 76 ug/L. The literature search and review do not include any saltwater data so no advisory is proposed for protection of saltwater aquatic organisms. Care should be taken in the application of this advisory, with consideration of its derivation, as stated in the attached support document.

A value given to protect aquatic life can be derived from no observed effect levels (NOEL), the lowest concentration found in the which has been observed to cause acute or chronic toxicity or other experimental data which may be applicable. When there is no valid experimental evidence, a value may be derived from a model which uses structure-activity relationships (SAR) as its basis. The advisory concentrations should be used with caution, since they are derived from minimal experimental evidence, or in the case of SAR derived values, without data on the specific chemical.

The advisory concentration for Alachlor in ambient water for the protection of human health is estimated to be 0.15 ug/L, based on data and information which are available to U.S. EPA. Care should be taken in the application of this advisory, with consideration of its derivation, as stated in the attached support document.

An advisory concentration can be derived from a number of sources: The Office of Drinking Water Health Effects Advisories; Acceptable Daily Intake(ADI) values from EPA; Office of Pesticides and Toxic Substances risk assessments; Carcinogen Assessment Group(CAG) cancer risk estimates; risk estimates derived from the open literature; or other sources which will be given in the support document. The advisory concentrations derived from these sources will vary in confidence and usefulness, based on the amount and quality of data used as well as the assumptions behind the original estimates. The user is advised to read the background information carefully to determine the strengths or deficiencies of the values given in the advisory.

HUMAN HEALTH AND AQUATIC LIFE LITERATURE SEARCH AND DATA BASE EVALUATION FOR ALACHLOR

U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF WATER REGULATIONS AND STANDARDS
CRITERIA AND STANDARDS DIVISION
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INTRODUCTION

Alachlor [2-chloro-2', 6'-diethyl-N-(methoxymethyl)acetanilide] is a herbicide used as either a preplant-incorporated or preemergence, earlypostemergence surface-applied treatment. Alachlor is used for the control of annual grasses and certain broadleaf weeds and yellow nutsedge. Tolerant crops include corn (all types), soybeans, dry beans, potatoes, peanuts, and cotton.

Alachlor was first introduced in 1966 by the Monsanto Company under the tradename Lasso and code number CP 50144 (Worthing, 1977). It is now manufactured by Monsanto, Makhteshim-Agan, and Pillar International under the trade names Lasso, Alanex, and Pillarzo, respectively (Hartley et al, 1983). Common formulations of alachlor products include an emulsifiable concentrate containing 4 lb of active ingredient per gallon, and a granule form of 150 g of active ingredient per kilogram (Worthing, 1977). In 1971, more than 20 million pounds of alachlor were applied in the United States, and it is now one of the most widely used chloracetamide herbicides in the country (McEwen and Stephenson, 1979).

Alachlor prevents germination in plants by penetrating the hypocotyl where it acts as a protein synthesis inhibitor (Hartley and Kidd, 1983). Application rates range from 1 to 2.5 kg/ha, depending on soil and climate conditions (Worthing, 1977).

Alachlor has the molecular formula $C_{14}H_{20}ClNO_2$. It is solid at room temperature, white to cream colored, and odorless. Physical and chemical properties of the pure chemical are given below: (WSSA, 1979; Worthing, 1977)

Molecular weight	269.8
Specific gravity	1.133 at 25-15.6 C

Melting point	39.5 to 41.5 C
Boiling point	100 C at 0.02 mm Hg 135 C at 0.3 mm Hg
Decomposition temperature	105 C
Vapor pressure	2.2×10^{-5} mm Hg at 25 C 0.02 mm Hg at 100 C
Solubility in water	242 ppm at 25 C

It is soluble in ether, acetone, benzene, chloroform, ethanol, and ethyl acetate and it is slightly soluble in heptane. Alachlor is hydrolyzed under strongly acidic or alkaline conditions.

Occurrence

Alachlor has one of the largest production volumes of any pesticide, 130 to 150 million lbs produced in 1983. Alachlor is applied to the soil either before or just after the crop has emerge

Alachlor is degraded in the environment by a number of mechanisms. It is metabolized rapidly by crops after application. Once in the soil alachlor is degraded by bacteria both under aerobic and anerobic conditions. It is not photodegradeable and does not hydrolyze under environmental conditions. The pesticide has moderate mobility in sandy and silty soils and has been demonstrated to migrate to ground water. Alachlor does not bioaccumulate.

Alachlor have been reported to occur in both ground and surface waters. Limited data have been reported in both Federal and state surveys of surface water where alachlor was reported to occur at levels of 1 ppb. Based upon the available data, alachlor is believed to have the potential to contaminate ground and surface water widely.

Food does not appear to be a major route of exposure. Residues of alachlor in food are usually non-detectable. Current EPA standards for alachlor food residues are limited to levels which when combined, would result in a maximum daily doses of 0.6 ug/kg. In areas where drinking water levels exceed 0.3 ug/L, water will exceed this permitted dose, and would be the major source of alachlor exposure.

SCOPE OF SEARCH

Literature searches were conducted for alachlor using the TOXLINE, TOXBACK, and NTIS computerized data bases, and through bibliographic review of aquired literature focusing primarily on controlled, dose-response studies. Only those sources dealing with human health effects and aquatic toxicity data were collected.

The quality assurance control measures employed in the studies were evaluated specifically on their use of positive and negative controls, large treatment and control groups, replication, and chemical analysis of test concentrations. Information on

bioaccumulation, field observations, food chain effects, and sublethal effects also was extracted from articles.

Data from each literature source were tabulated by biological species, medium of test exposure (water, fish, sediment, food), concentration, observed effects, and data quality-assurance specifications. Based on these findings, recommendations for appropriate interim criteria for alachlor for the protection of human health and aquatic life were formulated and finalized when data permitted.

The available dose-response data were compared to the requirements specified in the "Guidelines and Methodology Used in Preparation of Health Assessment Chapters of the Consent Decree Water Quality Criteria Documents" (FR 45:79347, November 28, 1980) and the "Guidelines for Deriving Numerical National Water Quality Criteria for The Protection of Aquatic Life and Their Uses" (Stephan et al., 1985).

SUMMARY OF FINDINGS

Aquatic Toxicity

The pertinent aquatic toxicity studies reviewed to date are summarized in Table 1.

Only one chronic study was located. Call et al. (1984) exposed early life-stages of the fathead minnow (embryos, fry, and juveniles) to a maximum concentration of 1.1 mg/L of alachlor for 64 days. The no observed effect level (NOEL) concentration was estimated to be between 0.52 and 1.10 mg/L.

Studies of acute effects (96 hr) with fathead minnow, rainbow trout, catfish and bluegill estimated a range of LD50s (lethal dose for 50% of the exposed population) for alachlor between 2.4 and 6.5 mg/L (Table 1, Figure 1). The range widens slightly to 1.4-13.4 ppm when all reported LC50s are considered. Concentrations of alachlor necessary to affect growth or to kill fathead minnows in laboratory studies were greater than maximum concentrations of alachlor measured in streams from watersheds where it was used (Call et al., 1984).

A number of aquatic toxicity tests were reviewed by the Office of Pesticide Programs (OPP) of EPA. Results of two of the studies indicated a range of 1.8 to 4.2 ppm as the 96-hour LC50 for rainbow trout. The 96-hour LC50 values in two studies on bluegill sunfish ranged from 2.8 to 6.4 ppm. These are very close to the values described above, and support the conclusion, that alachlor is moderately toxic to both coldwater and warmwater fish in amounts greater than 1.4 ppm.

No studies were found that noted biomagnification of alachlor through the aquatic food chain. In a model ecosystem study (Yu et al., 1975), species of algae, crab, daphnia, Elodea, fish, mosquito,

TABLE 1. SUMMARY OF AQUATIC TOXICITY LITERATURE REVIEW OF ALACHLOR

Test Species	LC_{50}[a] (ppm)	Test Duration	Exposure Medium	Quality Assurance Specifications	Miscellaneous Observed Effects	Reference
Fathead minnow (*Pimephales promelas*) (30 days old)	LC_{50} 9.9 LC_{50} 6.6 LC_{50} 5.0 LC_{50} 3.0	24 hr 48 hr 96 hr 192 hr	Lake Superior water (flow through system)	Technical grade alachlor (92.6%) Replication (20) Controls LC_{50}s determined by the trimmed Spearman-Karber method.	Concentrations necessary to kill fish in laboratory studies are greater than maximum concentrations measured in streams from watersheds where it is used. Not highly bioconcentrated in fish tissue (BCF = 6 after 6-d exposure); readily eliminated.	Call et al., 1984
Fathead minnow eggs, fry (<24 hrs) and juvenile fish	NOEL 0.52 - 1.10 Bioconcentration from days 1-21 was 50 and 41 for lower and higher exposures, respectively	64 days	Lake Superior water (flow through); Concentrations: 0.06, 0.14, 0.26, 0.52, 1.10 mg/L	Data analyzed by one-way analysis of variance in conjunction with Dunnett's procedure	No significant ($p<0.05$) effect on hatching success, incidence of dead and abnormal fry immediately after hatching, or fish survival.	Call et al., 1984
Rainbow trout (*Salmo gairdneri*) 100-150 g (avg. individual weight)	NR[b]	Low level alachlor exposure 4-5 days (sacrificed 24 hr after)	Injection of 37 kBq of ^{14}C-labeled alachlor	Samples analyzed by GC/MS Chromatogram development was in an	Readily eliminated both as parent compound and as metabolites. Most of the radioactivity from injected trout was recovered in tank water	Call et al., 1984

[a] LC_{50} - Lethal concentration for 50% of test organisms (unless otherwise noted).
[b] NR = Not reported in source document.

TABLE 1. (Continued)

Test Species	LC_{50} (ppm)	Test Duration	Exposure Medium	Quality Assurance Specifications	Miscellaneous Observed Effects	Reference
		injection of alachlor)		Eastman "Chromagram"• development apparatus.	within 24 hrs, of which 60% appeared to be parent compound.	
Rainbow trout (Salmo gairdneri) (0.8 g b.w.)	LC_{50} 2.4 (95% CI 1.8-3.1)	96 hr	Reconstituted deionized H_2O (flow through)	Toxicity data analyzed by a statistical method described by Litchfield and Wilcoxon (1949). Tests performed according to the Committee on Methods Methods for Toxicity Tests with Aquatic Organisms (1975). Technical Alachlor, (100%) Duplication Controls	NR	Johnson, and Finley, 1980
Bluegill (Lepomis macrochrius) (1.0 g b.w.)	LC_{50} 4.3 (95% CI 3.5-5.5)	96 hr	Same as above	Same as above		Johnson and Finley, 1980
Rainbow trout (Salmo gairdneri) (0.8 g b.w.)	LC_{50} 1.4 (95% CI 1.1-1.8)	96 hr	Same as above	Same as above except 43% liquid alachlor	NR	Johnson and Finley, 1980

TABLE 1. (Continued)

Test Species	LC_{50} (ppm)	Test Duration	Exposure Medium	Quality Assurance Specifications	Miscellaneous Observed Effects	Reference
Bluegill (*Lepomis macrochirus*) (1.0 g b.w.)	LC_{50} 3.2 (95% CI 2.3-4.5)	96 hr	Same as above	Same as above except 43% liquid alachlor	NR	Johnson and Finley, 1980
Rainbow trout	TL_m[a] 2.3	96 hr	NR	NR	NR	WSSA, 1979
Bluegill	TL_m 13.4	96 hr	NR	NR	NR	WSSA, 1979
Catfish	LD_{50}[b] 6.5	96 hr	NR	NR	NR	WSSA, 1979
Algae, crab, daphnia, Elodea, fish, mosquito, snail (ecosystem study)	NR	33 days	Alachlor applied to base of 7 day -old sorghum plants in aquarium at rate of 2.7 lb/acre	99% alachlor Procedure of Metcalf et al., 1971 Thin layer chromatographic and radioauto-graphic analyses	Alachlor rapidly degraded in water. No evidence of magnification of parent compound or its metabolites in the food chain No parent compound detected in the organisms except snails (contained unknowns) Snail accumulated 24 x more alachlor metabolites than concentration in water.	Yu et al., 1975
Crayfish	LD_{50} 19.5	96 hr	NR	NR	NR	WSSA, 1979

[a] TL_m = Toxic lethal median concentration.
[b] LD_{50} = Lethal dose for 50% of the exposed population.

OBSERVED EFFECTS

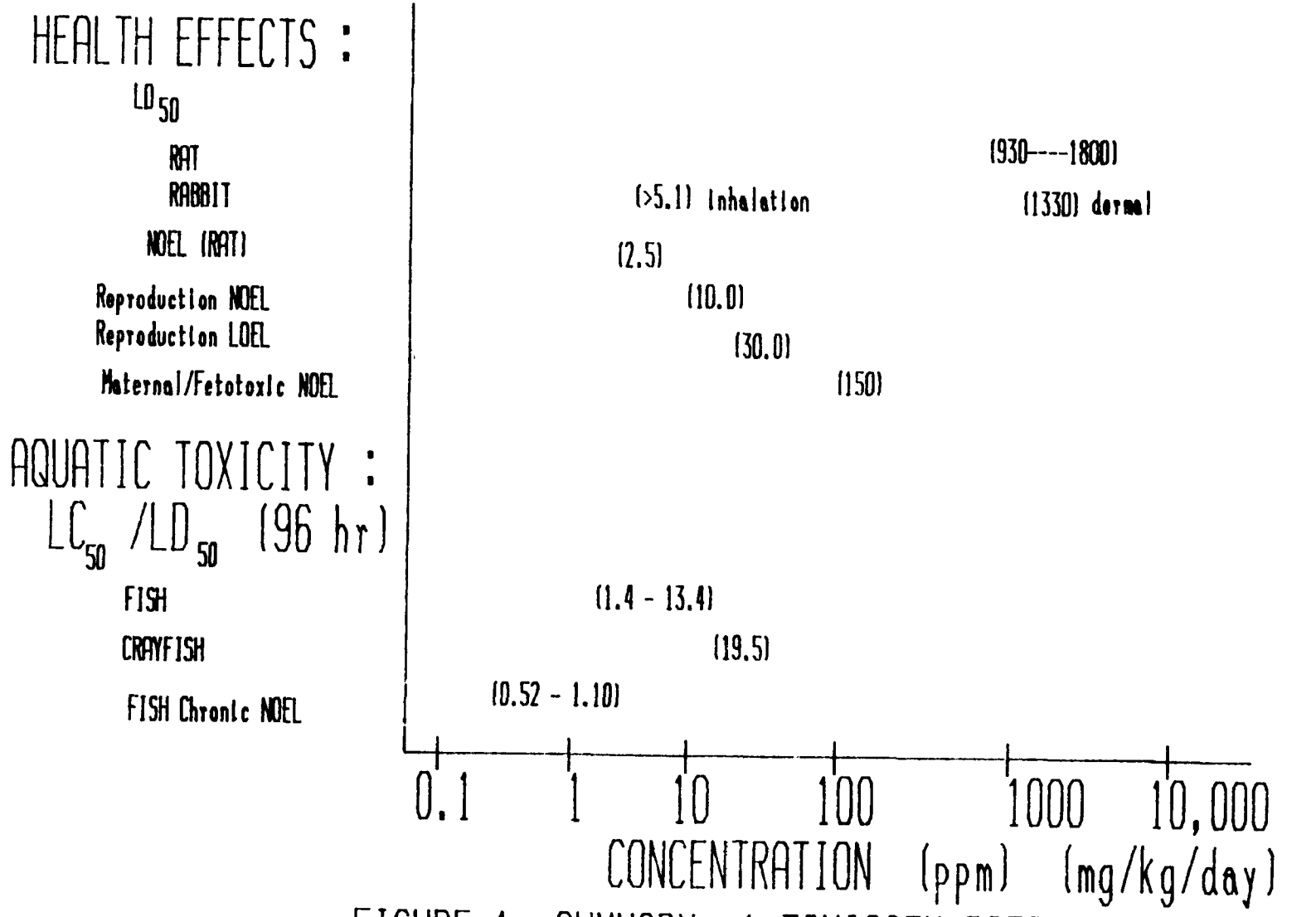

FIGURE 1. SUMMARY of TOXICITY DATA for ALACHLOR

and snail were exposed to alachlor (2.7 lb/acre) for 33 days. Alachlor was rapidly degraded in the water, with only 1.8% of the initial amount present after 33 days. When solvent extracts from water and organisms were analyzed by thin layer chromatography there was no evidence that alachlor or its degradation products were magnified in the food chain.

In an uptake and elimination study by Call et al. (1984), a 14C-labeled alachlor solution in methanol was delivered to aquaria containing 100 30-day-old fathead minnows. Alachlor uptake was rapid, with an equilibrium established within 24 hrs. About 13% of the total 14_C was extracted as the parent herbicide, for a mean bioconcentration factor (BCF) of 6.0 as alachlor. 14_C also was rapidly eliminated upon transfer of fish to uncontaminated water, with 81 and 98% being eliminated after 24 hours and 14 days, respectively.

Health Effects

Animal studies have reported acute oral LD50s in rats ranging from 930 to 1800 mg/kg body weight (Georgian et al., 1983; WSSA, 1979; Monsanto, 1978). Alachlor exhibits relatively low acute toxicity by the dermal (rabbit LC50 = 13.3 g/kg) and inhalation (rabbit LD50 ,5.1 ml/l) routes of exposure (Monsanto, 1978 and 1981) (Table 2, Figure 1). Eight-day oral LC50 values for pheasant, mallard ducklings, and bobwhite quail chicks were >10,000, >5,000 and >5,000 ppm, respectively (WSSA, 1979).

Rats and beagles fed 20, 200, or 2000 ppm alachlor for 90 days exhibited normal growth patterns at the lower concentrations; however, animals fed 2000 ppm alachlor exhibited some growth depression and weights of male dogs were below normal (WSSA, 1979). In a six-month dog feeding study, alachlor was shown to cause hepatoxicity at 5.0, 25.0, 50.0, and 75.0 mg/kg/day. Liver fatty degeneration and biliary hyperplasia occurred in both sexes at dose levels of 25 mg/kg/day and greater (Ahmed et al., 1981).

In a study by Georgian et al. (1983), Wistar rats were fed food containing 200 ppm alachlor for 280 days (daily intake of approximately 1.7 mg/kg. The treatment failed to induce any pre-eminent genetic effects, although chromatid gaps, breaks and fragments were observed.

TABLE 2. SUMMARY OF HEALTH EFFECTS LITERATURE REVIEW OF ALACHLOR

Test Species	LD50/NOEL LOEL (ppm)	Test Duration	Exposure Medium	Quality Assurance Specifications	Other Effects (Epidemiological Information)	Reference
Rat	LD_{50}[a] 1200 mg/kg	NR[b]	Oral	NR	NR	Georgian et al., 1983
	LD_{50} 1800 mg/kg	NR	Oral, acute; emulsifiable concentrate at 4 lb/gal	NR	NR	WSSA, 1979
	LC_{50} <32	1 hr (14 day observation)	Vapor inhalation	NR	NR	WSSA, 1979
Rat	LD_{50} 930 mg/kg	NR	Oral	NR	NR	Monsanto, 1978
Rat (Wistar)	NR	280 days	Oral; granulated food with 220 ppm alachlor (approx. daily intake of 1.7 mg/kg b.w)	Controls Replicates	Chromatid and chromosome breaks, chromatid and chromosome exchanges included as chromosomal abnormalities.	Georgian et al., 1983
	NR	24 hr	Single i.p. injection of 1.25, 2.50, and 5.0 mg alachlor/g b.w Observations made on bone marrow cells after 24 hrs.	Controls Replicates	Dose-related clastogenic effects found for 1.25 and 2.50 mg/g b.w doses	Georgian et al., 1983

[a] LD_{50} = Lethal dose for 50% of test organisms.
[b] NR = Not reported in source document.

TABLE 2. (Continued)

Test Species	LD50/NOEL LOEL (ppm)	Test Duration	Exposure Medium	Quality Assurance Specifications	Other Effects (Epidemiological Information)	Reference
Rats and Dogs	Subacute toxicity <2000	NR NR	Oral; emulsifiable concentrate 4 lb/gal	NR	NR	WSSA, 1979
Rats and Beagles	No lethal effects noted	90 day	Oral; levels of 20, 200, 2000 ppm emulsifiable concentrate 4 lb/gal	NR	Normal growth patterns for the 20, 200 ppm levels Some growth and weight depression of male dogs at 2,000 ppm	WSSA, 1979
Dog	--	6 mo	Oral; (5.0, 25.0, 50.0, 75 mg/Kg/day)	NR	Dose related hepatoxicity, liver fatty degeneration and biliary hyperplasia	Ahmed et al., 1981
Rabbit	LD_{50} 13.32/kg	NR	Dermal	NR	NR	Monsanto, 1978
Rabbit	LC_{50}[a] 75.1 ml/l	NR	Inhalation	NR	NR	Monsanto, 1981
Rat	--	2 yr	Oral; (14.0, 42.0, 126.0 mg/Kg/day)	NR	Hepatotoxicity, ocular lesions, ureal degeneration syndrome (UDS)	Monsanto, 1982

[a] LC_{50} = Lethal concentration for 50% of test organisms.

TABLE 2. (Continued)

Test Species	LD50/NOEL LOEL (ppm)	Test Duration	Exposure Medium	Quality Assurance Specifications	Other Effects (Epidemiological Information)	Reference
Rat (Long-Evans strain)	NOEL[a] for UDS = 2.5 mg/kg/day	2 yr	Oral; (0.5, 2.5, 15.0 mg/kg/day)	NR	Small increase in number of animals exhibiting the initial stage of UDS.	Stout, 1983a
Rat (Long-Evans strain)	--	2 yr	Oral; (0.5, 2.5, 15.0 mg/kg/day)	NR	Irreversible UDS	Stout, 1983b
Rabbit	LD_{50} 5,000	NR (acute)	Dermal	NR	NR	WSSA, 1979
	Score - 6/8 (severe)	NR	Dermal; emulsifiable concentrate 4 lb/gal	NR	Skin irritation, severely irritated	
	Score 63/110 (extreme)	NR	Ocular; emulsifiable concentrate 4 lb/gal	NR	Extreme eye irritation	
	Low inhalation hazard					
			Reproduction and Teratology			
Rat	Reproduction NOEL = 10.0 mg/kg/day Reproduction LOEL[b] = 30.0 mg/kg/day	3 generation	Oral; (3.0, 10.0, 30.0 mg/kg/day)	NR	Renal toxicity observed in F_2 males and F_3 pups (kidney discoloration, chronic nephritis and increased relative and absolute kidney weights)	Schroeder et al., 1981

[a] NOEL = No observed effect level.
[b] LOEL = Lowest observed effect level.

TABLE 2. (Continued)

Test Species	LD50/NOEL LOEL (ppm)	Test Duration	Exposure Medium	Quality Assurance Specifications	Other Effects (Epidemiological Information)	Reference
Rat	Maternal and fetotoxic NOEL = 150 mg/kg/day	NR	Gavage; (50, 150, 400 mg/kg/day)	NR	NR	Rodwell and Tacher, 1980
			Carcinogenicity			
Mice (CD-1 strain)	--	18 mo	Oral; (26, 78, 260 mg/kg/day)	NR	Statistical increase in lung tumors in females only	Daly et al., 1981a
Rat	--	2 yr	Oral; (0.5, 2.5, 15.0 mg/kg/day)	NR	Nasal epithelial adenomas, submucosal gland adenocarcinoma in a mid-dose male (not treatment related)	Stout et al., 1983a
Rat	--	2 yr	Oral; (0.5, 2.5, 15.0, 126, mg/kg/day)	NR	Nasal epithelial thyroid follicular cell adenomas or carcinomas in males; rare stomach tumor in a 2.5 mg/Kg male	Stout et al., 1983b
Rat (Long-Evans strain)	--	2 yr	Oral; (14, 42, 126 mg/kg/day)	NR	Dose related response observed for tumors of the nasal turbinate of both sexes for mid and high doses. Significant increases in incidence of malignant stomach and thyroid tumors.	Daly et al., 1981b

A two-year rat feeding study in the Long Evans Strain showed alachlor to be toxic at all doses tested (14.0, 42.0 or 126.0 mg/kg/day) (Monsanto, 1982). The principal toxic effects observed were hepatoxicity and an ocular lesion, referred to as the uveal degeneration syndrome (UDS). A second two-year feeding study using the same strain of rat was conducted at 0.5, 2.5 or 15.0 mg/kg/day (Stout et al., 1983a). Animals in the high dose group exhibited the inital stage of UDS. The 2.5 mg/kg/day was judged to be the NOEL for UDS.

In a three-generation rat study, alachlor showed a reproduction NOEL level at 10.0 mg/kg/day and reproduction lowest-observed-effect-level at 30.0 mg/kg/day (Schroeder et al., 1981). In a teratology study in the rat, alachlor was administered at dose levels of 50, 150 or 400 mg/kg/day. A maternal and fetotoxic NOEL was established at 150 mg/kg/day with no teratogenic potential indicated at the highest dose tested, 400 mg/kg/day (Rodwell and Tacher, 1980).

Alachlor feeding studies in mice and rats have demonstrated carcinogenic effects which include (1) lung tumors in mice and (2) stomach, thyroid, and nasal turbinate tumors in rats. Alachlor administered in the diet of mice for 18 months produced a statistically significant increase in lung bronchioalveolar tumors in female mice at the highest dose tested (260 mg/kg/day) (Daly et al., 1981a). The increase of lung tumors in male mice was not significant. Two chronic feeding studies were conducted in the Long-Evans strain of rat. In the first study (Daly et al., 1981b), animals of both sexes were 14, 42 or 126 mg/kg/day alachlor. Dose-related responses were observed for tumors of the nasal turbinate in both sexes at the mid and high doses. A statistically significant increase was also noted in the incidence of stomach tumors in the high dose for both sexes. Thyroid follicular tumors (adenomas plus carcinomas) increased in both sexes at the high dose level with the increase being statistically significant in males.

In the second two-year feeding study (Stout et al., 1983a), male and female rats were exposed to 0.5, 2.5, and 15 mg/kg/day alachlor. Incidences of nasal epithelial adenoma response was statistically significant in both sexes. Data from an additional study which ran concurrently with this study used a fourth treatment group, 126 mg/kg/day (Stout et al., 1983b). The design of this study was different from the previous study (Stout et al., 1983a) because it used a variety of dosing regimens and had the primary purpose of investigating the nature and reversibility of the ocular lesions (UDS). This study also used a chemical stabilizer different from that used by Daly et al. (1981b). The results of Stout et al. (1983b) indicate that the tumor response observed in Daly et al. (1981b) cannot be explained by the presence of the stabilizer used in the test material.

An increase was noted in the number of thyroid follicular cell tumors in males, and in the number of nasal epithelial tumors in both sexes (Stout et al., 1983b). A rare stomach tumor was also found in a

male of the 2.5 mg/kg treatment and is considered biologically significant since no stomach tumors were found in the control animals in any of the cited chronic rat studies. No studies pertaining to the effects of alachlor in humans were found in this review.

CRITERIA EVALUATION AND RECOMMENDATIONS

Aquatic

An Aquatic Life Criterion as defined by Stephan et al. (1985) consists of two concentrations: the Criterion Maximum Concentration (CMC) and the Criterim Continuous Concentration (CCC). The current literature search has not yielded data on acute tests for eight different genera, as required by the Guidelines to derive a CMC. There is also insufficient information to calculate a CCC. A tentative acute value can be determined, however, even in the absence of a complete data base. An estimate of the FAV was calculated using the following equations from the Guidelines:

$$\text{Final Acute Value} = e^{A}$$

where:

$$A = S(0.05) + L$$
$$L = ((\ln GMAV) - S(P))/4)$$

$$S^2 = \frac{((\ln GMAV)^2) - ((\ln GMAV))^2/4)}{(P) - ((P))^2/4}$$

P = cumulative probability as R/(N+1);
R = rank from "1" for the lowest to "N" for the highest GMAV

Genus Mean Acute Values (GMAVs) were obtained from the reviewed literature (Table 1). Values used in calculating the FAV are presented in Table 3.

TABLE 3. VALUES USED IN CALCULATION OF FINAL ACUTE VALUE

Species	96-hr LC50s	GMAV	Rank	P
Fathead minnow (*Pimephales promelas*)	5.0	5.0	2	0.33
Rainbow trout (*Salmo gairdneri*)	2.4, 2.3	2.35	1	0.17
Bluegill (*Lepomis macrochirus*)	13.4, 4.3	7.6	4	0.67
Catfish (*Ictalurus punctatus*)	6.5	6.5	3	0.50
Crayfish	19.5	19.5	5	

Substituting appropriate values into the equations gave an estimate of the FAV of 1.52 ppm for alachlor. The estimated CMC (one-half the FAV) is 0.76 ppm for alachlor.

This estimated CMC is limited by the lack of reported information on test conditions and quality control measures employed in the studies, as well as by the limited number of representative phyla tested. However, the value of 0.76 ppm is supported by the study by Call et al. (1984) which estimated a no-effect-level between 0.52 and 1.10 ppm. From this comparison, it appears that the CMC is conservative and reasonable for the protection of aquatic life.

The CCC is equal to the lowest of the Final Chronic Value, the Final Plant Value or the Final Residue Value.

Table 4 lists the data requirements needed to calculate these values, as well as those for the CMC, as described by the EPA guidelines (Stephan et al., 1985). Data are lacking for both acute and chronic test results in several classes of organisms, including planktonic crustaceans, insects, rotifers and/or annelids and molluscs.

The only chronic data available are for freshwater fish (Call et al., 1984), and no acute or chronic studies were located for any invertebrate or insect species. Information was also lacking for other phyla (other than Arthropoda or Chordata). Furthermore, none of the studies reviewed noted any biomagnification of alachlor in the aquatic food chain, although Call et al. (1984) noted a BCF of 6.0 in the fathead minnow after 21-day exposure to alachlor. The lack of these data precludes any further criteria calculations. One may estimate a chronic protective value by assuming an acute-chronic ratio of 10. The resultant advisory concentration would be 0.76mg/L/10 or 76 ug/L.

Health

Tolerances have been established (40 CFR 180.249) for alachlor and its metabolites resulting from the use of the herbicide in or on raw agricultural commodities. These tolerances range from 0.05 ppm to 3.0 ppm in vegetables and 0.02 ppm in animal meat-by-products and fat (U.S. EPA, 1984).

No epidemiological studies of the effects of alachlor on human health have been found which could contribute data useful to the derivation of a criterion (Table 5).

Alachlor feeding studies have demonstrated oncogenic effects which include: (1) lung tumors in mice and (2) stomach, thyroid and nasal turbinate tumors in rats (U.S. EPA, 1984). The results of these studies were presented in a U.S. EPA position document for alachlor (U.S. EPA, 1984). Data were from unpublished studies submitted to EPA for review. EPA has determined that the weight of evidence for these experiments demonstrates that alachlor is oncogenic to laboratory

animals and, in the absence of data on humans, believes it necessary to treat alachlor as a probable human carcinogen. Therefore, since the actual studies are unavailable for review, the following recommendations are consistent with the data presented in the position document.

EPA's Carcinogenic Assessment Group (CAG) is currently evaluating alachlor for carcinogenic risk assessment. However, EPA's Office of Pesticide Programs (OPP) has performed a risk characterization of the nasal tumors of alachlor (U.S. EPA, 1984). The OPP assessment for drinking water is summarized in the following table.

Table 1. Assessment of Drinking Water Risks for Alachlor

Exposure Level (ug/L)	Upper Limit Estimate of Excess LifetimeCancerRisk for:	
	10 Kg Child	60 Kg Adult
0.15	10-6	10-7 to 10-6
1.5	10-5	10-6 to 10-5
15.0	10-4	10-5 to 10-4

The Office of Water has traditionally used the 70 kg man as its surrogate. In these risk calculations, we would not expect to see any significant change in the degree of calculated risk because of the difference in the reference man of 10 Kg.

Applying the criteria described in EPA's proposed guidelines for assessment of carcinogenic risk (U.S. EPA, 1984b), alachlor may be classified in Group B: Probable human carcinogen. This category is for agents for which there is inadequate evidence from human studies and sufficient evidence from animal studies.

The Office of Drinking Water has prepared a draft human health advisory document for alachlor (U.S. EPA, 1985) which is presently under review. The values given below are taken from the draft document, and should not be taken as final. They will, however, give an indication of health effects which may result from exposure to alachlor for times shorter than a lifetime.

Health Advisories are based upon the identification of adverse health effects associated with the most sensitive and meaningful non-carcinogenic end-point of toxicity. The induction of this effect is related to a particular exposure dose over a specified period of time, most often determined from the results of an experimental animal

TABLE 4. DATA REQUIREMENTS FOR CALCULATION OF AQUATIC LIFE INTERIM CRITERIA -- ALACHLOR

Criterion Requirements Aquatic Toxicity	Available Data	Data Acceptability
Acute Test Results from tests on:		
A salmonid (class Osteichthyes)	YES	YES (controls, replicates)
A warm water species commercially or recreationally important (class Osteichthyes)	YES	YES (controls, replicates)
Another family in the phylum Chordata (fish, amphibian, etc.)	YES	NO (questionable due to light exposures)
A planktonic crustacean (cladoceran, copepod, etc.)	NO	--
Benthic crustacean (ostracod, isopod, scud, crayfish, etc.)	YES	Questionable (96 hr test; no QA specifications)
Insect (mayfly, dragonfly, damselfly, stonefly-, mosquito, etc.)	NO	--
Phylum other than Arthropoda/ Chordata (Rotifera, Annelida, Mollusca)	NO	--
Another family of insect	NO	--
Acute-chronic ratios with species from three different families: One fish One invertebrate Acutely sensitive freshwater animal species	NO	--
Acceptable test results from a test with:		
Freshwater algae	YES	NO (controls; replicates; 24-hr, not 96-hr; no effect conc.)
A vascular plant	NO	--
Bioaccumulation factor with a freshwater species (if a maximum permissible tissue concentration is available)	YES	YES (controls, replicates)

TABLE 5. DATA REQUIREMENTS FOR CALCULATION OF HUMAN HEALTH INTERIM CRITERIA -- ALACHLOR

Criterion Requirements Aquatic Toxicity	Available Data	Data Acceptability
Non-Threshold: Carcinogen	YES	YES (EPA Approved)
Tumor incidence tests (Incidence of tumor formation significantly more than the control for as least one dose level), or		
Data set which can be used to estimate of carcinogenic risk, or	YES	YES (EPA Approved)
Lifetime average exposure tests, or	YES	YES (EPA Approved)
Human epidemiology studies (if available, not required)	NO	--
Threshold: Non-carcinogens	NA	
No observed adverse effect level (at least 90-day), or	YES	YES (EPA Approved)
Lowest observed effect level	YES	YES (EPA Approved)
Lowest observed adverse effect level	YES	YES (EPA Approved)
Acceptable Daily Intake:		
Daily water consumption	YES	YES (EPA assumption)
Daily fish consumption	YES	YES (EPA assumption)
Bioconcentration factor	NO	--
Non-fish dietary intake	YES	YES (EPA assumption)
Daily intake by inhalation	NO	--
Threshold Limit Value: (Based on 8-hour time-weighted average concentrations in air)	NO	--
Inhalation Studies:	YES	YES
Available pharmacokinetic data		(1-hr exposure LC noQA specifications
Measurements of absorption efficiency		
Comparative excretion data		

NA = Not applicable

study. The advisories are designed for use where short term exposure is expected. Traditional risk characterization methodology for threshold toxicants is applied in HA development. The general formula is as follows:

$$\frac{\text{(NOAEL or LOAEL) (BW)}}{\text{(UF(s)) (\_\_\_L/day)}} = \text{\_\_\_\_\_ ug/L}$$

Where:

NOAEL or LOAEL = No-Observed-Adverse-Effect-Level

or

Lowest-Observed-Adverse-Effect-Level (the exposure dose in mg/kg bw)

BW = assumed body weight of protected individual in kg (10 or 70)

UF(s) = uncertainty factors, based upon quality and nature of data

____L/day = assumed daily water consumption (1 or 2) in liters

One-day Health Advisory

No duration-specific data are available to derive a One-day Health Advisory; therefore, it is recommended that the Ten-day Health Advisory be applied for the One-day HA as well.

Ten-day Health Advisory

The Ten-day Health Advisory is derived from the teratogenicity study in the rat reported by Rodwell and Taylor (1980). As noted above, there was no teratogenicity produced but both maternal and fetotoxicity were expressed at 400 mg/kg/day. The Office of Pesticides Programs determined that the NOEL for this study was at 150 mg/kg/day (U.S. EPA, 1984). Alachlor was administered to the animals on days 6 through 15 of gestation.

The Ten-day HA for the 10 kg child is calculated as follows:

$$\frac{\text{(150 mg/kg/day) (10 kg)}}{\text{(100) (1 L/day)}} = \text{15 mg/L or 15,000 ug/L}$$

Where:

150 mg/kg = NOAEL (No-Observed-Adverse-Effect-Level)

10 kg = Assumed weight of protected individual

100 = Uncertainty factor, appropriate for use with a NOAEL from an animal study

1 L/day = Assumed volume of water ingested per day by 10 kg child

Longer-term Health Advisory

A Longer-term Health Advisory will not be determined for alachlor because it has been shown to produce carcinogenicity in less than five and one-half months in rats at the same rate as did the lifetime exposure.

Life-time Health Advisory

See Longer-term HA.

Analysis

Determination of alachlor may be accomplished by a liquid-liquid extraction gas chromatographic procedure (Method 102. U.S. EPA 1983). In this procedure, a 1-L water sample is spiked with an internal standard and then extracted with methylene chloride. The extract is concentrated to 5 mL and the methylene chloride solvent is exchanged for a toluene/methanol mixture. Separation and identification is by packed column gas chromatography using a nitrogen selective detector. The method detection limit for alachlor is approximately 0.2 ug/L. If the sample chromatogram contains interfering peaks, the sample should also be analyzed using a electron capture detector.

Treatment

Data are available on the removal of alachlor from potable water using conventional treatment and absorption. The use of aeration has also been considered.

Available data suggest that conventional water treatment is not effective for removing alachlor from drinking water. Baker (1983) monitored the concentration of alachlor in raw river and in finished water after alum coagulation, flocculation, sedimentation and filtration. The concentration range was <0.5 to 5.0 ug/L in the influent and <0.2 to 2.0 ug/L in the effluent. The removal rate was not consistent and generally less than 50%.

No actual data are available which demonstrate the removal of alachlor using aeration. However, the estimated Henry's Law Constant (1.94 x 10-4 atm x m3/mole) suggests that this pesticide might be amenable to such treatment (ESE, 1984).

Limited data suggest that GAC (granular activated charcoal) adsorption would have limited effectiveness for alachlor. In a laboratory study (DeFilippi et al., 1980), a waste stream

containing 11 mg/L alachlor was passed, at 1.1 gpm/ft2, through a 3/8 inch diameter, 11-inch column containing seven grams of (GAC). After 2.6 liters had been passed through, an effluent concentration of 0.22 mg/L broke through the column. It was estimated that, for this effluent concentration, a usage rate of 21.7 lb/1,000 gal would be required.

Laboratory studies with rapid sand filters capped with 16.5 inches of GAC (Filtrasorb 300) operated at a filtration rate of 1.2 gpm/ft^2 with an empty bed contact time of nine minutes were performed by Baker (1983). Reported alachlor concentrations ranged form 0.7 to 5.0 mg/L in the raw river and 0.1 to 0.7 mg/L in the finished water. However, powdered activated carbon in conventional treatment (PAC dose not reported) resulted in an average concentration reduction of only 43%.

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