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To: Product Manager 25 (Taylor)
TS-767

Through: Dr. Gunter Zweig, Chief
Environmental Fate Branch

From: Review Section No. 1
Environmental Fate Branch

Attached please find the environmental fate review of:

Reg./File No.: 524-308

Chemical: Glyphosate, monoisopropylamine salt [N-(phosphonomethyl) glycine]

Type Product: Herbicide

Product Name: Roundup

Company Name: Monsanto

Submission Purpose: Removal of Crop Rotation Restriction

EFB # 333 Action Code 305

ZBB Code: Sec. 3

Date in: 12/10/79

Date Completed: FEB 11 1980

Ecological Effects Branch

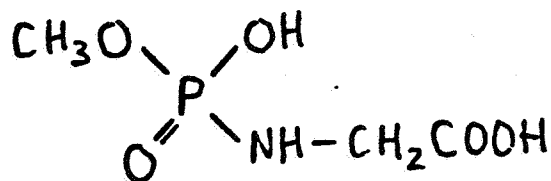
Residue Chemistry Branch

Toxicology Branch

1. INTRODUCTION

1.1 The registrant proposes deleting the crop rotation restriction from the ROUNDUP herbicide 524-308 label. The restriction states "Do not plant subsequent crops other than those on the label for one year following application."

1.2 Structure (glyphosate acid)



2. DIRECTIONS FOR USE

2.1 Non-crop areas - Industrial, recreational and public areas, farmstead weed control, ornamentals, turfgrasses and grasses for seed production.

Field crops - Alfalfa, asparagus, barley, beans (edible, all), corn, cotton, oats, peas (English or green), sorghum (milo), soybeans, sugarcane and wheat.

Tree and orchard crops - Almond, apple, avocado, cherry (non-bearing), filbert, grapefruit, kumquat, lemon, lime, macadamia, orange, pear, pecan, pistachio, tangelo, tangerine, walnut grapes and raisins.

The maximum rates for the above are 6 lb of glyphosate acid per acre per season on field crops except sugarcane and 7.95 lb of glyphosate acid per acre per season on ornamentals and sugarcane. Applications to non-crop areas may be repeated as needed but repeat treatments to field crops must be made before crop emergence.

2.2 For spot treatment use a 1-1-1/2% solution with hand-held equipment.

2.3 Roundup does not provide residual weed control.

2.4 Do not feed or graze treated areas within 8 weeks after application. Do not feed or graze treated cotton fields to livestock. Do not apply near water to be used for irrigation.

2.5 Keep out of lakes, streams and ponds. Do not reuse container, destroy when empty.

2.6 The label contains tank mix use directions for Roundup with Lasso, atrazine, Princep, LoroX, Lexone and Sencor. See the label for rates.

When using the tank mix, do not apply more than 4 quarts of Roundup (which is 3 lb of glyphosate acid) per acre.

3. DISCUSSION OF DATA

3.1 Uptake and Metabolism of Glyphosate in Root, Leaf and Cereal Type Rotation Crops, section J of special report MSL-0882, R.D. #280, accession number 241426, November 27, 1979.

Procedure

PRIMARY CROPS

Sixteen pots, 8" diameter x 6" deep (0.35 sq. ft.), were filled with Lintonia sandy loam soil (pH 6.5, 0.6% organic matter, 86.0% sand, 11.0% silt, and 1.8% clay). Eight of the pots were each treated with 14.92 mg (4 lbs/A) of ^{14}C -labeled PMG (PMG = N-[phosphonomethyl- ^{14}C]-glycine) and the remaining pots were treated with an equivalent amount of unlabeled herbicide. Three days after treatment, pots were planted with wheat, beets, soybeans, or transplanted cabbage plants. When growth was assured, the wheat was thinned to 15 plants, cabbage to one, and beets and soybeans to two plants per pot.

The plants were placed on carts in the greenhouse, watered as needed from the bottom, and fertilized monthly. At maturity and/or after 120 days the crops were harvested.

Also, in order to differentiate between ^{14}C activity taken up by the roots of the plants growing in the ^{14}C glyphosate treated soil from the photosynthetic fixation of $^{14}\text{CO}_2$ released from the soil due to soil degradation of ^{14}C glyphosate, the pots treated with unlabeled glyphosate were maintained in the same cubicle of the greenhouse as those pots containing ^{14}C glyphosate treated soil.

FOUR MONTH ROTATION CROPS

After the harvest of the primary crops, the soil surface of the pots was lightly tilled by hand and replanted with beets replacing soybeans and wheat, cabbage replacing beets, and wheat replacing cabbage. Subsequent handling and harvest was carried out as described for the primary crop.

ONE YEAR ROTATION CROPS

One year after treatment, the soil surface was lightly tilled by hand and replanted with cabbage, beets, and wheat replacing the primary crops of wheat, cabbage, and beets, respectively. In the interim between the 4 month and 1 year rotation crops, the pots of soil were kept moist by watering and fertilizing as needed. The crop harvest was carried out as above.

EMERGENCY CROPS

A second treatment as described for the primary crops was initiated with thirty-two pots of soil. Four pots were used for each set of cold ai and hot ai treated plants as described above. The pots were planted with soybeans, cabbage, wheat, and beets as in the primary crops. This first planting was harvested after 30 days and the pots replanted with cabbage replacing beets and soybeans. These crops were harvested as above after 90 days of growth. These crops are representative of the crops that would be planted after the failure of the initial crop. The crops grown for the first 30 days were not analyzed.

EXPOSURE OF SOYBEANS TO $^{14}\text{CO}_2$

Soybeans exposed to $^{14}\text{CO}_2$ ~~extract of plants exposed only to $^{14}\text{CO}_2$~~ were utilized to establish the chromatographic pattern of the radiolabeled aqueous extract of plants exposed only to $^{14}\text{CO}_2$. Briefly, two week old soybean plants grown in sand were maintained in hydroponic culture under fluorescent light. These plants were exposed photosynthetically to 2.5 mC of $^{14}\text{CO}_2$ (released from Ba $^{14}\text{CO}_3$) for 60 minutes. The plants were allowed to grow in hydroponic solution for an additional 23 hours. After this period of time, the roots and aerial portions of the plants were separated, frozen, lyophilized, and ground to 40 mesh in a Wiley Mill. The resulting plant material was analyzed as below except that proportionately smaller samples were used.

EXPOSURE OF WHEAT TO $^{14}\text{CO}_2$

Fourteen pots, 4" by 4" square, of one week old wheat plants grown in Lintonia sandy loam soil were placed in a glove bag under mercury lamps. $^{14}\text{CO}_2$ was released from 3 mC of $^{14}\text{NaCO}_3$ contained in a vial in the glove bag by addition of and excess of H_3PO_4 . The wheat plants were removed from the glove bag after 2 hours of exposure to $^{14}\text{CO}_2$ and maintained in the greenhouse. After two weeks the plants were harvested, weighed, frozen, lyophilized, weighed, and ground to 40 mesh in the Wiley Mill.

Analytical Methods

Plant samples were ground and extracted with deionized water. The extract was analyzed by column chromatography (AG 1-X8 in the bicarbonate form) by eluting the extract with ammonium bicarbonate solution. Five ml fractions were collected for LSC. Aminomethylphosphonic acid (AMP) and PMG eluted with 185-202 ml and 224-255 ml of solvent, respectively.

Standard ^{14}C combustion techniques were also used.

Results

Uptake of ^{14}C by Primary and Rotational Crops from a 4 lb ai/A ^{14}C -Glyphosate (ppm)			
Crop	^{14}C from $^{14}\text{CO}_2$ incorporation only	^{14}C from growth in glyphosate treated soil	Expected uptake from non $^{14}\text{CO}_2$ sources
Primary			
wheat	0.26	3.65	3.39
beet foliage	0.10	0.46	0.36
beet root	0.06	0.31	0.25
soybean foliage	0.15	0.21	0.06
soybean pod	0.10	0.14	0.04
cabbage	0.03	0.13	0.10
30 day replant			
beet foliage	0.05	0.26	0.21
beet root	0.07	0.43	0.36
cabbage	0.07	0.18	0.11
wheat	0.23	1.31	1.08
4 month rotation			
beet foliage	0.03	0.07	0.04
beet root	0.02	0.09	0.08
cabbage	0.01	0.08	0.07
wheat	0.27	1.12	0.85
1 year rotation			
cabbage	0.02	0.04	0.02
wheat	0.05	0.19	0.14
beet foliage	0.01	0.05	0.04
beet root	0.01	0.05	0.04

- 3) ^{14}C activity taken up in the form of $^{14}\text{CO}_2$ was incorporated in the plant as primarily insoluble natural plant products.

Conclusions

- 1) Since this rotational crop study was run at 2/3 the maximum label rate, the values reported in the Results (2) above, could be as much as 50% greater.
- 2) The majority of the glyphosate residues taken up by the rotational crops planted 30 days and later after treatment and harvested at 97-120 days growth would be as natural plant constituents. However, 10 - 20% of the residues taken up by rotational cabbage, beet roots and wheat and 5 - 8% of the residues taken up by rotational beet foliage would be in the form of a mixture of glyphosate and the degradation product aminomethylphosphonic acid (AMP) in ratios of 14:3 to 2:9.
- 3) The residue levels found in the wheat plants are abnormally high due to the plants laying on the treated soil surface during growth and due to the abnormally low moisture content of the harvested wheat plants.

4. RECOMMENDATIONS

4.1 The following residue levels could be expected in rotational crops planted in glyphosate treated soils:

<u>Crop</u>	<u>Rotational Interval</u>	<u>Days After Planting</u>	<u>ppm</u>
Cabbage	30 days	120	0.16
	4 months	120	0.11
	1 year	97	0.03
Beet foliage	30 days	120	0.32
	4 months	120	0.06
	1 year	120	0.06
Beet root	30 days	120	0.54
	4 months	120	0.12
	1 year	120	0.06

Most of the residues would be in the form of natural plant constituents; however, 10-20% of the residues taken up by rotational cabbage and beet roots and 5-8% of the residues taken up by rotation beet foliage would be in the form of a mixture of glyphosate and the degradation product aminomethylphosphonic acid (AMP) in ratios of 5:1 to 1:5.

2) Uptake of Glyphosate ¹⁴C Soil Residues^{a/} (ppm)

<u>Crop</u>	<u>Type^{b/}</u>	<u>Uptake from non CO₂ sources</u>	<u>Residues as parent^{c/}</u>	<u>Residues as AMP^{d/}</u>
Cabbage	PR	0.10	0.008	0.005
	EM	0.11	0.007	0.003
	4M	0.07	0.008	0.005
	1Y	0.02	0.002	0.002
Wheat	PR	3.39	0.362	0.116
	EM	1.08	0.046	0.128
	4M	0.85	0.014	0.003
	1Y	0.14	<0.001	<0.001
Beet foliage	PR	0.36	0.008	0.021
	EM	0.21	0.004	0.005
	4M	0.04	<0.001	0.001
	1Y	0.04	<0.001	0.002
Beet Root	PR	0.25	0.022	0.030
	EM	0.36	0.015	0.039
	4M	0.08	0.002	0.009
	1Y	0.04	0.002	0.004

a/ 4lb. ai/A application

b/ PR = primary
EM = emergency
4M = 4 month
1Y = 1 year

c/ N - phosphonomethylglycine or PMG

d/ aminomethylphosphonic acid

4.2 For the toxicological significance of these residues the Toxicology Branch/HED must be consulted.

4.3 If the rotational crop residue levels are considered toxicologically insignificant, then the rotation crop restriction on the label may be dropped for uses of glyphosate when applied alone.

Samuel M. Creeger Feb 4, 1980
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January 14, 1980
Review Section #1
Environmental Fate Branch
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