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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

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OFFICE OF
PREVENTION, PESTICIDES AND
TOXIC SUBSTANCES

MEMORANDUM

SUBJECT: Reregistration Eligibility Document for Glyphosate

FROM: Bernice Slutsky
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Environmental Fate and Effects Division

Thru: Fred Betz, Acting Chief
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Environmental Fate and Effects Division

TO: Walter Waldrop
Reregistration Branch
Special Review and Reregistration Division

Attached is the Environmental Fate and Effects Division's position concerning the environmental fate and ecological effects assessment for glyphosate. This information is intended for use in the production of the Reregistration Eligibility Document (RED). Included are the support chapters prepared by Candace Brassard (EEB) and Kevin Poff (EFGWB).

In completing the EFGWB chapter, interim field data was used. The completed studies were not available but have just been received by the Agency. The completed studies would be used to complement and confirm laboratory data.

Based upon Tier II aquatic plant growth studies (123-2), adverse effects to non-target plants occur from the use of glyphosate. Tier III studies (124-2) are triggered, however, EEB will assess risk using available information.

Additional data are needed in order to fully evaluate the effects of glyphosate on nontarget terrestrial plants. This includes more specific information on incidents, results from 123-1 vegetative vigor testing, droplet size spectrum (201-1) and drift field evaluation (202-1) study should be submitted and reviewed. Risk reduction measures cannot be recommended until data are submitted and evaluated.

The Environmental Fate and Effects Division reviews the potential effects of pesticide uses on endangered species. Many

endangered plants may be at risk from the use of glyphosate on the registered use patterns. In addition, as discussed in the 1986 Amended Glyphosate Registration Standard, it was determined that based on habitat, the Houston Toad may be at risk from the use of glyphosate on alfalfa. At the present time, EPA is working with the US Fish and Wildlife Service and other federal and state agencies to develop a program to avoid jeopardizing the continued existence of the identified species by the use of pesticides. When this program goes into effect, endangered species precautionary labeling will be required.

Please contact Bernice Slutsky if you have any question concerning this RED.

cc:
Anne Barton
Henry Jacoby
Anthony Maciorowski

C. Environmental Fate and Ecological Effects Assessment

1. Environmental Fate

A. Environmental Fate and Transport

1. Topical Summaries

a. Hydrolysis

File or reg # 524-308, Acc #00108192, 6/30/78. Glyphosate is stable at pH 3, 6, 9 at 5 and 35°C.

b. Photodegradation in Water

EFGWB #90-0745, 92-0032, 90-0753,91-0356,92-0011,91-0506, MRID #41689101. Glyphosate is stable in pH 5, 7, and 9 buffered solutions under natural sunlight.

c. Photodegradation on Soil

EFGWB # 90374, MRID #41335101; 6/28/90. This study indicates stability.

d. Aerobic Soil Metabolism

EFGWB #92-1143,1144 and (EFGWB #90-0745, 92-0032, 90-0753,91-0356,92-0011,91-0506), MRID #42372501. These studies indicate half-life values of 1.85 and 2.06 days in the Kickapoo sandy loam and Dupo silt loam respectively were reported. Aminomethyl phosphonic acid (AMPA) was the major degradate.

e. Anaerobic Aquatic Metabolism

EFGWB #92-1143,1144 and (EFGWB #90-0745, 92-0032, 90-0753,91-0356,92-0011,91-0506), MRID #42372502. The half-life reported was 8.1 days in anaerobic (flooded plus nitrogen atmosphere) silty clay loam sediment. AMPA was the major degradate.

f. Aerobic aquatic metabolism

EFGWB #92-1143,1144 and (EFGWB #90-0745, 92-0032, 90-0753,91-0356,92-0011,91-0506), MRID #42372503. The half-life reported was 7 days in flooded silty clay loam sediment that was incubated in the dark at 24.6 $\pm$ 0.57 C for 30 days. AMPA was the major degradate.

g. Leaching/Adsorption/Desorption

EFGWB # 70727-29, Acc. #'s 00108192, 00076493, 00108140 (data taken from Dynamac review 6/7/85); (unaged batch equilibrium). K_d values of 62, 90, 70, 22, and 175 were reported for Drummer silty clay loam, Ray silt, Spinks sandy loam, Lintonia sandy loam, and

Cattail Swamp sediment respectively. After (aged) leaching 7 soils with 20" of water, the recovered radioactivity in the soils was 93-100% of the applied.

h. Aquatic Field Dissipation

EFGWB #92-1143,1144 and (EFGWB #:92-0228, and #91-0763), MRID #40881601. Glyphosate dissipated from the water (irrigation source) with a registrant calculated half-life of 7.5 days and 120 days from the sediment of the farm pond in Missouri.

MRID #41552801. In Michigan, Georgia and Oregon pond and stream water, the maximum glyphosate concentrations were measured immediately posttreatment and dissipated rapidly. Glyphosate accumulated in the pond sediment, and to a lesser extent in the stream sediments; glyphosate was present in pond sediment at $\geq$1 ppm in Michigan and Oregon at approximately 1 year posttreatment.

i. Forestry Dissipation

EFGWB # 91-0763, MRID #41552801. When aerially applied at 3.75 lb/A to forested sites in Michigan, Oregon, and Georgia, glyphosate averaged 652-1273 ppm in tree foliage immediately posttreatment. It then declined rapidly with half-lives of <1 day at the Michigan and Georgia sites and <14 days at the Oregon site.

The forestry dissipation study results demonstrate that when used under normal silviculture practices according to label directions, the maximum combined glyphosate and AMPA residue level in soil is less than 5 ppm. Glyphosate and AMPA residues in soil dissipate with time. The average half-life for the dissipation of glyphosate was 100 days, and ranged from 35 to 158 days. The average half-life for the dissipation of AMPA was 118 days, and ranged from 71 days to 165 days.

j. Accumulation in Confined Rotational Crops

(EFGWB #90-0745, 92-0032, 90-0753,91-0356,92-0011,91-0506) MRID #41543201 and MRID #41543202[14]; Glyphosate residues (expressed as fresh weight) accumulated in lettuce, carrots, and barley planted 30, 119, and 364 days after sandy loam soil was treated with glyphosate at 3.71 lb ai/A. Accumulation decreased as the length of the rotation increased. In crops planted at 30 days posttreatment, [^{14}C]residues at harvest were 0.097 ppm in lettuce, 0.051 and 0.037 ppm in carrot tops and roots, respectively, and 0.188 and 0.175 ppm in barley grain and straw, respectively. In immature lettuce harvested at 40 and 60 days postplanting, [^{14}C]residues were 0.108 and 0.048 ppm, respectively. In crops planted at 119 days posttreatment, [^{14}C]residues at harvest were 0.037 ppm in lettuce, 0.028 and 0.017 ppm in carrot tops and roots, respectively, and 0.078 and 0.056 ppm in barley grain and straw, respectively. In immature lettuce harvested at 28 and 48 days postplanting, [^{14}C]residues were 0.059 and 0.055 ppm, respectively

In crops planted at 364 days posttreatment, [^{14}C]residues at harvest were 0.028 ppm in lettuce, 0.018 and 0.0096 ppm in carrot tops and roots, respectively, and 0.047 and 0.061 ppm in barley grain and straw, respectively. In immature lettuce harvested at 35 and 61 days postplanting, [^{14}C]residues were 0.057 and 0.043 ppm, respectively; in barley forage harvested at 48 days postplanting, [^{14}C]residues were 0.056 ppm.

k. Accumulation in Irrigated Crops

MRID #40541305 (EFGWB #90-0745, 92-0032, 90-0753,91-0356,92-0011,91-0506). Alfalfa, corn (grain and forage), grass (fescue or sudan) and lettuce were irrigated five to eight times during the 1987 growing season with glyphosate treated water containing a maximum of 21.3 ppm (on treatment day then fell to 0.46 ppm by 1 day after treatment) of glyphosate. Residues in the sediment beneath the treated water reached a maximum of 3.5 ppm at 14 days after treatment. Residues of glyphosate in the sprinkler water at the pond site were the highest 7 days after treatment at 0.12 ppm. One lettuce sample from the Missouri location (the pond site) at 29 days after treatment (of water source) and 5 irrigation events was found to contain 0.06 ppm glyphosate.

l. Bioaccumulation in Fish

(EFGWB #90-0745, 92-0032, 90-0753,91-0356,92-0011,91-0506), MRID #41228301. Maximum bioconcentration factors were 0.38X for edible tissues, 0.63X for nonedible tissues, and 0.52X for whole fish.

m. Laboratory and Field Volatility

These studies were waived, based on the low vapor pressure of glyphosate.

2. Summary of Terrestrial Field Data

MRID No:42607501 Volumes 1, 2, and 3. Oppenhuizen, M.E., December 1992, study in progress. The Terrestrial Field Dissipation of Glyphosate: An Interim Report. Performed by The Agricultural Group of the Monsanto Company, Environmental Science Department 700 Chesterfield Parkway North, St. Louis, Missouri 63198 and Pan-Agricultural Laboratories, Inc. 32380 Avenue 10 Madera, California 93638.

The outstanding data requirement for glyphosate was the terrestrial field (164-1) dissipation data requirement. The registrant submitted study MRID #42607501, Volumes 1, 2, and 3 which is an interim report and contains data from eight different field sites. Some of the data from the individual field sites are deficient, however, the EFGWB may use the data from the eight field sites together to satisfy the terrestrial field dissipation 164-1 data requirement.

The interim report results from the first 12 months of bareground field dissipation trials from eight sites show that the median half-life (DT_{50}) for glyphosate (Roundup) applied at maximum annual use rates (7.95 lb a.e./acre, 10.7 lb a.i./acre) was 13.9 days with a range of 2.6 (Texas) to 140.6 (Iowa) days. Acceptable aerobic soil, aerobic aquatic and anaerobic aquatic metabolism studies demonstrate that under those conditions at 25°C in the laboratory glyphosate degrades rapidly with half-lives of approximately 2, 7 and 8 days respectively. The reported half-lives (DT_{50}) from the field studies conducted in the coldest climates, ie. Minnesota, New York and Iowa, were the longest at 28.7, 127.8, and 140.6 days respectively indicating that glyphosate residues in the field are somewhat more persistent in cooler climates as opposed to milder ones (Georgia, California, Arizona, Ohio, and Texas).

Glyphosate (as well as AMPA) was shown to predominantly remain in the 0-6 inch soil layer throughout the duration of the study at all field sites. Iowa was the individual test site to have average glyphosate residues, at all sampling times, greater than 0.01 ppm in the 6-12 inch depth. There were a number of detections from 0.01 to 0.09 ppm in the 6-12 inch layer in Minnesota, New York and Texas, and glyphosate was detected at generally <0.05 ppm at the other 5 field sites (6-12 inch depth).

Glyphosate was detected at three different sites below 12 inches. In California, at 0 DAT, average glyphosate residues were 0.21 ppm and 0.10 ppm in the 12-18 and 18-24 inch soil horizons respectively. Soil core contamination was attributed to these detections since movement of residues to this depth on the first day of sampling is unlikely. In Arizona at 21 DAT the average glyphosate residues were 0.06, in the 18-24 inch soil layer. There were no glyphosate residues in the 6-12 or 12-18 inch soil layer in Arizona on 21 DAT and in subsequent samples below 12 inches which may indicate a problem with sampling technique. In Iowa at 190 DAT the average glyphosate residues were 0.05 ppm in the 12-18 inch soil layer. Since there were no glyphosate residues detected in the 6-12 inch soil layer at 190 DAT, and the lack of a significant amount of rainfall between sampling intervals in combination with the amount of time between sampling intervals and the high adsorptive characteristics of glyphosate give an indication that there may have been a problem with sampling technique.

AMPA was also shown to predominantly remain in the 0-6 inch soil layer. AMPA was found at every test site on Day 0 samples indicating the rapid degradation of parent glyphosate. The AMPA levels generally reached a maximum between day 14 and day 30. Where the field half-lives were longer (Iowa, Minnesota, New York) the maximum average AMPA levels occurred between 62 and 95 DAT. The maximum average AMPA levels found in the 0-6 inch soil layer were 0.6 ppm and occurred in Ohio and Georgia at 21 DAT and 61 DAT respectively. The AMPA levels at those sites then decreased to 0.12 and 0.44 ppm at 12 months after treatment.

In all samples but three, AMPA residue levels were <0.05 ppm in the 6-12 inch soil layer. In New York at 14 and 30 DAT average residues were detected at 0.06 ppm. In Iowa at the 92 DAT sample average AMPA residues were 0.08 ppm. Iowa and New York also exhibited 50% dissipation times of 140.6 and 127.8 days respectively.

AMPA levels were detected at 0.06 ppm in the 18-24 inch soil layer on 21 DAT in Arizona and 0.04 and 0.03 ppm in the 12-18 inch soil layer at 90 and 180 DAT respectively in New York.

B. Environmental Fate and Groundwater Assessment

In general, the available field and laboratory data indicate glyphosate adsorbs strongly to soil and would not be expected to move vertically below the 6 inch soil layer. Based on unaged batch equilibrium studies glyphosate and glyphosate residues are expected to be immobile with $Kd_{(ads)}$ values ranging from 62 to 175. The mechanism of adsorption is unclear, however it is speculated that it may be associated with vacant phosphate sorption sites or high levels of metallic soil cations. The data indicate that chemical and photochemical decomposition is not a significant pathway of degradation of glyphosate in soil and water. However, glyphosate is readily degraded by soil microbes to aminomethyl phosphonic acid (AMPA), which is degraded to CO_2, although at a slower rate than parent glyphosate. Even though glyphosate is highly water soluble it appears that parent glyphosate and AMPA have a low potential to move to ground-water due to their strong adsorptive characteristics demonstrated in the laboratory and field studies. However, glyphosate does have the potential to contaminate surface waters due to its aquatic use patterns and erosion via transport of residues adsorbed to soil particles suspended in runoff water. If glyphosate were to reach surface water it would be resistant to hydrolysis and aqueous photolysis.

Based on the low vapor pressure of glyphosate, volatilization from soils will not be an important dissipation mechanism. The low octanol/water coefficient suggests that glyphosate will have a low tendency to accumulate in fish.

2. Ecological Effects

A. Ecological Hazard

1. Topical Summaries

a. <u>Effects to Nontarget Birds</u>

Eight studies (contained in eight references) were received and evaluated under this topic. Seven studies are acceptable for use in a risk assessment. To establish the toxicity of glyphosate to birds, the following tests are required using the technical

grade material:

a. One avian single-dose oral study on either a waterfowl species (preferably mallard duck) or an upland species (preferably bobwhite quail);

b. Two subacute dietary studies: one study on a species of waterfowl(preferably mallard duck) and one on an upland game bird species(preferably a bobwhite quail).

Avian Single-Dose Oral LD_{50} - Technical

The acceptable acute oral toxicity study is listed below:

Species	% AI	LD_{50} (95% CL)	Author	Date	ID#	Fulfills Guideline Requirement
Bobwhite quail	83%	> 2000 mg/kg	Beaver & Fink	1978	MCOGLY04	YES

These data indicate that technical glyphosate is practically non-toxic to an upland bird species on an acute oral basis. The guideline requirement for an avian acute oral study is fulfilled.

Avian Dietary - Technical

The acceptable subacute dietary toxicity studies are listed below:

Species	% AI	Reproductive Impairment	Author	Date	ID#	Fulfills Guideline Requirement
Mallard duck	98.5% Tech	>4640 ppm	Fink	1973	MCOGLY11	Yes
Bobwhite quail	98.% Tech	>4640 ppm	Fink	1973	00086492	Yes

These data indicate that the technical glyphosate is no more than slightly toxic to birds on a dietary basis. The guideline requirement is fulfilled for both studies.

Avian Reproduction

An avian reproduction test is required to support registration of the end-use products of glyphosate since the following guideline criteria have been exceeded. The labeling for several use patterns contains directions for use under which birds may be subject to repeated exposure to glyphosate. The labeling allows repeat application for certain uses, such as alfalfa, barley, oats,

apples, cherries, and oranges.

The acceptable avian reproduction studies are listed below:

Species	% AI	Reproductive Impairment	Author	Date	ID#	Fulfills Guideline Requirement
Mallard duck	83% Tech	No effects up to 1000 ppm	Beavers & Fink	1978	MCOGLY13	Yes
Mallard duck	90.4% Tech	No effects up to 30 ppm	Fink	1975	00036328	Partially
Bobwhite quail	83% Tech	No effects up to 1000 ppm	Beavers & Fink	1978	MCOGLY12	Yes

These data indicate that technical glyphosate is not expected to cause reproductive impairment. The guideline requirements for an avian reproduction study on both upland game bird and waterfowl are fulfilled.

Precautionary Labeling

The available acute toxicity data do not indicate a requirement of precautionary labeling for birds on products containing glyphosate.

b. Effects on Non-Target Fish

Forty-one studies (in 25 references) were evaluated under this topic. Thirty-one studies were considered acceptable for use in a risk assessment.

Acute Toxicity-Freshwater Fish

The minimum data required for establishing the acute toxicity of glyphosate to freshwater fish are the results of two 96-hour studies with the technical grade product. One study should be performed on a cold water fish species (preferably rainbow trout) and one study should be performed using a warm water species (preferably bluegill sunfish).

The acceptable acute data are as follows:

Species	% AI	48-hr LC_{50} (95%CL)	Author	Date	ID#	Fulfills Guideline Requirements

Bluegill sunfish	96.5 %	>24 mg/l	Morrill	1973	00108112	Partially
Fathead Minnow	87.3 %	84.9 mg/L (72.9-99.3)	EG & G Bionomics	1975	00108171	Partially
Bluegill sunfish	83%	120 mg/L (111-130)	McAllister & Forbis	1978	MCOGLY07	Yes
Rainbow Trout	83%	86 mg/L (70-106)	Thompson, McAllister & Johnson	1978	MCOGLY08	Yes
Rainbow Trout	96.7 %	140 mg/l (120-170)	Folmar, Sanders & Julin	1979	MCOGLY16	Yes
Fathead minnow	96.7 %	97 mg/L (79-120)	Folmar, Sanders & Julin	1979	MCOGLY16	Yes
Channel catfish	96.7 %	130 mg/L (110-160)	Folmar, Sanders & Julin	1979	MCOGLY16	Yes
Bluegill sunfish	96.7 %	140 mg/L (110-160)	Folmar, Sanders & Julin	1979	MCOGLY16	Yes

The results of these eight studies indicate that technical glyphosate is slightly to practically nontoxic to both cold water and warm water fish. The guidelines requirement for acute toxicity testing of the technical on freshwater fish is fulfilled.

Chronic Toxicity-Freshwater Fish

Due to the aquatic use of the chemical, its presence in water is likely to be continuous or recurrent regardless of toxicity; therefore, chronic testing is required.

Species	**% AI**	**Results**	**Author**	**Date**	**ID#**	**Fulfills Guideline Requirements**
Fathead Minnow	87.3% tech	MATC>25.7 mg/L No effects at or below this level	EC & G Bionomics	1975	00108171	YES

This fish full life cycle study satisfies the guideline

requirement for chronic freshwater fish testing.

Formulated Product:

Testing of an end-use product is required if the pesticide will be introduced directly into an aquatic environment when used as directed by the label. Drainage systems would be included in such a category. Therefore, formulated product testing is required.

Twenty tests on formulated glyphosate were received and determined as acceptable for use in a risk assessment.

Species	% AI (IPA salt)	96-hr LC_{50} (95% CL)	Author	Date	ID#	Fulfills Guideline Requirements
Bluegill sunfish	41.8% Round up	5.8 mg/L (4.4-8.3)	Forbis	1982	MCOGLY10	Yes
Rainbow Trout	41.8% Round up	8.2 mg/L (6.4-9.0)	Forbis, Boudreau & Schofield	1982	MCOGLY10	Yes
Channel catfish	41.36 % Round up	16 mg/L (9.4-26)	LeBlanc, Wilson & Sleight	1980	00070894	No
Rainbow Trout	41.36 Round up	11 mg/L (8.7-14)	LeBlanc, Suprenant & Sleight	1980	00070895	Yes
Bluegill sunfish	41.36 % Round up	14 mg/L (8.7-24)	LeBlanc, Suprenant & Sleight	1980	00070897	Yes
Fathead Minnow	41.36 % Round up	9.4 mg/L (5.6-16)	LeBlanc, Dionne & Sleight	1980	00070896	No
Rainbow Trout	62.4%	>1000 mg/L	Thompson & Griffen	1980	00078661	Yes
Bluegill sunfish	62.4%	>1000 mg/L	Thompson & Griffen	1981	00078662	Yes

Species	% AI (IPA salt)	96-hr LC_{50} (95% CL)	Author	Date	ID#	Fulfills Guideline Requirements
Rainbow Trout	*41.2 % + 15.3 "AA" surfactant	120 mg/L (56-180)	Thompson, Griffen & Forbis	1980	00078658	Yes
Rainbow Trout	*40.7 % + 15% "W" surfactant	150 mg/L (100-320)	Thompson, Griffen & Boudreau	1980	00078655	Yes
Bluegill sunfish	*40.7 % + 15% "W" surfactant	>100 mg/L	Thompson & Griffen	1980	00078656	Yes
Bluegill sunfish	*41.2 % + 15.3% "AA" surfactant	>180 mg/L	Thompson & Griffen	1980	00078659	Yes
Rainbow Trout	7.03% + 0.5% "X-77"	240 mg/L (180-320 mg/L)	Thompsson & Griffen	1980	00078664	Yes
Bluegill sunfish	7.03% + 0.5% "X-77"	830 mg/L (620-1600)	Thompson & Griffen	1980	00078665	Yes
Rainbow Trout	51% Round up	8.3 mg/L (7.0-9.9)	Folmar, Sanders & Julin	1979	MCOGLY16	Yes
Fathead minnows	41% Round up	2.3 mg/L (1.9-2.8)	Folmar, Sanders & Julin	1979	MCOGLY16	Yes
Rainbow Trout	41% Round up	9.0 mg/L (7.5-11)	Folmar, Sanders & Julin	1979	MCOGLY16	Yes

Species	% AI (IPA salt)	96-hr LC_{50} (95% CL)	Author	Date	ID#	Fulfills Guideline Requirements
Bluegill sunfish	41% round up	4.3 mg/L (3.4-5.5)	Folmar, Sanders & Julin	1979	MCOGLY16	Yes
Channel catfish	41% Round up	13 mg/L (11-16)	Folmar, Sanders & Julin	1979	MC(GLY16	Yes
Bluegill sunfish	41% Round up	5 mg/L (3.8-6.6)	Folmar, Sanders & Julin	1979	MC)GLY16	Yes
Rainbow Trout	41% Round up	1.3 mg/L (1.1-16)	Folmar, Sanders & Julin	1979	MCOGLY16	Yes

According to the surfactant selected, the formulated product toxicity ranges from moderately toxic to practically non-toxic.

Special Tests:

Testing of the surfactant may be required under unusual circumstances. When inerts are likely to be toxic, testing can be required.

Species	% AI	96-hour LC_{50} (95% CL)	Author	Date	ID#	Fulfills Guideline Requirements
Fathead minnow	MONO818 Tech 100%	1.0 mg/L (1.2-1.7)	Folmar, Sanders & Julin	1979	MCOGLY16	Yes
Rainbow trout	MONO818 Tech 100%	2.0 mg/L (1.5-2.7)	Folmar, Sanders & Julin	1979	MCOGLY16	Yes
Rainbow Trout	MONO818	0.65 mg/L (.54-.78)	Folmar, Sanders & Julin	1979	MCOGLY16	Yes
Channel Catfish	MONO818 Tech 100%	13 mg/L (10-17)	Folmar, Sanders & Julin	1979	MCOGLY16	Yes

Bluegill sunfish	MONO818 Tech 100%	3.0 (2.5-3.7)	Folmar, Sanders & Julin	1979	MCOGLY16	Yes
Bluefish sunfish	MONO818 Tech 100%	1 mg/L (.72-1.4)	Folmar, Sander & Julin	1979	MCOGLY16	Yes

These data indicate that MONO818 is ranges from moderately toxic to very highly toxic to both cold and warmwater fish after 96 hour exposure.

Precautionary Labeling

Based upon available data products containing MONO818 must include the statement, "This pesticide is toxic to fish."

c. Effects on Aquatic Invertebrates

Twenty-two studies (contained in 11 references) were received and evaluated under this topic. All were found acceptable for use in a risk assessment.

Acute Toxicity-Freshwater Invertebrates

The minimum data requirement to establish the acute toxicity of glyphosate to freshwater invertebrates is a 48-hour acute study using the technical material. Test organisms should be first instar Daphnia magna or early instar amphipods, stone flies or mayflies.

Species	**% AI**	**48-hr LC_{50} (ppm)**	**Author**	**Date**	**ID#**	**Fulfills Guideline Requirements**
Daphnia magna	83% tech	780	McAllister & Forbis	1978	00108172	YES
Chironomus plumosus	96.7% tech	55 (31-97)	Folmar Sanders & Julin	1979	MCOGLY16	NO

The results of these studies indicate that technical glyphosate is slightly toxic to Chironomus plumosus and is practically non toxic to Daphnia magna. The guideline requirement for acute testing on a freshwater invertebrate has been fulfilled.

Chronic Toxicity-Freshwater Invertebrates

Due to the aquatic use of the chemical its presence in water is likely to be continuous or recurrent regardless of toxicity; therefore, chronic testing is required.

Species	% AI	Results	Author	Date	ID#	Fulfills Guideline Requirements
Daphnia magna	99.7% tech	MATC >50-<96 mg/L Reduced repro-ductive capacity	McKee, McAllister & Schofield	1982	MCOGLY02	YES

This study satisfies the guideline requirement for chronic freshwater invertebrate testing.

Formulated Product:

Testing of an end-use product is required if the pesticide will be introduced directly into an aquatic environment when used as directed by the label. Drainage systems (wet and dry) would be included in such a category. Therefore, formulated product testing is required.

Fourteen tests on formulated glyphosate were received and determined as acceptable for use in risk assessment.

Species	% AI (IPA salt)	48-hr LC50 (ppm)	Author	Date	ID#	Fulfills Guideline Requirements
Daphnia magna	62.4%	869 (703-1019)	Forbis & Boudreau	1981	00078663	YES
Daphnia magna	7.03% + X-77 surfa ctant @0.5%	>1000	Forbis & Boudreau	1980	00078666	YES

Species	% AI (IPA salt)	48-hr LC50 (ppm)	Author	Date	ID#	Fulfills Guideline Requirements
Daphnia magna	41.2% + "AA" surfactant @ 15.3%	310 (250-400)	Boudreau & Forbis	1980	00078660	YES
Daphnia magna	40.7% MON2139 + 15% "W" surfactant	72 (62-83)	Forbis & Boudreau	1980	00078657	Yes
Daphnia magna	41% Round up	3 (2.6-3.4)	Folmar, Sanders & Julin	1979	MCOGLY16	Yes Suppl.
Gammarus pseudolimnaeus	41% Round up	62 (40-98)	Folmar, Sanders & Julin	1979	MCOGLY16	No Suppl.
Chironomus plumosus	41% Round up	18 (9.4-32)	Folmar Sanders & Julin	1979	MCOGLY16	No suppl.
Daphnia pulex	51% MON 2139	242(224-261.5)	Fraser & Jenkins	1973	00108109	Partially
Daphnia magna	41.36 % Round up	5.3 (4.4-6.3)	LeBlanc, Surprenant & Sleight	1980	00070893	Yes
Gammarus pseudolimnaeus	41.83 %	41.9 (30.7-62)	Forbis, Boudreau & Schofield	1982	MCOGLY03	Partially

According to the surfactant selected, the formulated product toxicity ranges from moderately toxic to practically non-toxic.

Species	% AI	Results	Author	Date	ID#	Fulfills Guideline Requirements

Ephemerella walkeri	41%	Mayfly nymphs avoided glyphosate (Roundup) at concentrations of 10 mg/L but not at 1.0 mg/l.	Folmar, Sanders & Julin	1979	JCOGLY16	Partially Suppl
Chironomus plumosus	41%	Significant increases in stream drift of midge larvae was observed after the 2.0 mg/l, but not at the 0.02 or 0.2 mg/l level.	Folmar, Sanders & Julin	1979	MCOGLY16	Partially Suppl.

Special Tests

Testing of the surfactant may be required under unusual circumstances. One test on the Roundup surfactant was received and determined as acceptable for use in a risk assessment.

Species	**% AI**	**48-hr LC_{50} (95%CL)**	**Author**	**Date**	**ID#**	**Fulfills Guideline Requirements**
Daphnia magna	100% MON0818 surfactant	13 mg/L (7.1-24)	Folmar, Sanders & Julin	1979	MCOGLY16	NO

Precautionary Labeling

The available acute toxicity data indicate that precautionary labeling for freshwater intervertebrates is not required for products containing glyphosate.

d. Effects on Marine/Estuarine Organisms

Three studies (in two references) were received and evaluated under this topic. All three studies were considered acceptable for use in a risk assessment.

Acute Toxicity

Acute toxicity testing for estuarine and marine organisms on technical glyphosate is required. The guidelines require estuarine and marine studies when exposure of such waters is likely. Crops, such as cotton, corn, sugarcane, turf, citrus, berries, forestry, sorghum, watermelon, etc. would allow this type of exposure to occur.

The following data on marine/estuarine species are acceptable for use in a risk assessment.

Species	% AI	Results	Author	Date	ID#	Fulfills Guideline Requirements
Grass shrimp	96.7% tech	LC_{50} 281 ppm (207-381)	Bentley	1973	00108111	Yes
Fiddler crab	96.7% tech	LC_{50} 934 ppm (555-1570)	Bentley	1973	00108111	Partially
Atlantic oyster	96.7% tech.	TL50>10 mg/L for 48 hrs	Bentley	1973	00108110	Partially

The available data indicate that technical glyphosate is practically non-toxic to grass shrimp, fiddler crab, and slightly toxic to the Atlantic oyster. Acute toxicity testing on an estuarine fish species is normally required. However, since there is such an extensive data set for this chemical, EEB can determine that glyphosate demonstrates low toxicity to fish species, and therefore is wavering the marine fish acute toxicity study.

Formulated Product

Acute toxicity testing for estuarine and marine organisms on formulated glyphosate may be required when exposure to estuarine and marine water is expected. The use in drainage systems (wet or dry) would allow this type of exposure. Minimum requirements are results from testing the technical on one estuarine fish (96 hrs LC_{50}) and either a 48 hrs oyster larvae study or a 96 hrs shell deposition study. Again, since there is such an extensive data set for this chemical, EEB can determine that glyphosate demonstrates low toxicity to fish and oyster species, and therefore is waiving the marine fish and oyster acute toxicity studies on the formulated product.

e. Effects on Non-Target Insects

Two studies (in one reference) were received and evaluated

under this topic. The studies were considered acceptable for use in a risk assessment.

Acute Toxicity

The guidelines require acute toxicity testing to honeybees on technical glyphosate when a herbicide is registered as a general use herbicide. Given the multitude of use patterns for which this chemical is registered, acute honeybee toxicity studies are required. The honeybee studies that are acceptable for use in a risk assessment are as follows:

Species	AI %	Results	Author	Date	Fiche No.	Fulfills Guideline Require.
Honeybee acute oral	tech*CP 67573	oral LD50>100 ug/bee	Fraser and Jenkins	1972	00026489	Yes
Honeybee acute oral	36 % MON2139	oral LD50>100 ug/bee	Fraser and Jenkins	1972	00026489	Yes
Honeybee acute contact	tech*CP 67573	contact LD50>100 ug/bee	Fraser and Jenkins	1972	00026489	Yes
Honeybee acute contact	36 % MON2139	contact LD50>100 ug/bee	Fraser and Jenkins	1972	00026489	Yes

* The percent active ingredient used for the technical was not reported.

Based on these data, glyphosate (CP67573) is considered practically nontoxic on the basis of acute contact toxicity, as well as on acute oral toxicity. These data satisfy guideline requirements for nontarget insect studies when glyphosate is used as a general use herbicide.

f. Effects to Non-Target Plants

Six studies (in six references) were received and evaluated under this topic. All six studies were considered acceptable for use in a risk assessment.

When a herbicide is applied as a terrestrial nonfood use, aquatic nonfood use, or as a forestry use, Tier I nontarget phytotoxicity studies are required in order to evaluate the effects of the herbicide on nontarget plants. The following data were submitted to support such registrations.

Species	%AI	Results	Author	Date	ID	Fulfills Guideline Requirements
Selenastrum capricornutum	96.6	4 day EC50 = 12.5 mg/l	Hughes	1987	402369-01	Yes
Navicula pelliculosa	96.6	4 Day EC 50= 39.9 mg/l	Hughes	1987	402369-02	Yes
Skeletonema costatum	96.6	4 day EC 50= 0.85 mg/l	Hughes	1987	402369-03	Yes
Anabaena flos-aquae	96.6	4 day EC 50=11.7 mg/l	Hughes	1987	402369-04	Yes
Lemna gibba	96.6	7 day EC 50=21.5 mg/l	Hughes	1987	402369-05	Yes

Based on the results of the preceding studies, the data indicates that the 4 day EC 50 ranged from 0.85 mg/l to 39.9 mg/l for four aquatic plant species, and a 7 day EC50 of 21.5 mg/l for one aquatic species. Based on the data submitted, the requirements for Tier I and Tier II Aquatic Plant Growth Studies (122-2 and 123-2)have been fulfilled.

A seed germination/seedling emergence study was conducted (Bohn 1987 MRID No 401593-01) on isopropylamine salt of glyphosate CP-70139 (Tech) 50% acid basis. The results indicate that CP-70139 applied at a rate up to 10.0 lb ai/A resulted in <25 % effect on the spectrum of monocots and dicots tested. Based on the results of this study, Tier I data requirements for seed germination/seedling emergence guideline reference 122-1 have been satisfied.

Based on the use patterns, the method of application, and the chemical properties of glyphosate, additional studies are required to evaluate the effects on nontarget plants. The recommended labels do not preclude off-target movement of glyphosate by drift. Nor do they address the potential off-target movement via terrestrial plants as well as aquatic plants. Therefore, EEB must have terrestrial plant test data to assess potential risk to nontarget plants. The data required are the Tier II Vegetative Vigor Guideline Reference No. 123-1.

Special Tests

In addition, droplet size spectrum (201-1) and drift field evaluation (202-1) data are required. The registrant, Monsanto, may elect to satisfy these data requirements through the Spray Drift Task Force, provided that neither EFED/EFGWB nor HED/TOX require these data in advance of the Task Force's final report (currently scheduled for December 1994). If the registrant wishes to satisfy these data requirements in this manner, the procedures outlined in PR Notice 90-3 should be followed (Jones, A. 1993. Personal Communications).

2. Disciplinary Review Summation

a. Non-Target Terrestrial

Glyphosate is practically non-toxic to bobwhite quail on the basis of acute oral toxicity. An LD50 greater than 2000 mg/kg was determined for bobwhite quail given a single oral dose of technical glyphosate (Beavers & Fink 1978, ID# MCOGLY04). The results of studies by Fink (1973, ID# MCOGLY011) indicate that the 8-day dietary LC50 of the chemical is greater than 4000 ppm for both mallard ducks and bobwhite quail. These data indicate that the chemical is slightly toxic to birds. Avian reproduction studies both by Beavers and Fink (1978, ID #'s MCOGLY012 and MCOGLY013) indicate reproductive impairment would not be expected at a dietary level of up to 1000 ppm.

b. Non-Target Aquatic (Fish, Aquatic Invertebrates and Estuarine/marine Organisms)

(1) Freshwater Organisms

A 48-hour LC50 of 780 ppm (mg/l) was found for Daphnia magna exposed to technical glyphosate (McAllister and Forbis 1978, ID #00108172). The results of this study indicate that the chemical is practically non-toxic to aquatic invertebrates.

Three tests on warm water species, one bluegill and two with fathead minnow, produced the 96-hour LC50s of 120 ppm, 84.9 ppm, and 97 ppm, respectively (McAllister and Forbis 1978, ID #MCOGLY07; EG & G Bionomics 1975, ID #00108171 and Folmar, Sanders, and Julin 1979, ID #MCOGLY16). Two rainbow trout 96-hour LC50's provided values of 86 ppm and 140 ppm (Thompson & McAllister 1978, ID# MCOGLY08 and (Folmar, Sanders , and Julin 1979, ID #MCOGLY16, respectively). Based on these tests, technical glyphosate ranges from slightly to practically non-toxic to freshwater fish species.

In addition to these acute studies, a fish life-cycle study indicates technical glyphosate has a MATC greater than 25.7 ppm (EG&G Bionomics 1975, ID# 00108171). No effect was observed at the highest level tested. A Daphnia magna life cycle study with an MATC of >50-<96 ppm (McKee, McAllister & Schofield 1982 ID# MCOGLY02) reported reduced reproductive capacity, the most sensitive

2nd

parameter.

(2) Marine Organisms

A series of studies were performed on marine/ estuarine species (Bentley 1973, ID #00108110 and 00108111). A 96-hour LC50 of 281 ppm was determined for grass shrimp (Palaemonetas vulgaris). In a study on fiddler crabs (Uca pugilator), it was determined that the 96-hour LC50 is 934 ppm glyphosate. Both of these studies indicate technical glyphosate is practically non-toxic to grass shrimp and fiddler crabs. An embryo-larvae 48-hour TL50 for Atlantic oyster greater than 10 ppm indicating glyphosate is slightly toxic.

(3) Formulated Product

Isopropylamine salt of glyphosate

In order to determine the effect of the three surfactants ("W", "AA", and "X-77") on invertebrates, additional Daphnia studies were conducted. The 7.03 percent isopropylamine salt of glyphosate with a surfactant at 0.5 percent identified as X-77 resulted in an LC50 of greater than 1000 mg/l or practically non-toxic category for Daphnia. (Forbis and Boudreau 1980, ID #00078666.) The second combination was 41.2 percent isopropylamine and 15.3 percent of a surfactant identified as "AA" (Boudreau and Forbis 1980, ID #00078660.) This LC50 was 310 ppm which would indicate it is practically non-toxic to Daphnia. The third combination consisted of 40.7 percent isopropylamine and 15 percent of a surfactant identified as "W" (Forbis and Boudreau 1980, ID #00078657). The resultant LC50 of 72 ppm reveals that this material is slightly toxic to Daphnia.

The Roundup formulation was tested several times with different invertebrates. The LC50 values ranged from 3 mg/l for Daphnia to 62 mg/l for Gammarus indicating a moderately toxic material for Daphnia and no more than slightly toxic for Gammarus. (Folmar et al. 1979, ID #MCOGLY16).

Similar surfactant testing was performed with both cold water and warm water fish. In this case, the initial formulation demonstrated an application rate much lower than technical glyphosate. The LC50 for rainbow trout was 1.3 mg/l or moderately toxic (Folmar et al. 1979, ID #MCOGLY16). The surfactant (MON0818) when tested alone produced an LC50 value of 0.65 mg/l for rainbow trout indicating a highly toxic category (Folmar et al. 1979, ID #MCOGLY16). In contrast, the formulation of 41.2 percent isopropylamine salt and 15.3 percent "AA" surfactant provided a rainbow trout LC50 of 120 mg/l, indicating a practically non-toxic compound (Thompson and Griffen 1980, ID #00078658). Bluegill are in the same category of toxicity with an even higher LC50 of greater than 180 mg/l (Thompson and Griffen 1980, ID #00078659). The bluegill and rainbow trout were similar in sensitivity to the formulation containing the "W" surfactant with LC50 values of 150

and >100 mg/l, respectively (Thompson et al. 1980, ID #00078655 and 00078656, respectively). Also, neither rainbow trout (LC50 240 mg/l) or bluegill (LC50 830 mg/l) were very sensitive to the x-77(.5) surfactant and glyphosate(7.03%) (Thompson 1980, ID #00078664 and 00078665).

Surfactant (MON0818)

This surfactant has been tested separately, producing an LC50 of 13 mg/l on Chironomous indicating it is a slightly toxic material (Folmar, Sanders & Julin 1979, ID # MCOGLY16). For fish, the catfish appears to be the most tolerant with an LC50 value of 13 mg/l, and rainbow trout the most sensitive with an LC50 value of 0.65 mg/l (Folmar, Sander & Julin 1979, ID# MCOGLY16).

c. Non-Target Insects

Four studies were conducted, two on technical glyphosate and two on the formulation MON2139, consisting of 36 % active ingredient. Results from the honeybee acute oral toxicity study indicates both technical and formulated glyphosate practically nontoxic to the honey bee with LD 50 values greater than 100 ug/bee. Results from the honeybee acute contact toxicity study indicates both technical and formulated glyphosate is practically nontoxic to the honey bee with LD 50 values greater than 100 ug/bee.

d. Non-Target Plants

Based on the results of the aquatic plant growth studies which were conducted on 5 species, the data indicates that the 4 day EC50 ranged from 0.85 mg/l to 39.9 mg/l for four aquatic plant species, and a 7 day EC50 of 21.5 mg/l for one aquatic species.

A seed germination/seedling emergence study was conducted (Bohn 1987 MRID No 401593-01) on isopropylamine salt of glyphosate CP-70139 (Tech) 50% acid basis. The results indicate that CP-70139 applied at a rate up to 10.0 lb ai/A resulted in <25 % effect on the spectrum of monocots and dicots tested.

B. Ecological Effects Risk Assessment

Based on the current data, it has been determined that effects to birds, mammals, fish and invertebrates are minimal. Under certain use conditions, glyphosate is expected to cause adverse effects to nontarget aquatic plants. Additional data are needed in order to fully evaluate the effects of glyphosate on nontarget terrestrial plants. This includes more specific incident information, results from vegetative vigor testing (123-1), droplet size spectrum (201-1). In addition, the drift field evaluation (202-1) study must be submitted and reviewed. Risk reduction measures cannot be recommended until data are submitted and

evaluated.

1. Non-Endangered Species

a. Terrestrial Species

The acute oral LD50 found for bobwhite quail dosed with technical glyphosate is greater than 3851 mg/kg. This indicates that the chemical is practically non-toxic to an upland game species. On a dietary basis, the available data indicate that, at most, technical glyphosate is slightly toxic to both mallards and bobwhite (LC50 > 4640). The articles of Hoerger and Kenaga (1972) and Kenaga (1973) were consulted in order to estimate the maximum concentration of glyphosate which may occur at the highest application rate for such sites as, cotton and corn. The following chart addresses the major vegetation categories upon which fauna are expected to feed.

Feed Categories	Concentrations (ppm) @ 5.0625 lbs ai/A
Short grass	1215
Long grass	557
Leafy crops	632
Forage; Small insects	294
Pods; Large insects	61
Fruit	35

Comparing these residues to the dietary data for both bobwhite and mallards (LC50 > 4640; 1/5th the LC50 > 928), higher use rates may produce potentially toxic residues on short grass only (assuming the LC50 is just over > 4640). Wildlife ingesting significant amounts of insects, pods and/or fruits should not be affected by single applications.

Directions for some of the use patterns do indicate that applications can be repeated. Multiple treatments could potentially increase residues on dietary items within an extended time period. Also, the available information suggest that glyphosate is relatively persistent. The half-life in soil is as high as 90.2 days. However, avian reproduction studies demonstrated no adverse effects at the highest level tested, 1000 parts per million. Similarly, 90-day dietary studies with dogs and rats indicate no significant abnormalites when the maximum level tested is 2000 parts per million. Based on this, minimal risk is expected.

b. Aquatic Species

Aquatic organisms do not appear to be sensitive to technical glyphosate. The most sensitive aquatic invertebrate tested is Chironomus plumosus with a 48-hr LC50 of 55 ppm which is very near to the lower limit of the Daphnia chronic MATC of 50 mg/l. The most sensitive fish species are fathead minnow and rainbow trout which have 96-hour LC50s of 84.9 and 86 mg/l. Chronic testing for the technical with fathead minnow provided an MATC of > 25.7 mg/l. Based on the toxicity and the various EEC's EEB has determined technical glyphosate should not cause acute or chronic adverse effects to aquatic environments. Therefore, minimal risk is expected to aquatic organisms from the technical glyphosate.

c. Terrestrial Plants and Aquatic Macrophytes

A seed germination/seedling emergence study was conducted (Bohn 1987 MRID No 401593-01) on isopropylamine salt of glyphosate CP-70139 (Tech) 50% acid basis. The results indicate that CP-70139 applied at a rate up to 10.0 lb ai/A resulted in <25 % effect on the spectrum of monocots and dicots tested. Considering the use patterns that are terrestrial food crop and non-food crop the above EEC's were considered for evaluating the effects to nontarget plants. The highest exposure of 0.404 lb a.i. (from aerial application, mist blower and sprinkler irrigation) is well below the 10.0 lb a.i./A rate which resulted in < 25 % effect on the monocots and dicots tested. Therefore, it has been determined that the use of glyphosate is not expected to cause adverse effects on seed germination/seedling emergence with the various registered use patterns.

No vegetative vigor (123-1) plant studies have been conducted. Based on the use patterns, the method of application and the chemical properties of glyphosate, additional studies are required to evaluate these effects on nontarget terrestrial plants. The recommended labeling precautions do not preclude off-target movement of glyphosate by drift. To assess potential risk to terrestrial plants it is necessary to have additional terretrial plant test data. This includes more specific information on incidents, results from 123-1 vegetative vigor testing, droplet size spectrum (201-1) and drift field evaluation (202-1) study should be submitted and reviewed. Risk reduction measure cannot be recommended until data are submitted and evaluated.

The aquatic EEC from direct application of 3.72 ppm was used to estimate exposure. Based on the results of the aquatic macrophyte toxicity data, the 4 day EC 50 was reported to be as low as 0.85 ppm indicating that there may be adverse effects to nontarget aquatic plant species.

2. Endangered Species

The Environmental Fate and Effects Division reviews the

potential effects of pesticide uses on endangered species. Based on the toxicity data and the estimated exposure, it is not expected that endangered terrestrial or aquatic organisms will be affected from the use of glyphosate on the registered uses since the EEC's are well below the endangered species criteria (birds= 1/10 LC 50, aquatic organisms= 1/20 LC 50). However, many endangered plants may be at risk from the use of glyphosate on the registered use patterns. In addition, as discussed in the 1986 Amended Glyphosate Registration Standard, it was determined that based on habitat, the Houston Toad may be at risk from the use of glyphosate on alfalfa. Please see Attachment A for all species (by county and state) that have been determined to possibly be affected from the use of this herbicide on the registered crops.

3. Incident Data

Monsanto has reported a total of 135 incidents to EEB involving roundup on various registered and nonregistered use patterns. Approximately 90 % of the incidents were associated with Roundup on Corn. EEB has requested in several documents (Dec, 20, 1991 and January 13, 1992) that additional data be submitted so that the incidents can be fully evaluated. To date, EEB has not received additional information with regards to these incidents.

C. Labeling

1. Manufacturing Use Product

"Do not discharge effluent containing this product into lakes, streams, ponds, estuaries, oceans, or public waters unless this product is specifically identified and addressed in an NPDES permit. Do not discharge effluent containing this product to sewer systems without previously notifying in writing the sewage treatment plant authority. For guidance contact your State Water Board or Regional Office of the EPA."

2. End Use Product

a. <u>Nonaquatic</u>

"Do not apply directly to water, to areas where surface water is present or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment washwaters and rinsate."

b. <u>Aquatic</u>

"Do not contaminate water when disposing of equipment washwaters and rinsate. Treatment of aquatic weeds can result in oxygen loss from decomposition for dead plants. This loss can cause fish kills."

D. Data Requirements

Name of Study	Guideline reference No.
Tier II Vegetative Vigor Study	123-1
Droplet Size Spectrum	201-1
Drift Field Evaluation	202-1
Completed Incident Reports	Not applicable.

Citations

1. Arkansas Cooperative Extension Service (1985) Recommended Chemicals for Weed and Brush Control, MP-A4, Arkansas.

2. Hill, E.F., Heath, R.G., Spann, J.W. and Williams, J.D.(1975) Lethal Dietary Toxicities of Environmental Pollutants to Birds, U.S.F.W.S. Special Scientific .Report--Wildlife No. 191.

3. Hoerger and Kenaga (1972) Pesticide Residues on Plants. Correlation of Representative Data as a Basis for Estimation of their Magnitude in the Environment. Environmental Quality. Academic Press, N.Y.1:9-28.

4. Jones, Arnet. 1993. Personal Communications. Environmental Fate and Groundwater Branch. Environmental Fate and Effects Division (H7507-C), USEPA. Washington, D.C. 20460.

5. Kenaga (1973) Factors to be considered in the Evaluation of Pesticides to Birds in their Environment. Environmental Quality, Academic Press, N.Y.II: 166-181.

6. Leonard, W.H. and Martin, J.H. (1963) Cereal Crops, Part V. Rice, Sorghum, and Millets, page 635.

7. McLane, Dennis. 1986. Amended Glyphosate Registration Standard. Ecological Effects Branch, Environmental Fate and Effects Division (H7507-C), USEPA. Washington, D.C. 20460.

8. USDA, The biologic and economic assessment of 2,4,5-T, Cooperative Impact Assessment Technical Bulletin Number 1671.

9. Wauchope (1978) The Pesticide Content of Surface Water Draining from Agricultural Fields - A Review, J. Environ. Qual., Vol. 7.7, No. 4.

DP Barcode : D184417
PC Code No : 103601
EEB Out : MAY 3 1993

To: WALTER WALDROP PM 71
Product Manager
Special Review and Reregistration Division (H7508W)

From: Douglas J. Urban, Acting Chief
Ecological Effects Branch/EFED (H7507C)

Attached, please find the EEB review of...

Reg./File # : REREG CASE NO 0178 LIST A
Chemical Name : GLYPHOSATE
Type Product : HERBICIDE
Product Name :
Company Name :
Purpose : PREPARE SCIENCE CHAPTER FOR REREGISTRATION ELIGIBILITY DOCUMENT

Action Code : Date Due : 5-1-93
Reviewer : CANDY BRASSARD Date In EEB: 11-19-92

EEB Guideline/MRID Summary Table: The review in this package contains an evaluation of the following:

GDLN NO	MRID NO	CAT	GDLN NO	MRID NO	CAT	GDLN NO	MRID NO	CAT
71-1(A)			72-2(A)			72-7(A)		
71-1(B)			72-2(B)			72-7(B)		
71-2(A)			72-3(A)			122-1(A)		
71-2(B)			72-3(B)			122-1(B)		
71-3			72-3(C)			122-2		
71-4(A)			72-3(D)			123-1(A)		
71-4(B)			72-3(E)			123-1(B)		
71-5(A)			72-3(F)			123-2		
71-5(B)			72-4(A)			124-1		
72-1(A)			72-4(B)			124-2		
72-1(B)			72-5			141-1		
72-1(C)			72-6			141-2		
72-1(D)						141-5		

Y=Acceptable (Study satisfied Guideline)/Concur
P=Partial (Study partially fulfilled Guideline but additional information is needed
S=Supplemental (Study provided useful information but Guideline was not satisfied)
N=Unacceptable (Study was rejected)/Nonconcur

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

MAY 3 1993

OFFICE OF
PREVENTION, PESTICIDES AND
TOXIC SUBSTANCES

MEMORANDUM

SUBJECT: Reregistration Eligibility Document for Glyphosate (D184417)

FROM: Anthony F. Maciorowski, Chief
Ecological Effects Branch
Environmental Fate and Effects Division (H7507-C)

TO: Walter Waldrop, Jr. Product Manager 71
Special Review and Reregistration Division (H7508-C)

The Ecological Effects Branch (EEB) has completed the Phase V review (RED) for Glyphosate. Since the Amended Glyphosate Registration Standard was completed in 1986 (McLane, D. 1986), glyphosate has become a widely used pre-emergent, pretransplant, postplant, pre-plant, and postemergent herbicide. Glyphosate is registered for over one hundred terrestrial food crops. In addition, there are many other uses under the categories of terrestrial nonfood crop, terrestrial feed crop, forestry use, and aquatic food crop.

It was determined in the 1986 amended glyphosate registration standard that the use of glyphosate at the maximum application rate of 5 lb a.i./A did not pose a risk to nontarget terrestrial or aquatic organisms. Since then, phytotoxicity data have been submitted and have been reviewed and evaluated by EEB.

A total of 5 Tier II aquatic plant growth studies(guideline reference number 123-2) have been submitted and been found to satisfy data requirements. Based on the risk assessment, adverse effects to non-target plants occur from the use of glyphosate. Tier III studies (124-2) are triggered, however, the EEB will assess risk using available information.

A seed germination/seedling emergence study was conducted on isopropylamine salt of glyphosate CP-70139 (Tech) 50% acid basis. The results indicate that CP-70139 applied at a rate up to 10.0 lb ai/A resulted in <25 % effect on the spectrum of monocots and dicots tested. Based on these data and the estimated exposure to terrestrial nontarget plants, EEB has determined that the use of glyphosate is not expected to cause adverse affects to the seed

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germination or seedling emergence to nontarget terrestrial plants.

No vegetative vigor (123-1) plant studies have been conducted. Based on the use patterns, the method of application, and the chemical properties of glyphosate, additional studies are required to evaluate these effects on nontarget terrestrial plants. The recommended labeling precautions do not preclude off-target movement of glyphosate by drift. To assess potential risk to terrestrial plants EEB must have additional terrestrial plant test data. It is recommended that the Tier II Vegetative Vigor (Guideline Reference No. 123-1) be required.

In addition, droplet size spectrum (201-1) and drift field evaluation (202-1) data are required to quantify drift potential. The registrant, Monsanto, may elect to satisfy these data requirements through the Spray Drift Task Force, provided that neither EFED/EEB nor HED/TOX require these data in advance of the Task Force's final report (currently scheduled for December 1994). If the registrant wishes to satisfy these data requirements in this manner, the procedures outlined in PR Notice 90-3 should be followed (Jones, A. 1993 Personal Communications).

Endangered Species Considerations

The Environmental Fate and Effects Division reviews the potential effects of pesticide uses on endangered species. Many endangered plants may be at risk from the use of glyphosate on the registered use patterns. In addition, it was determined that the Houston Toad may be at risk (through toxic effects to it's aquatic life stage) from the use of glyphosate on alfalfa. The EEB Science Chapter contains the list of all species (by county and state) we have determined may be affected from the use of this herbicide on the registered crops.

Incident Data

Monsanto has reported a total of 135 incidents to EEB involving Roundup on various registered and nonregistered use patterns. Approximately 90 % of the incidents were associated with Roundup on Corn. EEB has requested that additional data be submitted so that the incidents can be fully evaluated (EEB Reviews by Lewis, C. dated December 20, 1991 and January 13, 1992). To date EEB has not received additional information with regards to these incidents.

Conclusions

Based on the current data, EEB has determined that effects to birds, mammals, fish and invertebrates are minimal. Under certain use conditions, glyphosate is expected to cause adverse effects to nontarget aquatic plants. Additional data are needed

in order to fully evaluate the effects of glyphosate on nontarget terrestrial plants. This includes more specific information on the incidents, and results from 123-1 vegetative vigor testing, and droplet size spectrum (201-1) and drift field evaluation (202-1) study must be reviewed and submitted. Risk reduction measures cannot be recommended until data are submitted and evaluated.

If you have further questions, please feel free to contact Candace Brassard at 305-5392.

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DP Barcode : D184417
PC Code No : 103601
EEB Out :

To: WALTER WALDROP PM 71
Product Manager
Special Review and Reregistration Division (H7508W)

From: Douglas J. Urban, Acting Chief
Ecological Effects Branch/EFED (H7507C)

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Product Name :
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71-2(B)			72-3(B)			122-1(B)		
71-3			72-3(C)			122-2		
71-4(A)			72-3(D)			123-1(A)		
71-4(B)			72-3(E)			123-1(B)		
71-5(A)			72-3(F)			123-2		
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ECOLOGICAL EFFECTS BRANCH
SCIENCE CHAPTER FOR
REREGISTRATION ELIGIBILITY DOCUMENT
FOR GLYPHOSATE

A. Ecological Hazard

a. Effects on Non-Target Birds

Eight studies (contained in eight references) were received and evaluated under this topic. Seven studies are acceptable for use in a risk assessment.

Author	Date	Fiche ID#
Batt and Black	1978	00072211
Beavers and Fink	1978	MCOGLY04
Beavers and Fink	1978	MCOGLY12
Beavers and Fink	1978	MCOGLY13
Fink	1973	00076492
Fink	1973	MCOGLY11
Fink	1975	00036328
Sullivan	1978	00072210

To establish the toxicity of glyphosate to birds, the following tests are required using the technical grade material:

a. One avian single-dose oral study on either a waterfowl species (preferably mallard duck) or an upland species (preferably bobwhite quail);

b. Two subacute dietary studies: one study on a species of waterfowl(preferably mallard duck) and one on an upland game bird species(preferably a bobwhite quail).

Avian Single-Dose Oral LD_{50} - Technical

The acceptable acute oral toxicity study is listed below:

Species	% AI	LD_{50} (95% CL)	Author	Date	ID#	Fulfills Guideline Requirement
Bobwhite quail	83%	> 2000 mg/kg	Beaver & Fink	1978	MCOGLY04	YES

These data indicate that technical glyphosate is practically non-toxic to an upland bird species on an acute oral basis. The guideline requirement for an avian acute oral study is fulfilled.

Avian Dietary - Technical

The acceptable subacute dietary toxicity studies are listed below:

Species	% AI	Reproductive Impairment	Author	Date	ID#	Fulfills Guideline Requirement
Mallard duck	98.5% Tech	>4640 ppm	Fink	1973	MCOGLY11	Yes
Bobwhite quail	98.% Tech	>4640 ppm	Fink	1973	00086492	Yes

These data indicate that the technical glyphosate is no more than slightly toxic to birds on a dietary basis. The guideline requirement is fulfilled for both studies.

Avian Reproduction

An avian reproduction test is required to support registration of the end-use products of glyphosate since the following guideline criteria have been exceeded. The labeling for several use patterns contains directions for use under which birds may be subject to repeated exposure to glyphosate.

The labeling allows repeat application for certain uses, such as alfalfa, barley, oats, apples, cherries, and oranges.

The acceptable avian reproduction studies are listed below:

Species	% AI	Reproductive Impairment	Author	Date	ID#	Fulfills Guideline Requirement
Mallard duck	83% Tech	No effects up to 1000 ppm	Beavers & Fink	1978	MCOGLY13	Yes
Mallard duck	90.4% Tech	No effects up to 30 ppm	Fink	1975	00036328	Partially
Bobwhite quail	83% Tech	No effects up to 1000 ppm	Beavers & Fink	1978	MCOGLY12	Yes

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These data indicate that technical glyphosate is not expected to cause reproductive impairment. The guideline requirements for an avian reproduction study on both upland game bird and waterfowl are fulfilled.

Special Tests:

The following study was also submitted for review, but was not incorporated into the risk assessment:

Species	% AI	Hatchability Impairment	Author	Date	ID#	Fulfills Guideline Requirements
Chicken	Unknown (Roundup)	No effect	Batt & Black	1978	00072211	Partially

Precautionary Labeling

The available acute toxicity data do not indicate a requirement of precautionary labeling for birds on products containing glyphosate.

b. Effects on Non-Target Fish

Forty-one studies (in 25 references) were evaluated under this topic. Thirty-one studies were considered acceptable for use in a risk assessment.

Author	Date	Fiche ID No.
Morrill	1973	00108112
EG & G Bionomics	1975	00108171
McAllister & Forbis	1978	MCOGLY07
Thompson, McAllister & Johnson	1978	MCOGLY08
Forbis	1982	MCOGLY09
Forbis, Boudreau & Schofield	1982	MCOGLY10
EG & G Bionomics	1975	MCOGLY06
Le Blanc, Wilson & Sleight	1980	00080894
Le Blanc, Surprenant & Sleight	1980	00070895
Le Blanc, Dionne & Sleight	1980	00070896

Author	Date	Fiche ID No.
Le Blanc, Surprenant & Sleight	1980	00070897
Thompson & Griffen	1981	00078661
Griffen & Thompson	1981	00078662
Thompson, Griffen & Forbis	1980	00078658
Thompson, Griffen & Boudreau	1980	00078655
Thompson & Griffen	1980	00078656
Thompson & Griffen	1980	00078659
Thompson & Griffen	1980	00078664
Thompson & Griffen	1980	00078665
Folmar, Sanders & Julin	1979	MCOGLY16
Russel	1972	00108194
Rausina	1973	00111952
Rausina	1974	00108201
USDI	1969	MCOGLY14
Fraser	1975	00036325

The minimum data required for establishing the acute toxicity of glyphosate to freshwater fish are the results from two 96-hour studies with the technical grade product. One study should be performed on a cold water fish species (preferably rainbow trout) and one study should be performed using a warm water species (preferably bluegill sunfish).

The acceptable acute data are as follows:

Species	% AI	48-hr LC_{50} (95%CL)	Author	Date	ID#	Fulfills Guideline Requirements
Bluegill sunfish	96.5 %	>24 mg/l	Morrill	1973	00108112	Partially
Fathead Minnow	87.3 %	84.9 mg/L (72.9-99.3)	EG & G Bionomics	1975	00108171	Partially

Species	% AI	48-hr LC_{50} (95%CL)	Author	Date	ID#	Fulfills Guideline Requirements
Bluegill sunfish	83%	120 mg/L (111-130)	McAllister & Forbis	1978	MCOGLY07	Yes
Rainbow Trout	83%	86 mg/L (70-106)	Thompson, McAllister & Johnson	1978	MCOGLY08	Yes
Rainbow Trout	96.7 %	140 mg/l (120-170)	Folmar, Sanders & Julin	1979	MCOGLY16	Yes
Fathead minnow	96.7 %	97 mg/L (79-120)	Folmar, Sanders & Julin	1979	MCOGLY16	Yes
Channel catfish	96.7 %	130 mg/L (110-160)	Folmar, Sanders & Julin	1979	MCOGLY16	Yes
Bluegill sunfish	96.7 %	140 mg/L (110-160)	Folmar, Sanders & Julin	1979	MCOGLY16	Yes

The results of these eight studies indicate that technical glyphosate is slightly to practically nontoxic to both cold water and warm water fish. The guidelines requirement for acute toxicity testing of the technical on freshwater fish is fulfilled.

Due to the aquatic use of the chemical, its presence in water is likely to be continuous or recurrent regardless of toxicity; therefore, chronic testing is required.

Species	% AI	Results	Author	Date	ID#	Fulfills Guideline Requirements
Fathead Minnow	87.3% tech	MATC>25.7 mg/L No effects at or below this level	EC & G Bionomics	1975	00108171	YES

This fish full life cycle study satisfies the guideline requirement for chronic freshwater fish testing.

Formulated Product:

Testing of an end-use product is required if the pesticide will be introduced directly into an aquatic environment when used as directed by the label. Drainage systems would be included in such a category. Therefore, formulated product testing is required.

Twenty tests on formulated glyphosate were received and determined as acceptable for use in a risk assessment.

Species	% AI (IPA salt)	96-hr LC_{50} (95% CL)	Author	Date	ID#	Fulfills Guideline Requirements
Bluegill sunfish	41.8% Round up	5.8 mg/L (4.4-8.3)	Forbis	1982	MCOGLY10	Yes
Rainbow Trout	41.8% Round up	8.2 mg/L (6.4-9.0)	Forbis, Boudreau & Schofield	1982	MCOGLY10	Yes
Channel catfish	41.36 % Round up	16 mg/L (9.4-26)	LeBlanc, Wilson & Sleight	1980	00070894	No
Rainbow Trout	41.36 Round up	11 mg/L (8.7-14)	LeBlanc, Suprenant & Sleight	1980	00070895	Yes
Bluegill sunfish	41.36 % Round up	14 mg/L (8.7-24)	LeBlanc, Suprenant & Sleight	1980	00070897	Yes
Fathead Minnow	41.36 % Round up	9.4 mg/L (5.6-16)	LeBlanc, Dionne & Sleight	1980	00070896	No
Rainbow Trout	62.4%	>1000 mg/L	Thompson & Griffen	1980	00078661	Yes
Bluegill sunfish	62.4%	>1000 mg/L	Thompson & Griffen	1981	00078662	Yes

Species	% AI (IPA salt)	96-hr LC_{50} (95% CL)	Author	Date	ID#	Fulfills Guideline Requirements
Rainbow Trout	*41.2 % + 15.3 "AA" surfactant	120 mg/L (56-180)	Thompson, Griffen & Forbis	1980	00078658	Yes
Rainbow Trout	*40.7 % + 15% "W" surfactant	150 mg/L (100-320)	Thompson, Griffen & Boudreau	1980	00078655	Yes
Bluegill sunfish	*40.7 % + 15% "W" surfactant	>100 mg/L	Thompson & Griffen	1980	00078656	Yes
Bluegill sunfish	*41.2 % + 15.3% "AA" surfactant	>180 mg/L	Thompson & Griffen	1980	00078659	Yes
Rainbow Trout	7.03% + 0.5% "X-77"	240 mg/L (180-320 mg/L)	Thompsson & Griffen	1980	00078664	Yes
Bluegill sunfish	7.03% + 0.5% "X-77"	830 mg/L (620-1600)	Thompson & Griffen	1980	00078665	Yes
Rainbow Trout	51% Round up	8.3 mg/L (7.0-9.9)	Folmar, Sanders & Julin	1979	MCOGLY16	Yes
Fathead minnows	41% Round up	2.3 mg/L (1.9-2.8)	Folmar, Sanders & Julin	1979	MCOGLY16	Yes

Species	% AI (IPA salt)	96-hr LC_{50} (95% CL)	Author	Date	ID#	Fulfills Guideline Requirements
Rainbow Trout	41% Round up	9.0 mg/L (7.5-11)	Folmar, Sanders & Julin	1979	MCOGLY16	Yes
Bluegill sunfish	41% round up	4.3 mg/L (3.4-5.5)	Folmar, Sanders & Julin	1979	MCOGLY16	Yes
Channel catfish	41% Round up	13 mg/L (11-16)	Folmar, Sanders & Julin	1979	MC(GLY16	Yes
Bluegill sunfish	41% Round up	5 mg/L (3.8-6.6)	Folmar, Sanders & Julin	1979	MC)GLY16	Yes
Rainbow Trout	41% Round up	1.3 mg/L (1.1-16)	Folmar, Sanders & Julin	1979	MCOGLY16	Yes

According to the surfactant selected, the formulated product toxicity ranges from moderately toxic to practically non-toxic.

Special Tests:

Testing of the surfactant may be required under unusual circumstances. When inerts are likely to be toxic, testing can be required.

Species	% AI	96-hour LC_{50} (95% CL)	Author	Date	ID#	Fulfills Guideline Requirements
Fathead minnow	MONO818 Tech 100%	1.0 mg/L (1.2-1.7)	Folmar, Sanders & Julin	1979	MCOGLY16	Yes
Rainbow trout	MONO818 Tech 100%	2.0 mg/L (1.5-2.7)	Folmar, Sanders & Julin	1979	MCOGLY16	Yes
Rainbow Trout	MONO818	0.65 mg/L (.54-.78)	Folmar, Sanders & Julin	1979	MCOGLY16	Yes

Channel Catfish	MONO818 Tech 100%	13 mg/L (10-17)	Folmar, Sanders & Julin	1979	MCOGLY16	Yes
Bluegill sunfish	MONO818 Tech 100%	3.0 (2.5-3.7)	Folmar, Sanders & Julin	1979	MCOGLY16	Yes
Bluefish sunfish	MONO818 Tech 100%	1 mg/L (.72-1.4)	Folmar, Sander & Julin	1979	MCOGLY16	Yes

These data indicate that MONO818 is ranges from moderately toxic to very highly toxic to both cold and warmwater fish after 96 hour exposure.

Precautionary Labeling

Based upon available data products containing MONO818 must include the statement, "This pesticide is toxic to fish."

c.Effects on Aquatic Invertebrates

Twenty-two studies (contained in 11 references) were received and evaluated under this topic. All were found acceptable for use in a risk assessment.

Author	Date	Fiche ID No.
Forbis & Boudreau	1981	00078663
Boudreau & Forbis	1980	00078660
Forbis & Boudreau	1980	00078657
Forbis & Boudreau	1980	00078666
Fraser & Jenkins	1973	00108109
McAllister & Forbis	1978	00108172
LeBlanc, Suprenant & Sleight	1980	00070893
McKee, McAllister Schofield	1982	MCOGLY02
Forbis, Boudreau & Schofield	1982	MCOGLY03

Folmar, Sanders, & Julin	1979	MCOGLY16
Rausina	1974	00108201 (00047770)

The minimum data requirement to establish the acute toxicity of glyphosate to freshwater invertebrates is a 48-hour acute study using the technical material. Test organisms should be first instar Daphnia magna or early instar amphipods, stone flies or mayflies.

Species	% AI	48-hr LC_{50} (ppm)	Author	Date	ID#	Fulfills Guideline Requirements
Daphnia magna	83% tech	780	McAllister & Forbis	1978	00108172	YES
Chironomus plumosus	96.7% tech	55 (31-97)	Folmar Sanders & Julin	1979	MCOGLY16	NO

The results of these studies indicate that technical glyphosate is slightly toxic to Chironomus plumosus and is practically non toxic to Daphnia magna. The guideline requirement for acute testing on a freshwater invertebrate has been fulfilled.

Due to the aquatic use of the chemical its presence in water is likely to be continuous or recurrent regardless of toxicity; therefore, chronic testing is required.

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Species	% AI	Results	Author	Date	ID#	Fulfills Guideline Requirements
Daphnia magna	99.7% tech	MATC >50-<96 mg/L Reduced repro-ductive capacity	McKee, McAllister & Schofield	1982	MCOGLY02	YES

This study satisfies the guideline requirement for chronic freshwater invertebrate testing.

Formulated Product:

Testing of an end-use product is required if the pesticide will be introduced directly into an aquatic environment when used as directed by the label. Drainage systems (wet and dry) would be included in such a category. Therefore, formulated product testing is required.

Fourteen tests on formulated glyphosate were received and determined as acceptable for use in risk assessment.

Species	% AI (IPA salt)	48-hr LC50 (ppm)	Author	Date	ID#	Fulfills Guideline Requirements
Daphnia magna	62.4%	869 (703-1019)	Forbis & Boudreau	1981	00078663	YES
Daphnia magna	7.03% + X-77 surfactant @0.5%	>1000	Forbis & Boudreau	1980	00078666	YES
Daphnia magna	41.2% + "AA" surfactant @ 15.3%	310 (250-400)	Boudreau & Forbis	1980	00078660	YES

Species	% AI (IPA salt)	48-hr LC50 (ppm)	Author	Date	ID#	Fulfills Guideline Requirements
Daphnia magna	40.7% MON2139 + 15% "W" surfactant	72 (62-83)	Forbis & Boudreau	1980	00078657	Yes
Daphnia magna	41% Round up	3 (2.6-3.4)	Folmar, Sanders & Julin	1979	MCOGLY16	Yes Suppl.
Gammarus pseudolimnaeus	41% Round up	62 (40-98)	Folmar, Sanders & Julin	1979	MCOGLY16	No Suppl.
Chironomus plumosus	41% Round up	18 (9.4-32)	Folmar Sanders & Julin	1979	MCOGLY16	No suppl.
Daphnia pulex	51% MON 2139	242(224-261.5)	Fraser & Jenkins	1973	00108109	Partially
Daphnia magna	41.36 % Round up	5.3 (4.4-6.3)	LeBlanc, Surprenant & Sleight	1980	00070893	Yes
Gammarus pseudolimnaeus	41.83 %	41.9 (30.7-62)	Forbis, Boudreau & Schofield	1982	MCOGLY03	Partially

According to the surfactant selected, the formulated product toxicity ranges from moderately toxic to practically non-toxic.

Species	% AI	Results	Author	Date	ID#	Fulfills Guideline Requirements
Ephemerella walkeri	41%	Mayfly nymphs avoided glyphosate (Roundup) at concentrations of 10 mg/L but not at 1.0 mg/l.	Folmar, Sanders & Julin	1979	JCOGLY16	Partially Suppl
Chironomus plumosus	41%	Significant increases in stream drift of midge larvae was observed after the 2.0 mg/l, but not at the 0.02 or 0.2 mg/l level.	Folmar, Sanders & Julin	1979	MCOGLY16	Partially Suppl.

Testing of the surfactant may be required under unusual circumstances. One test on the Roundup surfactant was received and determined as acceptable for use in a risk assessment.

Species	% AI	48-hr LC_{50} (95%CL)	Author	Date	ID#	Fulfills Guideline Requirements
Daphnia magna	100% MON0818 surfactant	13 mg/L (7.1-24)	Folmar, Sanders & Julin	1979	MCOGLY16	NO

Precautionary Labeling

The available acute toxicity data indicate that precautionary labeling for freshwater intervertebrates is not required for products containing glyphosate.

Effects on Marine/Estuarine Organisms

Three studies (in two references) were received and evaluated under this topic. All three studies were considered acceptable for use in a risk assessment.

Author	Date	Fiche ID No.
Bentley	1973	00108110
Bentley	1973	00108111

Acute toxicity testing for estuarine and marine organisms on technical glyphosate is required. The guidelines require estuarine and marine studies when exposure of such waters is likely. Crops, such as cotton, corn, sugarcane, turf, citrus, berries, forestry, sorghum, watermelon, etc. would allow this type of exposure to occur.

The following data on marine/estuarine species are acceptable for use in a risk assessment.

Species	% AI	Results	Author	Date	ID#	Fulfills Guideline Requirements
Grass shrimp	96.7% tech	LC_{50} 281 ppm (207-381)	Bentley	1973	00108111	Yes
Fiddler crab	96.7% tech	LC_{50} 934 ppm (555-1570)	Bentley	1973	00108111	Partially
Atlantic oyster	96.7% tech.	TL50>10 mg/L for 48 hrs	Bentley	1973	00108110	Partially

The available data indicate that technical glyphosate is practically non-toxic to grass shrimp, fiddler crab, and slightly toxic to the Atlantic oyster. Acute toxicity testing on an estuarine fish species is normally required. However, since there is such an extensive data set for this chemical, EEB can determine that glyphosate demonstrates low toxicity to fish species, and therefore is wavering the marine fish acute toxicity study.

Formulated product:

Acute toxicity testing for estuarine and marine organisms on formulated glyphosate may be required when exposure to estuarine and marine water is expected. The use in drainage systems (wet or dry) would allow this type of exposure. Minimum requirements are results from testing the technical on one estuarine fish (96 hrs LC_{50}) and either a 48 hrs oyster larvae study or a 96 hrs shell deposition study. Again, since there is such an extensive data set for this chemical, EEB can determine that glyphosate demonstrates low toxicity to fish and oyster species, and therefore is waivering the marine fish and oyster acute toxicity studies on formulated product.

e. Effects to Non-Target Insects

Two studies (in one reference) were received and evaluated under this topic. The studies were considered acceptable for use in a risk assessment.

Author	Date	Fiche No.
Fraser and Jenkins	1972	00026489

The guidelines require acute toxicity testing to honeybees on technical glyphosate when a herbicide is registered as a general use herbicide. Given the multitude of use patterns this chemical is registered for, acute honeybee toxicity studies are required. The honeybee studies that are acceptable for use in a risk assessment are as follows:

The following data on the honey bee acute oral and acute contact toxicity were available:

Species	AI %	Results	Author	Date	Fiche No.	Fulfills Guideline Require.
Honeybee acute oral	tech*CP 67573	oral LD50>100 ug/bee	Fraser and Jenkins	1972	00026489	Yes
Honeybee acute oral	36 % MON2139	oral LD50>100 ug/bee	Fraser and Jenkins	1972	00026489	Yes
Honeybee acute contact	tech*CP 67573	contact LD50>100 ug/bee	Fraser and Jenkins	1972	00026489	Yes

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Honeybee acute contact	36 % MON2139	contact LD50>100 ug/bee	Fraser and Jenkins	1972	00026489	Yes

* The percent active ingredient used for the technical was not reported.

Based on these data, glyphosate (CP67573) is considered practically nontoxic on an acute contact toxicity basis as well as on acute oral basis. These data satisfy guideline requirements for nontarget insect studies when glyphosate is used as a general use herbicide.

f. Effects to Non-Target Plants

Six studies (in six references) were received and evaluated under this topic. All six studies were considered acceptable for use in a risk assessment.

Author	Date	MRID No.
Hughes	1987	402369-01
Hughes	1987	402369-02
Hughes	1987	402369-03
Hughes	1987	402369-04
Hughes	1987	402369-05
Bohn	1987	401593-01

When a herbicide is applied as a terrestrial nonfood use, aquatic nonfood use, or as a forestry use, Tier I nontarget phytotoxicity studies are required in order to evaluate the effects of the herbicide on nontarget plants. The following data were submitted to support such registrations.

Species	%AI	Results	Author	Date	ID	Fulfills Guideline Requirements
Selenastrum capricornutum	96.6	4 day EC50 = 12.5 mg/l	Hughes	1987	402369-01	Yes

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Species	%AI	Results	Author	Date	ID	Fulfills Guideline Requirements
Navicula pelliculosa	96.6	4 Day EC 50= 39.9 mg/l	Hughes	1987	402369-02	Yes
Skeletonema costatum	96.6	4 day EC 50= 0.85 mg/l	Hughes	1987	402369-03	Yes
Anabaena flos-aquae	96.6	4 day EC 50=11.7 mg/l	Hughes	1987	402369-04	Yes
Lemna gibba	96.6	7 day EC 50=21.5 mg/l	Hughes	1987	402369-05	Yes

Based on the results of the preceding studies the data indicates that the 4 day EC 50 ranged from 0.85 mg/l to 39.9 mg/l for four aquatic plant species, and a 7 day EC50 of 21.5 mg/l for one aquatic species. Based on the data submitted the requirements for Tier I and Tier II Aquatic Plant Growth Studies (122-2 and 123-2)have been fulfilled.

A seed germination/seedling emergence study was conducted (Bohn 1987 MRID No 401593-01) on isopropylamine salt of glyphosate CP-70139 (Tech) 50% acid basis. The results indicate that CP-70139 applied at a rate up to 10.0 lb ai/A resulted in <25 % effect on the spectrum of monocots and dicots tested. Based on the results of this study, Tier I data requirements for seed germination/seedling emergence guideline reference 122-1 have been satisfied.

Based on the use patterns, the method of application, and the chemical properties of glyphosate, additional studies are required to evaluate the effects on nontarget plants. The recommended labels do not preclude off-target movement of glyphosate by drift. Nor do they address the potential off-target movement via terrestrial plants as well as aquatic plants. Therefore, EEB must have terrestrial plant test data to assess potential risk to nontarget plants. The data that are required are the Tier II Vegetative Vigor Guideline Reference No. 123-1.

Special Tests

In addition, droplet size spectrum (201-1) and drift field evaluation (202-1) data are required. The registrant, Monsanto, may elect to satisfy these data requirements through the Spray Drift Task Force, provided that neither EFED/EFGWB nor HED/TOX require these data in advance of the Task Force's final report (currently scheduled for December 1994). If the registrant wishes to satisfy these data requirements in this manner, the procedures outlined in PR Notice 90-3 should be followed (Jones, A. 1993. Personal Communications).

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II. DISCIPLINARY REVIEW

a. Non-Target Terrestrial (Birds, Mammals, Etc.)

An LD50 of > 2000 mg/kg was determined for bobwhite quail given a single oral dose of technical glyphosate (Beavers & Fink 1978, ID# MCOGLY04). Glyphosate is practically non-toxic to bobwhite quail on an acute oral basis.

The results of studies by Fink (1973, ID# MCOGLY011) indicate that the 8-day dietary LC50 of the chemical is greater than 4000 ppm for both mallard ducks and bobwhite quail. These data indicate that the chemical is slightly toxic to birds.

Avian reproduction studies both by Beavers and Fink (1978, ID #'s MCOGLY012 and MCOGLY013) indicate reproductive impairment would not be expected at dietary level up to 1000 ppm.

b. Non-Target Aquatic (Fish, Aquatic Invertebrates and Estuarine/marine Organisms)

Freshwater Organisms

A 48-hour LC50 of 780 ppm (mg/l) was found for Daphnia magna exposed to technical glyphosate (McAllister and Forbis 1978, ID #00108172). The results of this study indicate that the chemical is practically non-toxic to aquatic invertebrates.

Three tests on warm water species, one bluegill and two with fathead minnow, produced the 96-hour LC50s of 120 ppm, 84.9 ppm, and 97 ppm, respectively (McAllister and Forbis 1978, ID #MCOGLY07; EG & G Bionomics 1975, ID #00108171 and Folmar, Sanders, and Julin 1979, ID #MCOGLY16). Two rainbow trout 96-hour LC50's provided values of 86 ppm and 140 ppm (Thompson & McAllister 1978, ID# MCOGLY08 and (Folmar, Sanders , and Julin 1979, ID #MCOGLY16, respectively). Based on these tests technical glyphosate ranges from slightly to practically non-toxic to freshwater fish species.

In addition to these acute studies, a fish life-cycle study indicates technical glyphosate has a MATC greater than 25.7 ppm (EG&G Bionomics 1975, ID# 00108171). No effect was observed at the highest level tested. A Daphnia magna life cycle study with an MATC of >50-<96 ppm (McKee, McAllister & Schofield 1982 ID# MCOGLY02) reported reduced reproductive capacity, the most sensitive parameter.

Marine Organisms

A series of studies were performed on marine/ estuarine species (Bentley 1973, ID #00108110 and 00108111). A 96-hour LC50 of 281 ppm was determined found for grass shrimp (Palaemonetas vulgaris). In a study on fiddler crabs (Uca pugilator), it was determined that the 96-hour LC50 is 934 ppm glyphosate. Both of these studies indicate technical glyphosate is practically non-toxic to grass shrimp and fiddler crabs. An embryo-larvae 48-hour TL50 for Atlantic oyster greater than 10 ppm indicating glyphosate is slightly toxic.

Formulated Product

Isopropylamine salt of glyphosate

In order to determine the effect of the three surfactants ("W", "AA", and "X-77") on invertebrates, additional Daphnia studies were conducted. The 7.03 percent isopropylamine salt of glyphosate with a surfactant at 0.5 percent identified as X-77 resulted in an LC50 of > 1000 mg/l or practically non-toxic category for Daphnia. (Forbis and Boudreau 1980, ID #00078666.) The second combination was 41.2 percent isopropylamine and 15.3 percent of a surfactant identified as "AA" (Boudreau and Forbis 1980, ID #00078660.) This LC50 was 310 ppm which would indicate it is practically non-toxic to Daphnia. The third combination consisted of 40.7 percent isopropylamine and 15 percent of a surfactant identified as "W" (Forbis and Boudreau 1980, ID #00078657). The resultant LC50 of 72 ppm reveals that this material is slightly toxic to Daphnia.

The Roundup formulation was tested several times with different invertebrates. The LC50 values ranged from 3 mg/l for Daphnia to 62 mg/l for Gammarus indicating a moderately toxic material for Daphnia and no more than slightly toxic for Gammarus. (Folmar et al. 1979, ID #MCOGLY16).

Similar surfactant testing was performed with both cold water and warm water fish. In this case the initial formulation demonstrated an application rate much lower than technical glyphosate. The LC50 for rainbow trout was 1.3 mg/l or moderately toxic (Folmar et al. 1979, ID #MCOGLY16). The surfactant (MON0818) when tested alone produced an LC50 value of 0.65 mg/l for rainbow trout or the highly toxic category (Folmar et al. 1979, ID #MCOGLY16). In contrast, the formulation of 41.2 percent isopropylamine salt and 15.3 percent "AA" surfactant provided a rainbow trout LC50 of 120 mg/l or practically non-toxic compound (Thompson and Griffen 1980, ID #00078658). Bluegill are in the same category of toxicity with an even higher LC50 of >180 mg/l (Thompson and Griffen 1980, ID #00078659). The bluegill and rainbow trout were both near the same sensitivity to the formulation containing the "W" surfactant with LC50 values of

150 and >100 mg/l, respectively (Thompson et al. 1980, ID #00078655 and 00078656, respectively). Also, neither rainbow trout (LC50 240 mg/l) and bluegill (LC50 830 mg/l) were very sensitive to the x-77(.5) surfactant and glyphosate(7.03%) (Thompson 1980, ID #00078664 and 00078665).

Surfactant (MON0818)

This surfactant has been tested separately, producing an LC50 of 13 mg/l on Chironomous indicating it is a slightly toxic material (Folmar, Sanders & Julin 1979, ID # MCOGLY16). For fish, the catfish appears to be the most tolerant with an LC50 value of 13 mg/l, and rainbow trout the most sensitive with an LC50 value of 0.65 mg/l (Folmar, Sander & Julin 1979, ID# MCOGLY16).

c. Non-Target Insects

Four studies were conducted, two on technical glyphosate and two on the formulation MON2139, consisting of 36 % active ingredient. Results from the honeybee acute oral toxicity study indicates both technical and formulated glyphosate practically nontoxic to the honey bee with LD 50 values greater than 100 ug/bee. Results from the honeybee acute contact toxicity study indicates both technical and formulated glyphosate is practically nontoxic to the honey bee with LD 50 values greater than 100 ug/bee.

d. Non-Target Plants

Based on the results of the aquatic plant growth studies which were conducted on 5 species, the data indicates that the 4 day EC 50 ranged from 0.85 mg/l to 39.9 mg/l for four aquatic plant species, and a 7 day EC50 of 21.5 mg/l for one aquatic species.

A seed germination/seedling emergence study was conducted (Bohn 1987 MRID No 401593-01) on isopropylamine salt of glyphosate CP-70139 (Tech) 50% acid basis. The results indicate that CP-70139 applied at a rate up to 10.0 lb ai/A resulted in <25 % effect on the spectrum of monocots and dicots tested.

B. ECOLOGICAL Risk ASSESSMENT

1. Use Profile

Glyphosate is currently registered as a pre-emergent, pretransplant, postplant, pre-plant, and postemergent herbicide. Specifically, glyphosate is registered for the following terrestrial food crops: apples, alfalfa, almonds, apricot, artichoke, asparagus, atemoya, avocado, banana, barley, beans, beets, blackberry, blueberry, boysenberry, broccoli, cabbage,

carambola, carrot, cauliflower, celery, cherry, chicory, citrus, coffee, corn, cranberry, cucumber, currant, dewberry, eggplant, fig, filbert, garlic, gooseberry, gourds, grapefruit, grapes, groundcherry, guava, horseradish, huckleberry, kale, kiwi fruit, kumquat, lemon, lentils, lettuce, lime, litchi nut, loganberry, longan, macadamia nut, mamey, mango, melons, mustard, nectarine, oats, okra, olives, onion, orange, papaya, parsnip, passion fruit, peach, peanuts, pear, peas, peach, pepper, pineapple, pistachio, plantain, plum, prune, pumpkin, radish, raspberry, rice, rutabaga, rye, sapodilla, sorghum, soybeans, spinach, squash, sugar apple, sugar beet, sugarcane, sweet potato, tangelo, tangerines, tea, tomato, turnip, walnut, water cress, wheat, and yam.

In addition, there are many other uses under the categories of terrestrial nonfood crop, terrestrial feed crop, forestry use, and aquatic food crop: The uses include agricultural drainage systems, rights of way, fencerows, hedgerows, uncultivated areas, airports, aquatic areas, christmas tree plantations, conifer release, forest plantings, forest trees, golf course turf, household/ domestic dwellings, industrial outdoor areas, jojoba, lakes/ponds/ reservoirs, nonagricultural outdoor buildings, nongrass forage, oats, ornamental and /or shade trees, ornamental herbaceous plants, ornamental lawns and turf, ornamental woody shrubs and vines, paths/patios, paved areas (private roads/sidewalks), recreational areas, rye, urban areas, and wheat.

Based on all the registered uses, it is clear that many species of fish, wildlife, and plants will be exposed from the use of glyphosate as a general use herbicide. The applications rates vary amongst the use patterns, with a range from 0.625 lb. a.i./A to 5.0625 lb a.i./A. Some of the use patterns are direct application to water with application rates as high as 5.0625 lb a.i./A.

2. Environmental Fate Profile

According to the Environmental Fate and Groundwater One-Line Summary(Last updated September 23, 1992), glyphosate is stable to hydrolysis from pH ranges of 3.0 to 9.0. It is extremely water soluble with a value of 12000 ppm in water. It is also stable to photolysis at pH 5, 7, and 9 sunlight, with a calculated half-life >410 days. Results from an aquatic dissipation study indicates glyphosate was still measured in the pond sediment at 1.0 ppm at 1 year post-treatment. Terrestrial field dissipation data indicates at an application rate of 8 lb ai/A, there was dissipation from upper 6" of variety of soils with a half life ranging from < 64 days to 301 days. In summary, this herbicide is extremely persistent under typical application conditions.

3. Ecological Risk Assessment

a. Non-Endangered Species

Terrestrial Species

The acute oral LD50 greater than 3851 mg/kg found for bobwhite quail dosed with technical glyphosate, indicates that the chemical is practically non-toxic to an upland game species. On a dietary basis, the available data indicate, at most, slightly toxicity of technical glyphosate to both mallards and bobwhite (LC50 > 4640). In order to estimate the maximum concentration of glyphosate which may occur at the highest application rate for such sites as, cotton and corn the articles of Hoerger and Kenaga (1972) and Kenaga (1973) were consulted. The following chart addresses the major vegetation categories upon which fauna are expected to feed.

Feed Categories	Concentrations (ppm) @ 5.0625 lbs ai/A
Short grass	1215
Long grass	557
Leafy crops	632
Forage; Small insects	294
Pods; Large insects	61
Fruit	35

Comparing these residues to the dietary data for both bobwhite and mallards (LC50 > 4640; 1/5th the LC50 > 928), higher use rates may produce potentially toxic residues on short grass only (assuming the LC50 is just over > 4640). Wildlife ingesting significant amounts of insects, pods and/or fruits should not be affected by single applications.

Directions for some of the use patterns do indicate that applications can be repeated. Multiple treatments could potentially increase residues on dietary items within an extended time period. Also, the available information suggest that glyphosate is relatively persistent. The half-life in soil is as high as 90.2 days. However, avian reproduction studies demonstrated no adverse effects at the highest level tested, 1000 parts per million. Similarly, 90-day dietary studies with dogs and rats indicate no significant abnormalites when the maximum

level tested is 2000 parts per million. Based on this, minimal risk is expected.

Aquatic

Several scenarios were considered in determining the estimated environmental concentration. The first two scenarios are based on non-aquatic uses. The third scenario considers the use of glyphosate as direct application for aquatic uses.

Estimated Environmental Concentration (EEC) Calculations - Water

I. FOR FOLIAR APPLICATION

- Runoff

5.062 lb x 0.05 (5% runoff) x 10 (A) (from 10 A drainage basin) = 2.53 lb (tot. runoff)

EEC of 1 lb ai direct application to 1 A pond 6-foot deep = 61 ppb.

Therefore, EEC = 61 ppb x 2.53 lb = 154.4 ppb

II. FOR AERIAL APPLICATION

A. Runoff

5.062 lb x 0.6 (appl. runoff) x 0.05 (5% runoff) x 10 (A) (10 A = drainage basin) = 1.51 lb (total)

B. Drift

5.0625 lb x 0.05 (5% drift) = 0.25 lb (tot. drift)

Tot. loading = 1.51 lb + 0.25 lb = 1.76 lb.

Therefore, EEC = 61 ppb x 1.76 (lb) = 107.5 ppb

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III. DIRECT APPLICATION TO WATER

Application rate X EEC of pesticides in bodies of water immediately following direct applications at 6" water depth= TOTAL EEC from direct application.

5.062 lb a.i./A X 734 ppb= 3.72 ppm

Aquatic organisms do not appear sensitive to technical glyphosate. The most sensitive aquatic invertebrate tested is Chironomus plumosus with a 48-hr LC50 of 55 ppm which is very near to the lower limit of the Daphnia chronic MATC of 50 mg/l. The most sensitive fish species are fathead minnow and rainbow trout which have 96-hour LC50s of 84.9 and 86 mg/l. Chronic testing for the technical with fathead minnow provided an MATC of > 25.7 mg/l. Based on the toxicity and the various EEC's EEB has determined technical glyphosate should not cause acute or chronic adverse effects to aquatic environments. Therefore, minimal risk is expected to aquatic organisms from the technical glyphosate.

Terrestrial Plants and Aquatic Macrophytes

The Estimated Environmental Concentration was determined for exposure to terrestrial plants as well as aquatic macrophytes. The calculations are as follows:

1). Unincorporated Ground Application (use seed germination/seedling emergence test results):

Runoff:5.0625 lb.a.i./A X 0.05 (%runoff) X 1 acre = **0.253 lb.a.i./A**

2). Aerial Application, Mist Blower and Sprinkler Irrigation (use seed germination/seedling emergence test results):

A) Runoff: (from site of after application)

5.0625 lb.a.i.A X 0.6 appl. efficiency X 0.05 (%runoff) X 1 acre=0.151 lb a.i./A

B) Drift: (from site during application)

5.0625 lb a.i./A X 5% (drift)= 0.253 lb a.i./A

Total a.i.= 0.151 lb a.i. and 0.253 lb a.i.= 0.404 lb a.i./A

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3). **Aerial Drift Calculation (use vegetative vigor test results):**

Drift:

5.0625 lb a.i./Acre X 5% (drift)= 0.253 lb a.i./A

A seed germination/seedling emergence study was conducted (Bohn 1987 MRID No 401593-01) on isopropylamine salt of glyphosate CP-70139 (Tech) 50% acid basis. The results indicate that CP-70139 applied at a rate up to 10.0 lb ai/A resulted in <25 % effect on the spectrum of monocots and dicots tested. Considering the use patterns that are terrestrial food crop and non-food crop the above EEC's were considered for evaluating the effects to nontarget plants. The highest exposure of 0.404 lb a.i. (from aerial application, mist blower and sprinkler irrigation) is well below the 10.0 lb a.i./A rate which resulted in < 25 % effect on the monocots and dicots tested. Therefore, there are no concerns for effects on seed germination/seedling emergence with the various registered use patterns.

The aquatic EEC from direct application of 3.72 ppm was used to estimate exposure (Refer to page 24 of this document). Based on the results of the aquatic macrophyte toxicity data, the 4 day EC 50 was reported to be as low as 0.85 ppm indicating that there may be adverse effects to nontarget aquatic plant species. Tier III studies would normally be triggered under these circumstances, however, under the new paradigm, we are not currently requiring Tier III Aquatic Field study (Guideline reference no. 124-2).

b. Endangered Species Considerations

The Environmental Fate and Effects Division reviews the potential effects of pesticide uses on endangered species. Based on the toxicity data and the estimated exposure, EEB does not expect endangered terrestrial or aquatic organisms to be affected from the use of glyphosate on the registered uses since the EEC's are well below the endangered species criteria(birds= 1/10 LC 50, aquatic organisms= 1/20 LC 50). However, many endangered plants may be at risk from the use of glyphosate on the registered use patterns. In addition, being consistent with the 1986 Amended Glyphosate Registration Standard, it was determined that based on habitat, the Houston Toad may be at risk from the use of glyphosate on alfalfa. Please see attachment A for all species (by county and state) we have determined may be affected from the use of this herbicide on the registered crops.

Incident Data

Monsanto has reported a total of 135 incidents to EEB involving roundup on various registered and nonregistered use patterns. Approximately 90 % of the incidents were associated with Roundup on Corn. EEB has requested in several documents (Dec, 20, 1991 and January 13, 1992 that additional data be submitted so that the incidents can be fully evaluated. To date EEB has not received additional information with regards to these incidents.

C. Labeling

1. Manufacturing - Use

"Do not discharge effluent containing this product into lakes, streams, ponds, estuaries, oceans, or public waters unless this product is specifically identified and addressed in an NPDES permit. Do not discharge effluent containing this product to sewer systems without previously notifying in writing the sewage treatment plant authority. For guidance contact your State Water Board or Regional Office of the EPA."

2. End Use

1. Nonaquatic

"Do not apply directly to water, to areas where surface water is present or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment washwaters and rinsate."

2. Aquatic

"Do not contaminate water when disposing of equipment washwaters and rinsate. Treatment of aquatic weeds can result in oxygen loss from decomposition for dead plants. This loss can cause fish kills."

D. Data Requirements

Name of Study	Guideline reference No.
Tier II Vegetative Vigor Study	123-1
Droplet Size Spectrum	201-1
Drift Field Evaluation	202-1
Completed Incident Reports	Not applicable.

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Citations

1. Arkansas Cooperative Extension Service (1985) Recommended Chemicals for Weed and Brush Control, MP-A4, Arkansas.

2. Hill, E.F., Heath, R.G., Spann, J.W. and Williams, J.D.(1975) Lethal Dietary Toxicities of Environmental Pollutants to Birds, U.S.F.W.S. Special Scientific .Report--Wildlife No. 191.

3. Hoerger and Kenaga (1972) Pesticide Residues on Plants. Correlation of Representative Data as a Basis for Estimation of their Magnitude in the Environment. Environmental Quality. Academic Press, N.Y.1:9-28.

4. Jones, Arnet. 1993. Personal Communications. Environmental Fate and Groundwater Branch. Environmental Fate and Effects Division (H7507-C), USEPA. Washington, D.C. 20460.

5. Kenaga (1973) Factors to be considered in the Evaluation of Pesticides to Birds in their Environment. Environmental Quality, Academic Press, N.Y.II: 166-181.

6. Leonard, W.H. and Martin, J.H. (1963) Cereal Crops, Part V. Rice, Sorghum, and Millets, page 635.

7. McLane, Dennis. 1986. Amended Glyphosate Registration Standard. Ecological Effects Branch, Environmental Fate and Effects Division (H7507-C), USEPA. Washington, D.C. 20460.

8. USDA, The biologic and economic assessment of 2,4,5-T, Cooperative Impact Assessment Technical Bulletin Number 1671.

9. Wauchope (1978) The Pesticide Content of Surface Water Draining from Agricultural Fields - A Review, J. Environ. Qual., Vol. 7.7, No. 4.

Date: 4/30/93
Case No:0178
Chemical No:103601

PHASE IV
DATA REQUIREMENTS FOR GLYPHOSATE
ECOLOGICAL EFFECTS BRANCH

Data Requirements	Composition[1]	Use Pattern[2]	Does EPA Have Data To Satisfy This Requirement? (Yes, No)	Bibliographic Citation	Must Additional Data Be Submitted under FIFRA3(c)(2)(B)?
6 Basic Studies in Bold					
71-1(a) Acute Avian Oral, Quail/Duck	TGAI	A,B,C,D,F,G,H	Yes	00108204	No
71-1(b) Acute Avian Oral, Quail/Duck	TGAI	A,B,C,D,F,G,H	Yes	00108204	No
71-2(a) Acute Avian Diet, Quail	TGAI	A,B,C,D,F,G,H	Yes	00108107	No
71-2(b) Acute Avian Diet, Duck	TGAI	A,B,C,D,F,G,H	Yes	00076492	No
71-3 Wild Mammal Toxicity	TGAI	A,B,C,D,F,G,H	No	00076492	No
71-4(a) Avian Reproduction Quail	TGAI	A,B,C,D,G	Yes	00108207	No
71-4(b) Avian Reproduction Duck	TGAI	A,B,C,D,G	Yes	00036328,00111953	No
71-5(a) Simulated Terrestrial Field Study	TEP	A,B,C,D,G	No		No
71-5(b) Actual Terrestrial Field Study	TEP	A,B,C,D,G	No		No
72-1(a) Acute Fish Toxicity Bluegill	TGAI	A,B,C,D,F,G,H	Yes	00136339, GS0178-025	No
72-1(b) Acute Fish Toxicity Bluegill	(TEP)	A,B,C,D,G	Yes	15296,152599,152601,152767	No
72-1(c) Acute Fish Toxicity Rainbow Trout	TGAI	A,B,C,D,F,G,H	Yes	00108112,00108205	No
72-1(d) Acute Fish Toxicity Rainbow Trout	(TEP)	A,B,C,D,G	Yes	00070895,00078661,00070897, 00078662,00078655,00078664, 00078656,00078665,00078658, 00108205,00078659,00124760,GS01 78025,5298,152766,152903,155477	No
72-2(a) Acute Aquatic Invertebrate Toxicity	TGAI	A,B,C,D,F,G,H	Yes	00108172	No
72-2(b) Acute Aquatic Invertebrate Toxicity	(TEP)	A,B,C,D,G	Yes	00070893,00078666,00078657, 00124762,00078660,GS0178- 025,0078663,152597,152600,15260 2,152768	No
72-3(a) Acute Estu/Mari Tox Fish	TGAI	A,B,C,D	No		No[3]
72-3(b) Acute Estu/Mari Tox Mollusk	TGAI	A,B,C,D	Yes	00108110	No
72-3(c) Acute Estu.Mari Tox Shrimp	TGAI	A,B,C,D	Yes	00108111	No

* In Bibliographic Citation column indicates study may be upgradeable

Date: 4/30/93
Case No:0178
Chemical No:103601

PHASE IV
DATA REQUIREMENTS FOR
ECOLOGICAL EFFECTS BRANCH

Data Requirements	Composition[1]	Use Pattern[2]	Does EPA Have Data To Satisfy This Requirement? (Yes, No)	Bibliographic Citation	Must Additional Data Be Submitted under FIFRA3(c)(2)(B)?
72-3(d) Acute Estu/Mari Tox Fish	(TEP)	A,B,C,D	No		No[4]
72-3(e) Acute Estu/Mari Tox Mollusk	(TEP)	A,B,C,D	No		No[4]
72-3(f) Acute Estu/Mari Tox Shrimp	(TEP)	A,B,C,D	No		No[4]
72-4(a) Early Life-Stage Fish	TGAI	A,B,C,D,G,H	No		No[5]
72-4(b) Live-Cycle Aquatic Invertebrate	TGAI	A,B,C,D,G,H	Yes	00124763	No
72-5 Life-Cycle Fish	TGAI	A,B,C,D,G,H	Yes	00108171	No
72-6 Aquatic Org. Accumulation	TGAI	N/A	No		No
72-7(a) Simulated Aquatic Field Study		N/A	No		No
72-7(b) Actual Aquatic Field Study		N/A	No		No
122-1(a) Seed Germ./Seedling Emerg.	TGAI	B,D,G	Yes	401593-01	No
122-1(b) Vegetative Vigor	TGAI	B,D,G	No		Yes[6]
122-2 Aquatic Plant Growth	TGAI	B,D,G	Yes	402369-01,402369-02,402369-03, 402369-04,402369-05	No
123-1(a) Seed Germ./Seedling Emerg.	TGAI	B,D,G	No		No
123-1(b) Vegetative Vigor	TGAI	B,D,G	No		Yes
123-2 Aquatic Plant Growth	TGAI	B,D,G	Yes	402369-01,402369-02,402369-03,402369-04,402369-05	No
124-1 Terrestrial Field Study	TGAI	B,D,G	No		No
124-2 Aquatic Field Study	TGAI	B,D,G	No		No
141-1 Honey Bee Acute Contact	TGAI	A,B,G,H	Yes	00026489	No
141-2 Honey Bee Residue on Foliage	TEP	A,B,G,H	No		No
141-5 Field Test for Pollinators	TEP	A,B,G,H	No		No

* In Bibliographic Citation column indicates study may be upgradeable

1.Composition: TGAI=Technical grade of the active ingredient; PAIRA=Pure active ingredient, radiolabeled; TEP=Typical end-use product

2.Use Patterns: A=Terrestrial Food Crop; B=Terrestrial Feed Crop; C=Terrestrial Non-Food Crop; D=Aquatic Food Crop; E=Aquatic Non-Food Outdoor; F=Aquatic Non-Food Industrial; G=Aquatic Non-Food Residential; H=Greenhouse Food Crop; I=Greenhouse Non-Food Crop; J=Forestry; K=Outdoor Residential; L=Indoor Food; M=Indoor Non-Food; N=Indoor Medical; O=Indoor Residential; Z=Use Group for Site 00000

3.Acute toxicity testing on fish is normally required. However, since there is such an extensive data set for this chemical, EEB can determine that glyphosate demonstrates low toxicity to fish species, and therefore is waivering the marine fish acute toxicity study.

4. EEB has determined that there is sufficient information based on the data set submitted for both technical and formulated product that additional testing for TEP is unnecessary. EEB expects there to be minimal risk to aquatic organisms.

5. Data are not required since a fish full life cycle study was conducted and satisfies data requirement.

6. Waivered since the registrant is committed to conducting Tier II Vegetative Vigor study.

DP Barcode :D184418,D186561
PC Code No. :103601
EFGWB Out : MAY 13 1993

TO: Walter Waldrop
Product Manager PM #71
Special Review and Reregistration Division

FROM: Akiva D. Abramovitch, Ph.D., Head
Environmental Chemistry Review Section #3
Environmental Fate & Ground Water Branch/EFED (H7507C)

THRU: Henry Jacoby, Chief
Henry Jacoby 5/13/93
Environmental Fate & Ground Water Branch/EFED (H7507C)

Attached, please find the EFGWB review of...

Reg./File # :103601

Common Name :Glyphosate

Product Name :Rodeo, Roundup, Accord

Company Name :Monsanto

Purpose :List A RED

Type Product :Herbicide Action Code: 627,637 EFGWB #(s): 93--0152,93-0324 Review Time: 6.0 days

EFGWB Guideline/MRID/Status Summary Table: The review in this package contains...

161-1		162-4		164-4		166-1	
161-2		163-1		164-5		166-2	
161-3		163-2		165-1		166-3	
161-4		163-3		165-2		167-1	
162-1		164-1	42607501 S	165-3		167-2	
162-2		164-2		165-4		201-1	
162-3		164-3		165-5		202-1	

Y = Acceptable (Study satisfied the Guideline)/Concur P = Partial (Study partially satisfied the Guideline, but additional information is still needed)
S = Supplemental (Study provided useful information, but Guideline was not satisfied) N = Unacceptable (Study was rejected)/Non-Concur

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1. CHEMICAL:
Common Name: Glyphosate

Chemical Name: Isopropylamine salt of N-(phosphono-methyl) glycine.

Type of product: Herbicide

Chemical Structure:

Physical/Chemical Properties (IPA salt)
Molecular formula: $C_3H_8NO_5P$.
(CAS No. IPA salt 38641-94-0)
Molecular weight: 169.1 g/mole.
Physical state: Zwitterion structure which forms colorless crystals.
Melting point: 200 C.
Bulk density: 0.5 g/cm^3. (TGAI)
Solubility (25 C): 1.16 g/100 ml; insoluble in common organic solvents.
Vapor pressure: 1.84 X 10^{-7} mmHg @ 45°C
Dissociation constants: pKa_1 = 2.6
pKa_2 = 5.6
pKa_3 = 10.6

2. STUDY/ACTION TYPE: List A RED.

3. REVIEWED BY:

Kevin L. Poff, Chemist
Environmental Chemistry Review Section #3
Environmental Fate and Groundwater Branch/EFED
Date: MAY 6 1993

4. APPROVED BY:

Akiva Abramovitch, Ph.D., Chemist
Environmental Chemistry Review Section #3
Environmental Fate and Groundwater Branch/EFED
Date: MAY 6 1993

REREGISTRATION ELIGIBILITY: (GLYPHOSATE)

For the purposes of reregistration of glyphosate the data file is complete. The outstanding data requirement previous to the generation of this RED was the terrestrial field (164-1) dissipation data requirement. The registrant submitted study MRID #42607501, Volumes 1, 2, and 3 which is an interim report and contains data from eight different field sites. Some of the data from the individual field sites are deficient, however, the EFGWB may use the data from the eight field sites together to satisfy the terrestrial field dissipation 164-1 data requirement. In addition, the terrestrial field data in study MRID #42607501 is sufficient for purposes of our assessment, and no further laboratory or field

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data requirements will be imposed for glyphosate.

ENVIRONMENTAL FATE AND GROUND WATER ASSESSMENT:

In general, the available field and laboratory data indicate glyphosate adsorbs strongly to soil and would not be expected to move vertically below the 6 inch soil layer. Based on unaged batch equilibrium studies glyphosate and glyphosate residues are expected to be immobile with $Kd_{(ads)}$ values ranging from 62 to 175. The mechanism of adsorption is unclear, however it is speculated that it may be associated with vacant phosphate sorption sites or high levels of metallic soil cations. The data indicate that chemical and photochemical decomposition is not a significant pathway of degradation of glyphosate in soil and water. However, glyphosate is readily degraded by soil microbes to aminomethyl phosphonic acid (AMPA), which is degraded to CO_2, although at a slower rate than parent glyphosate. Even though glyphosate is highly water soluble it appears that parent glyphosate and AMPA have a low potential to move to ground-water due to their strong adsorptive characteristics demonstrated in the laboratory and field studies. However, glyphosate does have the potential to contaminate surface waters due to its aquatic use patterns and erosion via transport of residues adsorbed to soil particles suspended in runoff water. If glyphosate were to reach surface water it would be resistant to hydrolysis and aqueous photolysis.

Based on the low vapor pressure of glyphosate, volatilization from soils will not be an important dissipation mechanism. The low octanol/water coefficient suggests that glyphosate will have a low tendency to accumulate in fish.

SUMMARY OF TERRESTRIAL FIELD DATA REVIEWED IN THIS DOCUMENT:

The interim report results from the first 12 months of bareground field dissipation trials from eight sites show that the median half-life (DT_{50}) for glyphosate (Roundup) applied at maximum annual use rates (7.95 lb a.e./acre, 10.7 lb a.i./acre) was 13.9 days with a range of 2.6 (Texas) to 140.6 (Iowa) days. Acceptable aerobic soil, aerobic aquatic and anaerobic aquatic metabolism studies demonstrate that under those conditions at 25°C in the laboratory glyphosate degrades rapidly with half-lives of approximately 2, 7 and 8 days respectively. The reported half-lives (DT_{50}) from the field studies conducted in the coldest climates, ie. Minnesota, New York and Iowa, were the longest at 28.7, 127.8, and 140.6 days respectively indicating that glyphosate residues in the field are somewhat more persistent in cooler climates as opposed to milder ones (Georgia, California, Arizona, Ohio, and Texas).

Glyphosate (as well as AMPA) was shown to predominantly remain in the 0-6 inch soil layer throughout the duration of the study at all field sites. Iowa was the individual test site to have average glyphosate residues, at all sampling times, greater than 0.01 ppm in the 6-12 inch depth. There were a number of detections from

0.01 to 0.09 ppm in the 6-12 inch layer in Minnesota, New York and Texas, and glyphosate was detected at generally <0.05 ppm at the other 5 field sites (6-12 inch depth).

Glyphosate was detected at three different sites below 12 inches. In California, at 0 DAT, average glyphosate residues were 0.21 ppm and 0.10 ppm in the 12-18 and 18-24 inch soil horizons respectively. Soil core contamination was attributed to these detections since movement of residues to this depth on the first day of sampling is unlikely. In Arizona at 21 DAT the average glyphosate residues were 0.06, in the 18-24 inch soil layer. There were no glyphosate residues in the 6-12 or 12-18 inch soil layer in Arizona on 21 DAT and in subsequent samples below 12 inches which may indicate a problem with sampling technique. In Iowa at 190 DAT the average glyphosate residues were 0.05 ppm in the 12-18 inch soil layer. Since there were no glyphosate residues detected in the 6-12 inch soil layer at 190 DAT, and the lack of a significant amount of rainfall between sampling intervals in combination with the amount of time between sampling intervals and the high adsorptive characteristics of glyphosate give an indication that there may have been a problem with sampling technique.

AMPA was also shown to predominantly remain in the 0-6 inch soil layer. AMPA was found at every test site on Day 0 samples indicating the rapid degradation of parent glyphosate. The AMPA levels generally reached a maximum between day 14 and day 30. Where the field half-lives were longer (Iowa, Minnesota, New York) the maximum average AMPA levels occurred between 62 and 95 DAT. The maximum average AMPA levels found in the 0-6 inch soil layer were 0.6 ppm and occurred in Ohio and Georgia at 21 DAT and 61 DAT respectively. The AMPA levels at those sites then decreased to 0.12 and 0.44 ppm at 12 months after treatment.

In all samples but three, AMPA residue levels were <0.05 ppm in the 6-12 inch soil layer. In New York at 14 and 30 DAT average residues were detected at 0.06 ppm. In Iowa at the 92 DAT sample average AMPA residues were 0.08 ppm. Iowa and New York also exhibited 50% dissipation times of 140.6 and 127.8 days respectively.

AMPA levels were detected at 0.06 ppm in the 18-24 inch soil layer on 21 DAT in Arizona and 0.04 and 0.03 ppm in the 12-18 inch soil layer at 90 and 180 DAT respectively in New York.

5. SUMMARY OF DATA REQUIREMENTS: (GLYPHOSATE)

The current status of environmental fate data requirements to support terrestrial food crop (field, vegetable, and tree fruit and nut crops), aquatic food crop (cranberries and rice), greenhouse nonfood crop, terrestrial nonfood crop (ornamental including turf), terrestrial nonfood (fallow and fence rows, highways and roadsides, railroad rights-of-way), aquatic non-food, domestic outdoor, and forestry (including Christmas tree plantations) sites is as follows:

Satisfied:

-Hydrolysis (161-1): File or reg # 524-308, Acc #00108192, 6/30/78; LC

Stable at pH 3, 6, 9 at 5 and 35°C.

-Photodegradation in Water (161-2): EFGWB #90-0745, 92-0032, 90-0753,91-0356,92-0011,91-0506, MRID #41689101; Stable in pH 5, 7, and 9 buffered solutions under natural sunlight.

-Photodegradation on Soil (161-3): EFGWB # 90374, MRID #41335101; 6/28/90; Stable.

-Aerobic Soil Metabolism (162-1): EFGWB #92-1143,1144 and (EFGWB #90-0745, 92-0032, 90-0753,91-0356,92-0011,91-0506), MRID #42372501; half-life values of 1.85 and 2.06 days in the Kickapoo sandy loam and Dupo silt loam respectively were reported. AMPA was the major degradate.

-Anaerobic Aquatic Metabolism (162-3): EFGWB #92-1143,1144 and (EFGWB #90-0745, 92-0032, 90-0753,91-0356,92-0011,91-0506), MRID #42372502; half-life reported was 8.1 days in anaerobic (flooded plus nitrogen atmosphere) silty clay loam sediment. AMPA was the major degradate.

-Aerobic aquatic metabolism (162-4): EFGWB #92-1143,1144 and (EFGWB #90-0745, 92-0032, 90-0753,91-0356,92-0011,91-0506), MRID #42372503; half-life of reported was 7 days in flooded silty clay loam sediment that was incubated in the dark at 24.6 $\pm$ 0.57 C for 30 days. AMPA was the major degradate.

-Leaching/Adsorption/Desorption (163-1): EFGWB # 70727-29, Acc. #'s 00108192, 00076493, 00108140 (data taken from Dynamac review 6/7/85); (unaged batch equilibrium) K_d values of 62, 90, 70, 22, and 175 were reported for Drummer silty clay loam, Ray silt, Spinks sandy loam, Lintonia sandy loam, and Cattail Swamp sediment respectively. After (aged) leaching 7 soils with 20" of water the recovered radioactivity in the soils was 93-100% of the applied.

-Aquatic Field Dissipation (164-2): EFGWB #92-1143,1144 and (EFGWB #:92-0228, and #91-0763), MRID #40881601; Glyphosate dissipated from the water (irrigation source) with a registrant calculated half-life of 7.5 days and 120 days from the sediment of the farm pond in MO. MRID #41552801, In Michigan, Georgia and Oregon pond and stream water, the maximum glyphosate concentrations were measured immediately posttreatment and dissipated rapidly. Glyphosate accumulated in the pond sediment, and to a lesser extent in the stream sediments; glyphosate was present in pond sediment at $\geq$1 ppm in Michigan and Oregon at approximately 1 year posttreatment.

-Forestry Dissipation (164-3): EFGWB # 91-0763, MRID #41552801; aerially applied at 3.75 lb/A to forested sites in Michigan, Oregon, and Georgia, glyphosate averaged 652-1273 ppm in tree foliage immediately posttreatment, then declined rapidly with half-lives of <1 day at the Michigan and Georgia sites and <14 days at the Oregon site.

The forestry dissipation study results demonstrate that when

used under normal silviculture practices according to label directions, the maximum combined glyphosate and AMPA residue level in soil is less than 5 ppm. Glyphosate and AMPA residues in soil dissipate with time. The average half-life for the dissipation of glyphosate was 100 days, and ranged from 35 to 158 days. The average half-life for the dissipation of AMPA was 118 days, and ranged from 71 days to 165 days.

-Accumulation in Confined Rotational Crops (165-1): (EFGWB #90-0745, 92-0032, 90-0753,91-0356,92-0011,91-0506) MRID #41543201 and MRID #41543202; Glyphosate residues (**expressed as fresh weight)** accumulated in lettuce, carrots, and barley planted 30, 119, and 364 days after sandy loam soil was treated with glyphosate at 3.71 lb ai/A. Accumulation decreased as the length of the rotation increased. In crops planted at 30 days posttreatment, [^{14}C]residues at harvest were 0.097 ppm in lettuce, 0.051 and 0.037 ppm in carrot tops and roots, respectively, and 0.188 and 0.175 ppm in barley grain and straw, respectively. In immature lettuce harvested at 40 and 60 days postplanting, [^{14}C]residues were 0.108 and 0.048 ppm, respectively (Table 7). In crops planted at 119 days posttreatment, [^{14}C]residues at harvest were 0.037 ppm in lettuce, 0.028 and 0.017 ppm in carrot tops and roots, respectively, and 0.078 and 0.056 ppm in barley grain and straw, respectively. In immature lettuce harvested at 28 and 48 days postplanting, [^{14}C]residues were 0.059 and 0.055 ppm, respectively (Table 7). In crops planted at 364 days posttreatment, [^{14}C]residues at harvest were 0.028 ppm in lettuce, 0.018 and 0.0096 ppm in carrot tops and roots, respectively, and 0.047 and 0.061 ppm in barley grain and straw, respectively. In immature lettuce harvested at 35 and 61 days postplanting, [^{14}C]residues were 0.057 and 0.043 ppm, respectively; in barley forage harvested at 48 days postplanting, [^{14}C]residues were 0.056 ppm.

-Accumulation in Irrigated Crops (165-3) MRID #40541305 (EFGWB #90-0745, 92-0032, 90-0753,91-0356,92-0011,91-0506); Alfalfa, corn (grain and forage), grass (fescue or sudan) and lettuce were irrigated five to eight times during the 1987 growing season with glyphosate treated water containing a maximum of 21.3 ppm (on treatment day then fell to 0.46 ppm by 1 day after treatment) of glyphosate. Residues in the sediment beneath the treated water reached a maximum of 3.5 ppm at 14 days after treatment. Residues of glyphosate in the sprinkler water at the pond site were the highest 7 days after treatment at 0.12 ppm. One lettuce sample from the MO location (the pond site) at 29 days after treatment (of water source) and 5 irrigation events was found to contain 0.06 ppm glyphosate.

-Bioaccumulation in Fish (165-4): (EFGWB #90-0745, 92-0032, 90-0753,91-0356,92-0011,91-0506), MRID #41228301; Maximum bioconcentration factors were 0.38X for edible tissues, 0.63X for nonedible tissues, and 0.52X for whole fish.

Waived:

-Laboratory Volatility (163-2) EFGWB #92-0707
-Field Volatility (163-3) EFGWB #92-0707

Ancillary:

-Terrestrial Field Dissipation (164-1): EFGWB # 93-0152,93-0324; (This review, see reference below) Study MRID #42607501 Volumes 1, 2, and 3 may be made acceptable when and after the final field study report is submitted and reviewed.

MRID No:42607501 Volumes 1, 2, and 3.
Oppenhuizen, M.E., December 1992, study in progress. The Terrestrial Field Dissipation of Glyphosate: An Interim Report. Performed by The Agricultural Group of the Monsanto Company, Environmental Science Department 700 Chesterfield Parkway North, St. Louis, Missouri 63198 and Pan-Agricultural Laboratories, Inc. 32380 Avenue 10 Madera, California 93638.

NOT SATISFIED:

-Droplet Spect. (201-1)
-Field Spray Drift Evaluation (202-1)

6. BACKGROUND :

Glyphosate is a non-selective, non-residual, postemergence herbicide registered for use to control annual weeds, herbaceous and woody perennial, aquatic weeds, and annual and perennial grasses in food and non-food crop sites. It may be applied (in spring, summer, or fall) as a direct application in established crops; as a recirculating or wiper application to control weeds that are taller than the crop; or as a broadcast spray before planting, before emergence of the crop, or to achieve total vegetation kill for turf renovation or site preparation. In some states in the U.S., aerial application is permitted. Glyphosate is applied with a non-ionic surfactant. Single active ingredient formulations include emulsifiable concentrate, soluble concentrate, and ready-to-use. Glyphosate may be tank mixed with alachlor, simazine, linduron, metribuzin, and metolachlor. Roundup herbicide used in the terrestrial field dissipation studies reviewed here contains 480 grams per liter or 4 pounds per U.S. gallon of the isopropylamine salt of glyphosate, which is equivalent to 356 grams per liter or 3 pounds per U.S. gallon of the free acid glyphosate. The maximum application rate for glyphosate is 7.95 lbs. per acre.

Glyphosate, sodium salt (N-(Phosphonomethyl)glycine sodium salt) is sold as a soluble concentrate/solid. Trade names: Polado. The sodium salt is used as a terrestrial food + feed crop on peanuts (max rate 0.0375 lb ai/A) and sugar cane (max rate 0.525 lb ai/A) in LA Louisiana. Restrictions placed on the label are "Do not apply through any type of irrigation system", " Do not apply by aircraft", and " Do not graze or feed forage".

Glyphosate, isopropylamine salt (N-(Phosphonomethyl)glycine

isopropylamine salt) is sold as a soluble concentrate/liquid, liquid ready to use, and a pressurized liquid. Trade names: Roundup, Rodeo, Roundup L&G, Shackle, Shakle C. The isopropylamine salt is used as a terrestrial food crop, terrestrial food + feed, terrestrial non-food + outdoor residential, aquatic food crop, aquatic non-food/outdoor industrial, forestry, greenhouse food, and indoor non-food. It is used throughout the United States and various other parts of the world. Applications vary from when needed to seasonal and the maximum application rate is 7.95 lbs. per acre.

Roundup, Rodeo and Accord contain glyphosate (N-phosphonomethylglycine) formulated as an aqueous solution of its isopropylamine salt at a concentration of 41.0%, 53.8% and 41.5% respectively.

7. DISCUSSION:

TERRESTRIAL FIELD DISSIPATION DER 1

(1) Study MRID #42607501 (interim report) contains data from eight field sites covering a time period of 12 months. Some of the data is deficient (ie. contamination of soil cores) but the EFGWB will be able to use the complete data set from all eight studies to satisfy the terrestrial field dissipation (164-1) data requirement for glyphosate.

(2) Study MRID #42607501 may be used as ancillary data and may be upgraded to acceptable pending the review of the final terrestrial field dissipation report.

(3) The interim report results from the first 12 months of bareground field dissipation trials from eight sites show that the median half-life (DT_{50}) for glyphosate (Roundup) applied at maximum annual use rates (7.95 lb a.e./acre, 10.7 lb a.i./acre) was 13.9 days with a range of 2.6 (Texas) to 140.6 (Iowa) days. The results indicate that glyphosate and aminomethylphosphonic acid (AMPA) possess a very limited potential for vertical movement to ground water because the majority of all glyphosate residues remained in the 0-6 inch soil layer. Maximum average glyphosate levels in the 0-6 inch soil layer ranged from 1.82 ppm to 4.58 ppm and dissipated to levels ranging from 0.02 to 0.83 ppm at 12 months after application date. Maximum average aminomethylphosphonic acid (AMPA) levels in the 0-6 inch soil layer occurred 14 to 95 days after treatment and ranged from 0.27 ppm to 0.60 ppm, and then decreased to levels ranging from 0.12 ppm to 0.44 ppm at 12 months after application date. The final report will contain storage stability and data from the final months of the dissipation studies including estimates of the rate of dissipation of AMPA.

DATA EVALUATION RECORD
DER 1

SHAUGHNESSY No.103601
COMMON NAME: Glyphosate
CHEMICAL NAME: Isopropylamine salt of N-(phosphono-methyl) glycine.
FORMULATION: Roundup (41.0% aqueous solution of its isopropylamine salt)
DATA REQUIREMENT: 164-1

MRID No: 42607501 Volumes 1, 2, and 3.
Oppenhuizen, M.E., December 1992, study in progress. The Terrestrial Field Dissipation of Glyphosate: An Interim Report. Performed by The Agricultural Group of the Monsanto Company, Environmental Science Department 700 Chesterfield Parkway North, St. Louis, Missouri 63198 and Pan-Agricultural Laboratories, Inc. 32380 Avenue 10 Madera, California 93638.

REVIEWED BY: Kevin L. Poff
Chemist EFGWB/EFED
Signature:
Date:

APPROVED BY: Akiva Abramovitch, Ph.D.
Chemist EFGWB/EFED
Signature:
Date:

CONCLUSIONS:

TERRESTRIAL FIELD DISSIPATION

(1) Study MRID #42607501 (interim report) contains data from eight field sites covering a time period of 12 months. Some of the data is deficient (ie. contamination of soil cores) but the EFGWB will be able to use the complete data set from all eight studies to satisfy the terrestrial field dissipation (164-1) data requirement for glyphosate.

(2) Study MRID #42607501 may be used as ancillary data and may be upgraded to acceptable pending the review of the final terrestrial field dissipation report.

(3) The interim report results from the first 12 months of bareground field dissipation trials from eight sites show that the median half-life (DT_{50}) for glyphosate (Roundup) applied at maximum annual use rates (7.95 lb a.e./acre, 10.7 lb a.i./acre) was 13.9 days with a range of 2.6 (Texas) to 140.6 (Iowa) days. The results indicate that glyphosate and aminomethylphosphonic acid (AMPA) possess a very limited potential for vertical movement to ground water because the majority of all glyphosate residues remained in the 0-6 inch soil layer. Maximum average glyphosate levels in the 0-6 inch soil layer ranged from 1.82 ppm to 4.58 ppm and dissipated to levels ranging from 0.02 to 0.83 ppm at 12 months after application date. Maximum average aminomethylphosphonic acid (AMPA) levels in the 0-6 inch soil layer occurred 14 to 95 days after treatment and ranged from 0.27 ppm to 0.60 ppm, and then decreased to levels ranging from 0.12 ppm to 0.44 ppm at 12 months after application date. The final report will contain storage stability and data from the final months of the dissipation studies including estimates of the rate of dissipation of AMPA.

MATERIALS AND METHODS:

Glyphosate (Roundup herbicide containing 41% glyphosate, isopropylamine salt 30.4% as acid equivalent, and an ethoxylated tallowamine surfactant) was applied in a broadcast spray at the maximum use rate of 7.95 lb a.e./acre. The application was to eight different bareground test plots in Yuma Arizona, Madera California, Hawkinsville Georgia, Danville Iowa, Lamberton Minnesota, Phelps New York, New Holland Ohio, and Snook Texas (see attachments for soil analysis). There was also one untreated control plot per test plot at each respective site. The actual application rates averaged 8.09 lb a.e./acre and varied from a high of 8.83 lb a.e./acre in California to a low of 7.84 lb a.e./acre in New York. Total test substance volume ranged from 14.4 gal/acre to 25.7 gal/acre. Test plots were maintained in a weed free condition by hand weeding and the use of herbicides. Irrigation was applied to supplement local rainfall. As a result of extensive flooding the Texas site was terminated as of March 6, 1992. Soil samples were collected randomly from both the treated and untreated plots prior to application of the test substance, on the day of application, and at 1, 7, 14, and 21 days after application except at the Minnesota and Texas sites. In Minnesota the 14 day sampling interval was day 15 and in Texas the 7, 14, and 21 day sampling interval was actually 12, 15, and 28 days after application. Longer term sampling intervals were collected at 1, 2, 3, 4, 6, and 12 months after application. At six of the eight sites (exceptions were the California and Iowa sites) preexcavation of the 0-6 inch soil layer was completed to lower the possibility of contamination of lower sampling cores (6-48 inch). All samples were placed in frozen storage within 4 hours of sectioning. After receipt by Monsanto the sectioned soil samples were composited to afford 3 representative samples for each treated and untreated plots and kept frozen until analysis. Soil samples were analyzed for parent glyphosate and aminomethylphosphonic acid (AMPA). Test substance stability and spray tank stability studies were conducted on parent glyphosate and AMPA. Frozen storage stability studies are currently in progress.

RESULTS:

This interim report contains the results from the first 12 months of the field dissipation studies from eight sites. The limit of detection for glyphosate and AMPA is 0.02 ppm and 0.03 ppm respectively. The lower limit of method validation was 0.05 ppm for both glyphosate and AMPA based on recoveries of spiked field samples. Half-lives of the parent were established through this period, but the half-life of AMPA was not reported in this study, but will be provided at a later date in the final report.

State Specific Results:

Arizona:

The length of time for 50% of the initial concentration of glyphosate to dissipate (DT_{50}) in Arizona was 14.0 days.

The maximum average residue level of glyphosate in the 0 to 6 inch soil layer was 3.54 ppm at 0 days after treatment (DAT). Glyphosate residues then declined to 0.59 ppm (14 DAT) 0-6 inch, increased to 1.91 ppm (21 DAT) 0-6 inch, then slowly dissipated to 0.04 ppm (364 DAT) 0-6 inch depth.

Residues of Glyphosate averaged <0.05 ppm in all but 2 samples below 6 inches. The 6 to 12 inch sample (7 DAT) contained an average glyphosate level of 0.08 ppm and one of the three replicate samples from the 18 to 24 inch depth at 21 DAT contained 0.15 ppm glyphosate. Since no glyphosate residues were detected in preceding sample depths movement of residues is unlikely.

The average residue level of AMPA in the 0 to 6 inch soil layer was 0.12 ppm at 0 days after treatment (DAT). AMPA residues then increased to a maximum average of 0.56 ppm (21 DAT), then decreased to 0.17 ppm (364 DAT).

AMPA residues were <0.01 ppm in all samples below 6 inches except one of three replicate 18 to 24 inch (21 DAT) sample mentioned above that contained 0.15 ppm glyphosate (AMPA residues were at 0.18 ppm in that sample). The average recoveries from check samples were 59.09% and 77.79 for glyphosate and

AMPA respectively. For the 12 months encompassing the study, the site received a total of 51.72 inches of precipitation and irrigation.

CALIFORNIA:

The length of time for 50% of the initial concentration of glyphosate to dissipate (DT_{50}) in California was 13.8 days.

The maximum average level of glyphosate in the 0 to 6 inch soil layer was 1.94 ppm at 1 DAT. Glyphosate residues then declined to 1.09 ppm (14 DAT) 0-6 inch, then slowly dissipated to 0.04 ppm (365 DAT) 0-6 inch depth.

Glyphosate residues were found in all the 0 DAT samples analyzed to a depth of 24 inches. The average glyphosate residues for day 0 was 1.12 ppm (0-6 inch), 0.30 ppm (6-12 inch), 0.21 ppm (12-18 inch), 0.10 ppm (18-24 inch). In all other sampling intervals glyphosate residues were present at <0.05 ppm. California was one of the sites where there was no preexcavation of the top 6 inches of soil.

The average AMPA residue level in the top 6 inches was 0.13 ppm (0 DAT). AMPA residues reached a maximum level of 0.36 ppm (14 DAT), then decreased slowly to 0.28 ppm (365 DAT).

AMPA residues were <0.05 ppm in all soil samples taken below 6 inches in all soil samples. For the 12 months encompassing the study, the site received a total of 21.78 inches of precipitation and irrigation.

GEORGIA:

The length of time for 50% of the initial concentration of glyphosate to dissipate (DT_{50}) in Georgia was 7.4 days.

The maximum average level of glyphosate in the 0 to 6 inch soil layer was 3.06 ppm at 0 DAT. Glyphosate residues then declined to 1.36 ppm (14 DAT) 0-6 inch, then slowly dissipated to 0.10 ppm (368 DAT) 0-6 inch.

Glyphosate residues averaged <0.05 ppm for all samples taken below 6 inches in all soil samples.

Residues of Glyphosate averaged <0.05 ppm in all but 2 samples below 6 inches. The 6 to 12 inch sample (7 DAT) contained an average glyphosate level of 0.08 ppm and one of the three replicate samples from the 18 to 24 inch depth at 21 DAT contained 0.15 ppm glyphosate. Since no glyphosate residues were detected in preceding sample depths movement of residues is unlikely.

The average AMPA residue level in the top 6 inches was 0.06 ppm (0 DAT). AMPA residues reached a maximum level of 0.60 ppm (61 DAT), then decreased slowly to 0.44 ppm (368 DAT).

AMPA residues were <0.05 ppm in all soil samples taken below 6 inches in all soil samples. For the 12 months encompassing the study, the site received a total of 62.39 inches of precipitation and irrigation.

IOWA:

The length of time for 50% of the initial concentration of glyphosate to dissipate (DT_{50}) in Iowa was 140.6 days.

The maximum average level of glyphosate in the 0 to 6 inch soil layer was 2.34 ppm at 1 DAT. Glyphosate residues then declined to 1.71 ppm (14 DAT) 0-6 inch, then decreased erratically to 0.83 ppm (366 DAT) 0-6 inch depth.

Glyphosate residues averaged <0.05 ppm for all but one sample taken below 6 inches. Glyphosate residues averaged 0.05 ppm in the 12-18 inch soil layer at 190 days posttreatment. Iowa was one of the sites where there was no preexcavation of the top 6 inches of soil.

The average AMPA residue level in the top 6 inches was 0.05 ppm (0 DAT). AMPA residues increased to a maximum level of 0.36 (62 DAT), then decreased slowly to 0.31 ppm (366 DAT).

AMPA residues were <0.05 ppm in all but one soil sample taken below 6 inches. AMPA residues averaged 0.08 ppm found in the 6 to 12 inch layer at 92 DAT. For the 12 months encompassing the study, the site received a total of 59.45 inches of precipitation and irrigation.

MINNESOTA:

The length of time for 50% of the initial concentration of glyphosate to dissipate (DT_{50}) in Minnesota was 28.7 days.

The maximum average level of glyphosate in the 0 to 6 inch soil layer was 1.82 at 15 DAT. Glyphosate residues then declined slowly to 0.04 at 377 DAT.

Glyphosate residues averaged 0.05, 0.07, and 0.06 ppm in the 6 to 12 inch layer at the 1, 7, and 15 DAT sampling intervals respectively. At all other sampling intervals below 6 inches glyphosate concentrations averaged <0.05 ppm.

The average AMPA residue level in the top 6 inches was 0.09 ppm (0 DAT), increased to a maximum of 0.43 ppm (95 DAT), then declined to 0.15 ppm at 372 DAT. AMPA residues were <0.05 ppm in all soil samples taken below 6 inches. For the 12 months encompassing the study, the site received a total of 29.43 inches of precipitation and irrigation.

NEW YORK:

The length of time for 50% of the initial concentration of glyphosate to dissipate (DT_{50}) in New York was 127.8 days.

The maximum average level of glyphosate in the 0 to 6 inch soil layer was 4.58 ppm at 14 DAT. Glyphosate residues then declined slowly to 0.51 ppm at 362 DAT. Glyphosate residues averaged 0.09 and 0.07 ppm in the 6 to 12 inch layer at the 30 and 90 DAT, respectively. At all other sampling intervals below 6 inches glyphosate concentrations averaged <0.05 ppm.

The average AMPA residue level in the top 6 inches was 0.11 ppm (0 DAT), increased to a maximum of 0.48 ppm (90 DAT), then declined to 0.20 ppm (362 DAT). AMPA residues were detected at 0.06 ppm in the 6 to 12 inch layer at 30 and 90 DAT. At all other sampling intervals below 6 inches AMPA was <0.05 ppm. For the 12 months encompassing the study, the site received a total of 38.30 inches of precipitation and irrigation.

Ohio:

The length of time for 50% of the initial concentration of glyphosate to dissipate (DT_{50}) in Ohio was 7.5 days.

The maximum average level of glyphosate in the 0 to 6 inch soil layer was 2.01 ppm at 0 DAT. Glyphosate levels then declined to 0.51 (14 DAT) 0-6 inch, then rapidly to 0.05 ppm at 177 DAT 0-6 inch. Glyphosate residues average <0.05 ppm for all samples taken below 6 inches.

The average AMPA residue level in the top 6 inches was 0.34 ppm (0 DAT). AMPA residues reached a maximum level of 0.60 ppm (21 DAT), then decreased slowly to 0.12 ppm (365 DAT). AMPA residues were <0.05 ppm in all soil samples taken below 6 inches. For the 12 months encompassing the study, the site received a total of 37.30 inches of precipitation and irrigation.

TEXAS:

The length of time for 50% of the initial concentration of glyphosate to dissipate (DT_{50}) in Texas was 2.6 days.

The maximum average level of glyphosate in the 0 to 6 inch soil layer was 1.93 ppm at 0 DAT. Glyphosate residues then declined rapidly to 0.01 ppm at 14 DAT and was variable through day 91 reaching a final concentration of 0.02 ppm on 91 DAT. Glyphosate residues averaged <0.06 ppm in the 6 to 12 inch depth sample at 0 DAT. In all other soil samples taken below 6 inches glyphosate residues were <0.05 ppm.

The average AMPA residue level in the top 6 inches was 0.11 ppm (0 DAT), increased to a maximum of 0.27 ppm (11 DAT), and (30 DAT), then declined to 0.02 ppm (183 DAT). AMPA residues were <0.05 ppm in all soil samples taken below 6 inches.

Sampling was halted after 6 months due to flooding of the test sites for three days due to record rainfall during December 1991. No 12, 15, or 18 month samples were collected. However, due to the rapid decrease in concentration of the parent molecule the 6 months of sampling was adequate to determine the dissipation rate. For the 12 months encompassing the study, the site received

a total of 34.79 inches of precipitation and irrigation.

General Results:

Maximum glyphosate levels were generally (six of eight sites) found at 0 to 1 DAT. The maximum glyphosate levels were used in calculations to confirm application rate. The mean calculated (from day 0 0-6 inch soil concentrations of residues) application rate of all eight sites based on maximum application rate was 62% with a range of 41 to 106%. The median time for 50% of the initially applied glyphosate residues to decline through 12 months of sampling was 13.9 days. The 50% dissipation times ranged from 2.6 days in Texas to 140.6 days at Iowa. The final report will contain results from 15 through 18 months and may change the above dissipation rates.

In all field studies the majority of glyphosate residues were generally associated with the 0-6 inch soil layer. However, in California, (no preexcavation to 6 inches) glyphosate was found at 0.21 ppm and 0.10 ppm (lower limit of method validation is 0.05 ppm) in the 12-18 and 18-24 inch soil horizons respectively on 0 DAT. There were other detections in the 6-12 inch depth but these were also below the limit of method validation and near the limit of detection. Since movement to these depths is unlikely at time 0 and no other soil samples below 12 inches contained glyphosate residues, soil core contamination was attributed to those detections. Glyphosate was detected at 0.08 ppm in the 6-12 inch soil layer at 7 DAT in Arizona. The lack of any substantial residues (greater than the limit of method validation) at subsequent sampling intervals 1, 2, and 3 weeks later at the 6-12, 12-18 or 18-24 inch depth indicate that soil core contamination is the cause for the detection.

In Georgia, glyphosate was detected one time at a maximum of 0.03 ppm in the 12-18 inch soil layer at 7 DAT. Throughout the studies progress glyphosate residues were found only in the 0-6 inch soil layer.

In Iowa, which exhibited the longest dissipation rate, glyphosate was found more often at lower soil layers than at the other 7 field sites. Glyphosate was detected at a maximum of 0.12 ppm in the 6-12 inch depth at 14 DAT and 92 DAT, a maximum of 0.05 ppm in the 12-18 inch depth at 190 DAT, and a maximum of 0.02 ppm in the 18-24 inch depth at 92 DAT.

In Minnesota, New York, Ohio and Texas there were infrequent detections of glyphosate and AMPA at levels below 6 inches generally associated with sampling times near the study initiation and also at or near the level of method validation.

DISCUSSION:

1. Frozen storage stability studies which encompass the soil samples are currently in progress.

2. Data from the final months of the study will be submitted at a later date and will contain estimates of the dissipation rate of AMPA.

Environmental Fate & Effects Division
PESTICIDE ENVIRONMENTAL FATE ONE LINE SUMMARY
GLYPHOSATE
Last Update on May 6, 1993
[V] = Validated Study [S] = Supplemental Study [U] = USDA Data

LOGOUT	Reviewer:	Section Head:	Date:

Common Name:GLYPHOSATE
Smiles Code:
PC Code # :103601 CAS #:1071-83-6 Caswell #:

Chem. Name :N-(PHOSPHONOMETHYL)GLYCINE

Action Type:Herbicide

Trade Names:GLYPHOSATE ISOPROPYLAMINE SALT; ROUNDUP; GLIFONOX
(Formul'tn): AQU. SOLN.; MAY BE FORMULATED WITH ALACHLOR OR ACIFLUORFEN
Physical State: COLORLESS CRYSTALS

Use Patterns (% Usage) :CONTROL OF MANY ANNUAL AND PERENNIAL GRASSES AND BROADLEAF :WEEDS PLUS MANY TREE AND WOODY BRUSH SPECIES IN CROPLAND :AND NONCROP SITES. :

Empirical Form: $C_3H_8NO_5P$
Molecular Wgt.: 169.10 Vapor Pressure: 7.50E -8 Torr
Melting Point : 200 °C Boiling Point: NA °C
Log Kow : pKa: @ °C
Henry's : 2.00E-11 Atm. M3/Mol (Measured) 1.39E-12 (calc'd)

Solubility in ...					Comments
Water	1.20E	4	ppm	@20.0 °C	
Acetone	E		ppm	@ °C	
Acetonitrile	E		ppm	@ °C	
Benzene	E		ppm	@ °C	
Chloroform	E		ppm	@ °C	
Ethanol	E		ppm	@ °C	
Methanol	E		ppm	@ °C	
Toluene	E		ppm	@ °C	
Xylene	E		ppm	@ °C	
	E		ppm	@ °C	
	E		ppm	@ °C	

Hydrolysis (161-1)
[ ] pH 5.0:
[ ] pH 7.0:
[V] pH 9.0:STABLE
[V] pH 3.0:STABLE
[V] pH 6.0:STABLE
[ ] pH :

76
50
14

Environmental Fate & Effects Division
PESTICIDE ENVIRONMENTAL FATE ONE LINE SUMMARY
GLYPHOSATE
Last Update on May 6, 1993
[V] = Validated Study [S] = Supplemental Study [U] = USDA Data

Photolysis (161-2, -3, -4)
[V] Water:Stable at pH 5,7,9 sunlight, 14.7-28.6 C (calc.half-life
[ ] : >410 days)
[ ] :
[ ] :

[V] Soil :90.2 day half-life in sandy loam, irradiated, 96.3 non-irr.
[ ] Air :

Aerobic Soil Metabolism (162-1)
[V] T 1/2= < 1 day SdLm
[V] T 1/2= 1-3 day SiLm
[ ]
[ ]
[ ]
[ ]
[ ]

Anaerobic Soil Metabolism (162-2)
[ ] See anaerobic aquatic metabolism.
[ ]
[ ]
[ ]
[ ]
[ ]
[ ]

Anaerobic Aquatic Metabolism (162-3)
[S] AT pH 4.2, T1/2 = 5 WEEKS
[S] " " 6.3, " = 7 WEEKS
[V] T 1/2= 8.1 days in silty clay loam sediment, major degradate was
[ ] AMPA.
[ ]
[ ]
[ ]

Aerobic Aquatic Metabolism (162-4)
[S] IN pH 6.2 NATURAL WATER, 51-
[ ] 61% REMAINED AFTER 63 DAYS.
[V] T 1/2= 7 days SiClLm, AMPA was the major degradate.
[ ]
[ ]
[ ]
[ ]

77
51
15

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Soil Partition Coefficient (Kd) (163-1)
[V] DRUMMER SiClLm 62
[V] RAY SILT 90
[V] SPINKS SdLm 70
[V] LINTONIA SdLm 22
[ ]
[ ]

Soil Rf Factors (163-1)
[V] AFTER LEACHING 7 SOILS WITH
[ ] 20" WATER, THE RECOVERED
[ ] RADIOACT. IN THE SOILS WAS
[ ] 93-100% OF THAT APPLIED.
[ ]
[ ]

Laboratory Volatility (163-2)
[ ] Waived
[ ]

Field Volatility (163-3)
[ ] Waived
[ ]

Terrestrial Field Dissipation (164-1)
[S] IN LmSd AND SiClLm SOILS, T1/2= <1.5 AND 3 WEEKS.
[S] AFTER APPL OF UP TO 8 LBS AIA, DISSIPATION FROM UPPER 6" OF
[ ] FEW SOILS HAD T1/2= < 64 DAYS; IN SdLm T1/2=194-301 DAYS.
[S] 50% dissipation time in Arizona 14.0 days
[S] DT 50 California 13.8 days
[S] DT 50 Georgia 7.4 days
[S] DT 50 Iowa 140.6 days
[S] DT 50 Minnesota 28.7 days
[S] DT 50 New York 127.8 days, DT 50 Ohio 7.5 days, DT 50 Texas 2.6
[ ]

Aquatic Dissipation (164-2)
[V] t1/2= 7.5 days from irrigation source, t1/2= 120 days from
[ ] sediment; In MI,GA and OR pond + stream water max conc. were
[ ] measured imm. following app. and decreased rapidly. In pond
[ ] sediment gly. was at ~1.00 ppm at 1 yr. post treatment.
[ ]
[ ]

Forestry Dissipation (164-3)
[V] half-lives of <1 day, MI and GA sites, <14 days in OR. Glyphos.
[ ] or AMPA did not leach in the soil below 6 inches.

78
52
16

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Long-Term Soil Dissipation (164-5)
[ ]
[ ]

Accumulation in Rotational Crops, Confined (165-1)
[V] 0.028 to 0.108 ppm, lettuce;0.018 to 0.051 ppm carrot tops,0/0096
[ ] to 0.037 ppm(roots) at 3.71 lbs.ai/A,30,119,364 days after treat.

Accumulation in Rotational Crops, Field (165-2)
[ ]
[ ]

Accumulation in Irrigated Crops (165-3)
[V] At 21.3ppm int.conc. then 0.46 at 1 day posttreatment alfalfa,
[ ] corn, grass did not acc. residues. Lettuce was at 0.06 ppm gly.

Bioaccumulation in Fish (165-4)
[V] Max conc. in bluegillsunfish, exposed to 12 ppm for 35 days, 0.38
[ ] X edible tissue, 0.63X nonedible tissue, 0.52X for whole fish

Bioaccumulation in Non-Target Organisms (165-5)
[ ]
[ ]

Ground Water Monitoring, Prospective (166-1)
[ ]
[ ]
[ ]
[ ]

Ground Water Monitoring, Small Scale Retrospective (166-2)
[ ]
[ ]
[ ]
[ ]

Ground Water Monitoring, Large Scale Retrospective (166-3)
[ ]
[ ]
[ ]
[ ]

Ground Water Monitoring, Miscellaneous Data (158.75)
[ ]
[ ]
[ ]

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Field Runoff (167-1)
[ ]
[ ]
[ ]
[ ]

Surface Water Monitoring (167-2)
[ ]
[ ]
[ ]
[ ]

Spray Drift, Droplet Spectrum (201-1)
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[ ]
[ ]
[ ]

Spray Drift, Field Evaluation (202-1)
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[ ]
[ ]
[ ]

Degradation Products

Aminomethylphosphonic acid (max conc of .21 ppm at day 31 in sandy loam soil in Iowa). In aerobic aquatic studies, this acid increased with time, amounting in one case to 23% of the applied radioactivity.
Aminomethylphosphonic acid (AMPA),Aerobic Soil, 26 to 28% of applid at 14 days;CO2 > 70.5% of applied at 12 months
(AMPA), Anaerobic Aquatic, 31% of applied at 15 days then 14 to 24% up to 365 days;CO2 at 35% of applied at 1 year
(AMPA), Aerobic Aquatic, 19-25% of applied from 7 to 30 days; CO2 23% of applied at 30 days

60
84
18

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Comments

Glyphosate dissipated in pond water with T1/2 of 14-21 days; none detectable after 129 days. Sediment conc. increased from 190 ppb at day 7 to 680 ppb at day 127.
Residues in 4-wk old soybeans grown in aged water extracted soils treated at 4 ppm ranged from .76 to 4.12 ppb; residues in the soil during the growing period ranged from .64 to 3.72 ppm.

References: WSSA 83, EFGWB Reviews
Writer : PJH,KLP