

MASSACHUSETTS DEPARTMENT OF TRANSPORTATION  
MassDOT Highway Division

YEARLY OPERATION PLAN  
For I-90 (Turnpike)  
Sturbridge-East-Brookline

2011

The following Yearly Operation Plan (YOP) has been developed to ensure compliance with the Rights of Way Management regulations (333 CMR 11.00)

Municipalities included in the MassDOT I-90 Sturbridge East 2011 Yearly Operation Plan (YOP).

Ashland, Auburn, Brookline, Charlton, Framingham, Grafton, Hopkinton, Millbury, Natick, Newton, Oxford, Southborough, Sturbridge, Upton, Wayland, Weston, Westborough,

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MAPS LOCATING THE RIGHT OF WAY AND SENSITIVE AREAS  
NOT READILY IDENTIFIABLE IN THE FIELD

HERBICIDES PROPOSED INCLUDING EPA REGISTRATION  
NUMBERS, APPLICATION RATES, CARRIERS AND ADJUVANTS

HERBICIDE: ACCORD CONCENTRATE

EPA REGISTRATION  
NUMBER: 62719-324

APPLICATION RATES 2 QUARTS PER ACRE

HERBICIDE: OUST EXTRA

EPA REGISTRATION  
NUMBER: 352-622

APPLICATION RATES: 4 OUNCES PER ACRE

ADJUVANTS: NONIONIC SURFACTANT AT 2 QTS/100 GAL.

DRIFT CONTROL AGENT AT RATE RECOMMENDED  
ON LABEL

## HERBICIDE APPLICATION TECHNIQUES AND ALTERNATIVE CONTROL PROCEDURES PROPOSED

MassDOT will utilize two methods of herbicide application, foliar treatment and cut stump surface treatment.

Chemical foliar treatments involve the selective application of approved herbicides and adjuvants diluted in water, to the foliage and stems of the target vegetation. The foliar treatment used shall be low pressure, below 60 psi at the nozzle, with a normal working pressure of 40 psi for application at volumes of less than 50 gallons/acre.

Low-pressure nozzles will be used to produce the largest possible droplet size and a drift control agent shall be added at the rate recommended on the label to keep spray drift to an absolute minimum. Previous studies and experience indicate minimal drift occurs when using low – pressure applications and adjuvants.

MassDOT's Integrated Roadside Vegetation Management (IRVMP) methods include roadside development (active planting to encourage appropriate competing vegetation), no-organic barriers, asphalt crack sealing, mechanical (mowing, hand cutting, selective trimming) and chemical (low volume foliar herbicide treatments). Each one of these methods has benefits and impacts, and each one by itself will not work effectively for long-term vegetation management. However, when these activities are integrated, they complement one another in terms of both effectiveness and minimize environmental impacts.

The methods listed above will be chosen by MassDOT personnel familiar with the right of way based on a variety of factors including, but not limited to, location, environment, and terrain and public/employee safety. The method chosen for a given vegetation problem will attempt to achieve a long term, low maintenance vegetation management program through the encouragement of a stable herbaceous community.

NAME, ADDRESS AND PHONE NUMBER OF THE COMPANY WHICH  
WILL PERFORM ANY HERBICIDE TREATMENT

MassDOT Environmental Engineering Department in conjunction with MassDOT  
Engineering and Maintenance Departments.

668 SOUTH AVE  
WESTON, MA 02493

(781) 431-5000

FIELD PERSONELL  
LICENSED OPERATORS

Anthony Staffierie  
668 SOUTH AVE  
WESTON, MA 02493  
(617) 276-7142

CREW LEADER PHONE

(781) 844-9702

## IDENTIFICATION OF TARGET VEGETATION

MassDOT will inventory roadways and develop priorities for control of target vegetation. These areas will be mapped and priorities on the basis of roadway volumes, speeds, and significance of vegetation condition.

From a highway operations standpoint, target vegetation along roadways falls into one or more of the following categories: hazard vegetation, detrimental vegetation, nuisance vegetation, and invasive vegetation. From a roadside vegetation management standpoint, target vegetation will be one or more of the following types: grasses, low-growing shrubs and vines, and tall growth (trees). Of these, some target vegetation may be determined to be persistent and invasive, meaning that the vegetation will resprout when removed by mechanical means.

- **Hazard Vegetation.** This category represents the primary target material, including vegetation obscuring sightlines, growing over and under guardrails, creating obstacles to signs or vehicular movement, posing windfall hazard over which weeds, vines, or grass becomes an obstacle obscuring sight lines or causing motorists to veer towards the center of the road. In special instance conifers may present a hazard. In the winter months, shadows cast on roadways by evergreen trees can delay melting (especially in “low salt” areas) resulting in possibility of hazardous road conditions and an increase in the amount of de-icing chemicals (road salt) applied.
- **Detrimental Vegetation.** This category comprises grasses and woody plants that are destructive to or comprise the function of highway structures, including grasses in pavement and bridge joints, medians barriers and traffic islands, as well as vegetation within drainage structures and compromising drainage ways. The roadway drainage impact of vegetation creates stormwater accumulation and hazardous icing conditions.
- **Nuisance Vegetation.** This category includes any vegetation growing along state roadways that could potentially cause problems to the general public and/or Masspike employees or contractors maintaining the ROW.

Poison Ivy and other nuisance vegetation growing within 30 feet of the edge of pavement, bridge abutments, a drainage structure or swale, other structures and appurtenances requiring maintenance, within MassDOT ROW, will be considered target vegetation.

- **Invasive Vegetation.** Some areas of MassDOT ROW have become heavily infested with invasive plant species. Working with input from environmental

## IDENTIFICATION OF TARGET VEGETATION (CONT)

agencies, MassDOT will seek opportunities to remove invasive material and to encourage growth of native species. Specific target invasive plants include but are not limited to Tree of Heaven (*Ailanthus altissima*), Japanese Knotweed (*Polygonum cuspidatum*), Multiflora Rose (*Rosa multiflora*), Oriental Bittersweet (*Celastrus* spp.), Autumn Olive (*E. umbellata*) and Russian Olive (*E. angustifolia*)

## NAME, ADDRESS AND PHONE NUMBER OF THE INDIVIDUAL REPRESENTING THE YOP APPLICANT

MassDOT Environmental Engineering Department in conjunction with MassDOT Engineering and Maintenance Departments.

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## DESCRIPTION OF METHODS USED TO FLAG OR OTHERWISE DESIGNATE SENSITIVE AREAS ON THE RIGHT OF WAY

Sensitive areas defined at 333 CMR 11.04 are identified as public groundwater supplies, public surface water supplies, private drinking water supplies, surface waters, wetlands, habitated areas and agricultural areas. For the purpose of identification, sensitive areas can be separated into two categories: areas not readily identifiable in the field; and areas that are readily identifiable in the field.

Sensitive areas not readily identifiable in the field include public groundwater supplies, wetlands, private water supplies and public surface water supplies.

Sources to identify sensitive areas not readily identifiable in the field include:

- 1.) Massachusetts Department of Environmental Protection (DEP) Watershed Maps (1:25,000: delineates the perimeter of public watersheds and the locations of public wells;
- 2.) Massachusetts DEP Wetland Conservancy Maps (scale usually 1:1,000);

DESCRIPTION OF METHODS USED TO FLAG OR OTHERWISE  
DESIGNATE SENSITIVE AREAS ON THE RIGHT OF WAY (CONT)

- 3.) Municipal maps and records, boards of Health, Conservation Commissions, and water suppliers;
- 4.) Regional Planning Agencies maps and records;
- 5.) University of Massachusetts, Cartographic Information Research Services, Amherst;

The following is a description of how the sensitive areas will be identified for required protection.

- 1.) Consult the appropriate reference materials and sources to determine the precise location of these areas.
- 2.) Place the boundaries of these sensitive areas on U.S. Geological Survey & USGS) topographical maps.
- 3.) Prior to commencement of herbicide application operation, the treatment crew will be provided the marked-up topographical map with which to flag boundaries or the boundaries of the appropriate buffer zone.

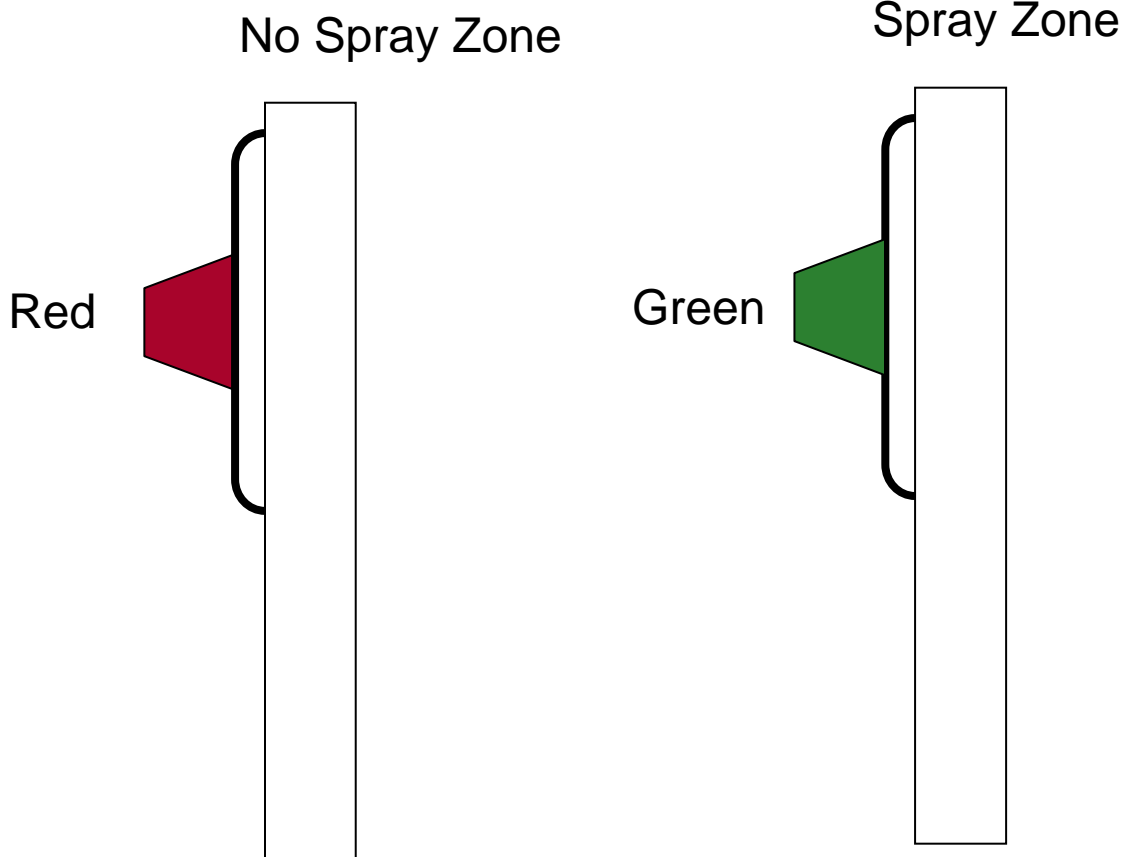
Sensitive Areas readily identifiable in the field include surface waters, inhabited areas, agricultural areas and major road crossings. The method utilized to identify these sensitive areas will be as follows:

- 1.) Consult USGS topographic maps to locate any of these sensitive areas that may be already being identified on these maps.
- 2.) Prior to commencement of herbicide application operations, the treatment crew will be provided the marked topographic map.
- 3.) The treatment crew will visually survey the area to be treated for any sensitive areas.

DESCRIPTION OF METHODS USED TO FLAG OR OTHERWISE DESIGNATE SENSITIVE AREAS ON THE RIGHT OF WAY

### Guardrail Cross-Section

Steel reflector bolted to beam face, covered with reflective sheathing



## PROCEDURES AND LOCATIONS FOR HANDLING, MIXING AND LOADING OF HERBICIDE CONCENTRATES

All mixing and loading of herbicides will be conducted at the central facility where the herbicides are stored. Only the amount of herbicides necessary to carry out the vegetation control, based on the monitoring results, will ensure that there will be no waste and minimize potential problems. The vehicle carrying out the spray operation will be equipped with a bag of absorbent, activated charcoal, leak-proof containers, a broom and a shovel in case of minor spills. A clipboard log of the herbicides on the vehicle will be kept on the vehicle. Herbicide labels and fact sheets should be carried onsite by the applicator.

As soon as any spill is observed, immediate action will be taken to contain the spill and protect the spill area. The source of the spill must be identified and secured. Spill containment will be accomplished by covering the spill with absorptive clay or other absorptive material or, for large spills, building clay or soil dikes to impede spill progress. Placing barriers, flagging or crewmembers at strategic locations will accomplish protection of the spill area. If a fire is involved, care will be taken to avoid breathing fumes from any burning chemicals.

In the event of a spill information on safety precautions and clean up procedure may be gathered from the following sources:

## HERBICIDE FACT SHEET APPROVED BT DAR

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### GLYPHOSATE

Common Trade Name(s): Roundup, Glyphosate VMF Round Up Pro, Rodeo, Accord, Accord Concentrate,

Chemical Name: N—(phosphonomethyl )glycine—isopropylamine salt

CAS No.: 1071-83-6

#### GENERAL INFORMATION

Glyphosate, n-phosphonomethyl glycine, is a systemic, broad spectrum herbicide effective against most plant species, including deep rooted perennial species, annual and biennial species of grasses, sedges, and broadleafed weeds. The major pathway for uptake in plants is through the foliage, however, some root uptake may occur. The presence of surfactants and humidity increases the rate of absorption of glyphosate by plants (15).

Foliarly applied glyphosate is readily absorbed and translocated from treated areas to untreated shoot regions. The mechanism of herbicidal action for glyphosate is believed to be inhibition of amino acid biosynthesis resulting in a reduction of protein synthesis and inhibition of growth (10, 15, 101).

Glyphosate is generally formulated as the isopropylamine salt in aqueous solution (122). Of the three products containing glyphosate considered here, Roundup is sold with a surfactant and Rodeo and Accord are mixed with surfactants prior to use (15). Glyphosate has been reviewed by US Forest Service (15), FAO (122), and EPA 00W (51).

#### ENVIRONMENTAL FATE

##### Mobility

Glyphosate is relatively immobile in most soil environments as a result of its strong adsorption to soil particles. Adsorption to soil particles and organic matter begins almost immediately after application. Binding occurs with particular rapidity to clays and organic matter (15).

Clays and organic matter saturated with iron and aluminum (such as in the Northeast) tend to absorb more glyphosate than those saturated with sodium or calcium. The soil phosphate level is the main determinant of the amount of glyphosate adsorbed to soil particles. Soils which are low in phosphates will adsorb higher levels of glyphosate (14, 15).

Glyphosate is classified as immobile by the Helling and Turner classification system. In soil column leaching studies using aged (1 month) Glyphosate, leaching of glyphosate was said to be insignificant after 0.5 inches of water per day for 45 days (14).

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##### Persistence

It has been reported that glyphosate dissipates relatively rapidly when applied to most soils (14). However, studies indicate that the soil half-life is variable and dependent upon soil factors. The half-life of glyphosate in greenhouse studies when applied to silty clay loam, silt loam, and sandy loam at rates of 4 and 8 ppm was 3, 27 and 130 days respectively, independent of application rate (14). An average half-life of 2 months has been reported in field studies for 11 soils (15).

Glyphosate is mainly degraded biologically by soil micro-organisms and has a minimal effect on soil microflora (15). In the soil environment, glyphosate is resistant to chemical degradation such as hydrolysis and is stable to sunlight (15). The primary metabolite of glyphosate is aminomethyl phosphonic acid (AMPA) which has a slower degradation rate than glyphosate (15). The persistence of AMPA is reported to be longer than glyphosate,

possibly due to tighter binding to soil (14). No data are available on the toxicity of this compound.

Glyphosate degradation by microorganisms has been widely tested in a variety of field and laboratory studies. Soil characteristics used in these studies have included organic contents, soil types and pHs similar to those that occur in Massachusetts (117).

Glyphosate degradation rates vary considerably across a wide variety of soil types. The rate of degradation is correlated with microbial activity of the soils and does not appear to be largely dependent on soil pH or organic content (117). While degradation rates are likely temperature dependent, most reviews of studies do not report or discuss the dependence of degradation rate on temperature. Mueller et al. (1981 cited in 117) noted that glyphosate degraded in Finnish agricultural soils (loam and fine silt soils) over the winter months; a fact which indicates that degradation would likely take place in similar soils in the cool Massachusetts climate. Glyphosate half-lives for laboratory experiments on sandy loam and loamy sand, which are common in Massachusetts, range up to 175 days (117). The generalizations noted for the body of available results are sufficiently robust to incorporate conditions and results applicable to glyphosate use in Massachusetts.

#### TOXICITY REVIEW

##### Acute (Mammalian)

Glyphosate has reported oral LD50s of 4,320 and 5,600 mg/kg in male and female rats (15,4). The oral LD50s of the two major glyphosate products Rodeo and Roundup are 5,000 and 5,400 mg/kg in the rat (15).

A dermal LD50 of 7,940 mg/kg has been determined in rabbits (15,4). There are reports of mild dermal irritation in rabbits (6), moderate eye irritation in rabbits (7), and possible phototoxicity in humans (9). The product involved in the phototoxicity study was Tumbleweed marketed by Murphys Limited UK (9). Maibach (1986) investigated the irritant and the photo irritant responses in individuals exposed to Roundup (41% glyphosate, water, and surfactant); Pinesol liquid, Johnson Baby Shampoo, and Ivory Liquid dishwashing detergent. The conclusion drawn was that glyphosate has less irritant potential than the Pinesol or the Ivory dishwashing liquid (120).

##### Metabolism

Elimination of glyphosate is rapid and very little of the material is metabolized (6,106).

##### Subchronic/Chronic Studies (Mammalian)

In subchronic tests, glyphosate was administered in the diet to dogs and rats at 200, 600, and 2,000 ppm for 90 days. A variety of toxicological endpoints were evaluated with no significant abnormalities reported (15,10).

In other subchronic tests, rats received 0, 1,000, 5,000, or 20,000 ppm (57, 286, 1143 mg/kg) in the diet for 3 months. The no observable adverse effect level (NOAEL) was 20,000 ppm (1,143 mg/kg) (115). In the one year oral dog study, dogs received 20, 100, and 500 mg/kg/day. The no observable effect level (NOEL) was 500 mg/kg (116).

##### Oncogenicity Studies

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Several chronic carcinogenicity studies have been reported for glyphosate including an 18 month, mouse study; and a two year rat study. In the rat study, the animals received 0, 30, 100 or 300 ppm in their diet for 2 years. EPA has determined that the doses in the rat study do not reach the maximum tolerated dose (112) and replacement studies are underway with a high dose of 20,000 ppm (123). The mice received 1000, 5000 or 30,000 ppm for 18 months in their diets. These studies were non-positive (112,109). There was a non-statistically significant increase in a rare renal tumor (renal tubular adenoma (benign) in male mice (109). The rat chronic study needs to be redone with a high dose to fill a partial data gap (112). The EPA weight of evidence classification would be D: not classified (51).

### Mutagenicity Testing

Glyphosate has been tested in many short term mutagenicity tests. These include 7 bacterial (including *Salmonella typhimurim* and *B. subtilis*) and 1 yeast strain *Sacchomyces cerevisiae* as well as a mouse dominant lethal test and sister chromatid exchange. The microbial tests were negative up to 2,000 mg/plate (15), as were the mouse dominant lethal and the Chinese hamster ovary cell tests. EPA considers the mutagenicity requirements for glyphosate to be complete in the Guidance for the Registration of Pesticide Products containing glyphosate (112).

The developmental studies that have been done using glyphosate include teratogenicity studies in the rat and rabbit, three generation reproduction studies in the rat, and a reproduction study in the deer mouse. (15)

Rats were exposed to levels of up to 3,500 mg/kg/d in one rat teratology study. There were no teratogenic effects at 3,500 mg/kg/d and the fetotoxicity NOEL was 1,000 mg/kg/d. In the rabbit study a fetotoxicity NOEL was determined at 175 mg/kg/d and no teratogenic effects were observed at 10 or 30 mg/kg/d in one study and 350 mg/kg/d in the other study (15). No effects were observed in the deer mouse collected from conifer forest sprayed at 2 lbs active ingredient per acre (15).

### Tolerances & Guidelines

EPA has established tolerances for glyphosate residues in at least 75 agricultural products ranging from 0.1 ppm (most vegetables) to 200 ppm for animal feed commodities such as alfalfa (8).

U.S. EPA Office of Drinking Water has released draft Health Advisories for Glyphosate of 17.50 mg/L (ten day) and 0.70 mg/L (Lifetime)(51).

### Avian

Two types of avian toxicity studies have been done with glyphosate: ingestion in adults and exposure of the eggs. The species used in the ingestion studies were the mallard duck, bobwhite quail, and the adult hen (chickens). The 8 day feeding LC50s in the mallard and bobwhite are both greater than 4,640 ppm. In the hen study, 1,250 mg/kg was administered twice daily for 3 days resulting in a total dose of 15,000 mg/kg. No behavioral or microscopic changes were observed (15).

### Invertebrates

A variety of invertebrates (mostly arthropods) and microorganisms from freshwater, marine, and terrestrial ecosystems have been studied for acute toxic effects of technical glyphosate as well as formulated Roundup. The increased toxicity of Roundup compared with technical glyphosate in some studies indicates that it is the surfactant (MONO 818) in Roundup that is the primary toxic agent (117). Acute toxicity information may be summarized as follows:

Glyphosate (technical): Acute toxicity ranges from a 48 hr EC50 for midge larvae of 55 mg/L to a 96 hr TL50 for the fiddler crab of 934 mg/L (15).

Roundup: Acute toxicity ranges from a 48 hr EC50 for *Daphnia* of 3 mg/L to a 95 hr LC50 for crayfish of 1000 mg/L (15).

Among the insects tested, the LD50 for honeybees was 100 mg/bee 48 hours after either ingestion, or topical application of technical glyphosate and Roundup. This level of experimental exposure is considerably in excess of exposure levels that would occur during normal field applications (15).

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Aquatic Species (Fish) Technical glyphosate and the formulation Roundup have been tested on various fish species. Roundup is more toxic than glyphosate, and it is the surfactant that is considered to be the primary toxic agent in Roundup:

Glyphosate (technical):

Acute 96 hr LC50s range from 24 mg/L for bluegill (Dynamic test) to 168 mg/L for the harlequin fish (15).

Roundup: Acute lethal toxicity values range from a 96 hr LC50 for the fathead minnow of 2.3 mg/L to a 96 hr TL50 for rainbow trout of 48 mg/L (15).

Tests with Roundup show that the egg stage is the least sensitive fish life stage. The toxicity increases as the fish enter the sac fry and early swim up stages.

Higher test temperatures increased the toxicity of Roundup to fish, as did higher pH (up to pH 7.5). Above pH 7.5, no change in toxicity is observed.

Glyphosate alone is considered to be only slightly acutely toxic to fish species (LC50s greater than 10 mg/L), whereas Roundup is considered to be toxic to some species of fish, having LC50s generally lower than 10 mg/L (15,118).

#### SUMMARY

Glyphosate when used as recommended by the manufacturer, is unlikely to enter watercourses through run-off or leaching following terrestrial application (117). Toxic levels are therefore unlikely to occur in water bodies with normal application rates and practices (118).

Glyphosate has oral LD50s of 4,320 and 5,600 in male and female rats respectively. The elimination is rapid and very little of it is metabolized. The NOAEL in rats was 20,000 ppm and 500 mg/kg/d in dogs. No teratogenic effect was observed at doses up to 3,500 mg/kg/d and the fetotoxicity NOELs were 1,000 mg/kg/d in the rat and 175 mg/kg/d in the rabbit.

The evidence of oncogenicity in animals is judged as insufficient at this time to permit classification of the carcinogenic potential of glyphosate. The compound is not mutagenic.

#### REFERENCE S

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7. NTP Technical Report Series
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9. Dept. of Justice - Drug Enforcement Administration Memo dated September 26, 1985
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  - Handbook of the Weed Science Society of America
  - Pub. by the Weed Science Society of America, Champaign, Ill.
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15. Pesticide Background Statements: Aug. 1984
  - USDA Forest Service Agriculture Handbook #633 Vol. 1
51. Office of Drinking Water Health Advisories, USEPA
101. IUPAC Advances In Pesticide Science (1978) V—2 p. 139.
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109. Dept. of Justice - Drug Enforcement Administration Memo dated September 26, 1985.
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  120. Maibach, H.I. (1986) Irritation, Sensitization, Photo Irritation and Photosensitization assays with Glyphosate Herbicide. *Contact Dermatitis* 15 152—156.
122. Pesticide Residues in Food - 1986
  - FAQ Plant Production and Protection Paper 77.
123. Personal communication with Bill Heydens of Monsanto 2/16/89.

## HERBICIDE FACT SHEET APPROVED BT DAR

### SULFOMETURON METHYL

COMMON TRADE NAME(S): Oust

CHEMICAL NAME : N-[4,6-dimethylpyrimidin-2-yl) amino-carbonyl -2-methoxycarbonylbenzenesulfonamide

CAS NO: 74222-97-2

#### GENERAL INFORMATION

Sulfometuron methyl, the active ingredient in the herbicide Oust, is a member of the group of sulfonyleurea herbicides. Sulfometuron Methyl is a broad-spectrum selective weed control agent used in non-crop areas. Oust is applied pre- or post-emergence which provides control against many broad-leaf weeds and grasses through contact and residual activity. (15)

#### ENVIRONMENTAL FATE

##### Mobility

The mobility of sulfometuron methyl has been reported in literature and the database available is complete. Sulfometuron methyl is a weak acid (pKa 5.2) and consequently, adsorption coefficients were calculated for various soils at pH values of 5, 6, and 7. In a low organic matter I soil (1%) the adsorption coefficients were 2.0, 0.8 and 0.3 at the respective pH values. This study indicates that sulfometuron methyl is more strongly adsorbed to soil as the pH decreased, and as organic matter increases. (15)

Soil thin layer chromatography and adsorption coefficients were performed and calculated for four standard soils. Kd values ranged from 0.71 to 2.85 and Rf values ranged from 0.33 to 0.85 indicated a moderate mobility. In addition, soil column studies using the same four soils indicate a moderate to moderately high mobility pesticide. Koc values calculated from the soil Kd values range from 61 to 122 which is lower than the EPA guideline of 400. (101)

In a field mobility study, sulfometuron methyl was applied to soil tubes in five locations (Delaware, North Carolina, Oregon, Colorado, and Saskatchewan, Canada) at a rate of 1 lb a.i./Acre. There was no report of rainfall

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at these sites. Each application was made at a different time making it difficult to compare results. Samples were taken for a minimum of a year and at some for two years, and at 8 cm (3 in) intervals to 32 cm (12 inches). Results indicate that sulfometuron methyl is moderately mobile under most conditions. One surprising fact is that immediately after application, all locations had detectable residues in a layer below the top layer of soil, and in two locations (Colorado and Oregon) in the deepest layer sampled. All locations except Delaware also had detectable residues at the 24-32 cm layer at other times during the study. There are also indications that sulfometuron methyl would leach further than the deepest soil layer which was sampled. (102)

#### **Persistence**

Sulfometuron methyl is degraded by microbial action, photo-decomposition and by hydrolysis at acidic pH's. The photolysis half-life on soil is between 1 to 2 weeks and in distilled water, approximately 160 hours. The hydrolysis half-life at pH 2 and 5 is 100 and 475 hours respectively. At neutral or basic pH's, sulfometuron methyl is stable to hydrolysis. (15,100, 101)

Reports indicate that the overall rate of sulfometuron methyl degradation in soil depends on pH and soil moisture content. Half-lives of one week were reported under laboratory conditions, but field studies at neutral pH revealed greater persistence. Increased soil moisture content resulted in increased degradation rates, but only approximately 10%. (15, 101)

The soil half-life is reported as four weeks with longer times in colder conditions. A review of available studies, however reveals that the shortest half-life was six weeks in Delaware. In the same study the half-life ranged from six weeks to one year in Oregon. (15, 102)

The reported half-life of four weeks is relatively short and would not be cause for concern. However, it seems evident that in most circumstances it may be significantly longer. In all cases reported in this study, the half-life was six weeks or longer and a more realistic estimate may be closer to two months. Another point discussed in the literature is the lack of any significant degradation during the cold periods of the year. Applications in the late fall could lead to longer half-lives and thereby more potential for increased leaching.

The field study discusses the faster degradation rates of sulfometuron methyl in the east as possibly attributable to the more acidic and moister soils in the east. This is certainly true and may in fact have contributed to shorter half-lives, but a point which is not discussed was the timing of the applications. The two western sites were treated in early to mid-July, whereas the western sites were treated in the fall. Saskatchewan was treated in late July, but the climate at that location is cooler and becomes much colder.

#### **TOXICITY REVIEW**

Five animals per sex per group were gavaged with sulfometuron methyl suspended in corn oil at a dosage of 5,000 mg/kg. Gross pathological examination revealed slight weight increase in the lungs that were pale red with grey foci in males and similar lung effects in one female. In addition, four females had a pink thymus and one had a slight liver weight. The oral LD50 in male and female ChR-CD rats was determined to be greater than 5,000 mg/kg. (110)

The inhalation LC50 was tested in groups of five male and five female Crl:CD rats. Rats were exposed to control air or test concentrations of either 6.4 or 11 mg/L. There were no clinical or pathological differences between controls or test groups. The inhalation LC50 was greater than 5.0 mg/L (111) while sulfometuron methyl was tested at 6.4 and 11 mg/L. The EPA cutoff for LC50 concentration is 5 mg/L.

Acute skin absorption LD50 tests were performed on five male and five female New Zealand white rabbits. Doses of 2,000 mg/kg of pesticide were applied to abraded skin on the back of the rabbit. Clinical signs in males

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were sporadic weight loss, slight erythema 1 to 2 days after treatment and diarrhea at 11 days. Gross pathological examination showed no changes due to the test material. The dermal LD50 in rabbits was greater than 2,000 mg/kg. (112)

In a separate acute dermal LD50 test, four groups of five adult male and one group of five adult female New Zealand rabbits were used. Groups of males were dosed at the following levels: 1,500 mg/kg, 2,000 mg/kg, and 8,000 mg/kg and the females were dosed at 2,000 mg/kg. Clinical signs in all the groups of males were moderate to mild redness and sporadic weight loss. The animals in the two highest dose experienced mild swelling, the 2,000 mg/kg group showed moderate swelling while the 1,500 mg/kg group had slight swelling. Clinical signs in the females were severe to mild redness, severe to slight swelling and sporadic weight loss. There were no compound related pathological observations. There was one death in the male 2,000 mg/kg group, but it was not believed to be related to the compound. The LD50 for the acute skin absorption in rabbits was greater than 2,000 mg/kg. (116)

Eye irritation studies were performed by placing 10 mg of solid test material in the conjunctival sac of each of two albino rabbits. There were no corneal or iritic effect. However, there was redness (1 hour to 1 day; not washed eyes and mild for 1 hour unwashed eyes); swelling (1 to 4 hours unwashed eyes) and no discharge was observed. Both washed and unwashed eyes were normal within 1 to 2 days. (113)

In guinea pigs, both primary skin irritation and sensitization tests were run. Ten animals per group were exposed to 0.05 ml of either a 50% or a 5% suspension of sulfometuron methyl. The 50% suspension showed mild to no skin irritation response in 24 hours and no irritation at 48 hours. The 5% suspension reproduced no skin irritation. There was no sensitization response. (114)

The oral LD50 test was conducted with the formulation using young male and female adult Crl:CD rats, five rats per group. 5,000 mg/kg was administered by gavage in a 25% suspension in corn oil. The only clinical finding was alopecia in males. Gross pathological examination showed in both males and females slightly heavy lungs that were pale to pale red with red to dark red foci and white mottling in 1 to 3 animals. The LD50 is greater than 5,000 mg/kg. Additionally in a range finding study, no mortalities were seen in doses from up to 7,500 mg/kg. (115)

Nine male albino rabbits were tested for eye irritation studies. The right eyes were treated with 0.1 ml (61.8 mg) of test material. The left eyes served as untreated controls. Results indicated a transient localized area of slight corneal cloudiness in 2 of the 6 unwashed eyes. The eyes returned to normal in 2 to 3 days. Two of the three eyes treated and washed showed a transient localized area slight corneal cloudiness and mild conjunctivitis with no iritic effects. The washed eyes returned to normal within 3 to 4 days. This compound was considered a slight to mild irritant. (117)

Skin irritation tests were conducted on six male albino rabbits. Doses of 0.5 g of solid pesticide (moistened with saline) were applied to two intact and two abraded skin areas on each rabbit. Each rabbit serves as its own control; treated areas were compared to adjacent untreated areas. Observations and scoring were done by the method of Draize (118) and at 24 and 72 hours after exposure. The compound was not found to be a primary irritant on either intact or abraded skin of rabbits. (119)

Primary skin irritation tests were performed on ten guinea pigs. The procedure was the same as used in testing the technical sulfometuron methyl. Doses of 0.05 ml of a 50% suspension of the pesticide in dimethyl phthalate were used. The 50% suspension caused mild to no irritation in five of the animals. No irritation was caused by the 5% suspension. No sensitization response was observed. (120)

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**Subchronic and Chronic Studies (Mammalian)**

Male and female CD-1 mice were fed diets to which had been added 0, 100, 1,000, or 7,500 ppm (0, 13.3, 133, or 997 mg/kg) (a) sulfometuron methyl for 90 days. Hematological evaluations were conducted on all mice (tail cut bleeding at approximately 1, 2 and 3 months after study initiation. All mice were sacrificed and necropsied at 90 days. Organs were weighed and examined histologically. Male mice fed the diet containing 7,500 ppm pesticide showed reduced mean body weights and weight gains. Growth of the 100 and 1,000 ppm groups of males and all treated females was the same as that in the control group. No mortalities occurred. (121)

Hemolytic effects were seen as a result of dietary exposure to sulfometuron methyl in all groups. Significant increases in leukocyte count were found in the 7,500 ppm (997 mg/kg) males. There were statistically significant changes in other blood parameters that were not dose related. Mean absolute and relative liver weights were elevated in all male treatment groups. Histological examination revealed bile stasis in five of ten males in the 7,500 ppm group. In the females, a slight increase in relative liver weight and increased hepatocellular cytoplasmic granularity was observed. Decreases in both mean and relative thymus weights were observed in all treated male groups. Thymic cortical atrophy occurred in three males in the 7,500 ppm group and one male in the 100 ppm group. Because of low frequency of occurrence 7,500 and 100 ppm and absence in the 1,000 ppm group, the thymic cortical atrophy is not considered to be related to the decreased thymus weights. Based on the observed hemolytic effect, there was no NOEL from this study.

In a second mouse study, five groups of 80 males and 80 female Crl:CD-1 (1 CR)BR mice were fed diets containing one of the following concentrations of sulfometuron methyl: 0, 5, 20, 100, or 1,000 ppm (0, 0.66, 2.66, 13.3, 133 mg/kg) for 18 months. Food consumption was monitored throughout the study, mice were weighed and hematological evaluations were performed at regular intervals. At 18 months, mice were sacrificed and necropsied. Mean body weights and mean body weight gains in all treatment groups except for the 1,000 ppm female group were comparable to control groups. Sporadic changes in weight gain were observed in that group.

(a) In these discussions the assumptions made for conversion of ppm (diet) to mg/kg/D were:

**SPECIES BODYWEIGHT (kg) INTAKE ((kg)**

Rat 0.35 0.020 Mouse 0.03 0.004 Dog 10 0.4

(133)

When data was presented as ppm the does was estimated in mg/kg and is presented in parenthesis.

Mild anemia was observed in the female 1,000 ppm group as evidenced by statistically significant decreases in erythrocyte count, hemoglobin concentration and hematocrit. There was also a significant increase in mean corpuscular volume and platelet count. While the hematological results appear to differ from those in the 90 day mouse study, the data indicate that there were several statistically significant changes in some blood parameters at the three month (90 day) sampling time which were not apparent at other sampling times. However, although reticulocyte smears were made, they were not evaluated and it cannot be ascertained that a response to a hemolytic effect actually occurred. If it did, a NOEL in this strain of mice for a hemolytic effect at 90 days in the 18 month study would be 5 ppm. There was a non-dose related but, statistically significant increase in the incidence of amyloidosis in the female 1,000 ppm groups, but no specific target organ was identified. The overall NOEL for dietary intake of sulfometuron methyl for male and female mice was 1,000 ppm (133 mg/kg) and 100 ppm (13.3 mg/kg) respectively

under the conditions of this study based on body weight, body weight gain, clinical pathology and pathological findings. (124)

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Groups of 16 male and 16 female CD rats were fed diets containing 0, 100, 1,000, 5,000 ppm (0, 5.7, 285 mg/kg) sulfometuron methyl. At 1, 2 and 3 months after the study initiation, hematological, urological and clinical chemistry evaluations were performed. At the end of the study, ten rats from each group were sacrificed and evaluated pathologically. There were no differences between treatments and controls in body weight, weight gain, food consumption and food efficiency. There were no mortalities. The only clinical sign observed was alopecia in three males in the 100 ppm group. The male 5,000 ppm treatment group showed slightly elevated mean leukocyte counts, increased mean relative number of lymphocytes and decreased mean relative number of neutrophils. Due to the effects of white blood cells in male 5,000 ppm group, the NOEL dietary concentration in this study was 1,000 ppm (56 mg/kg/D). (122)

Four groups of five male and five female New Zealand white rabbits were dermally exposed to either 1, 125, 500, or 2,000 mg/kg, six hours per day for 21 consecutive days. After the exposure period, three male and three female rabbits per group were sacrificed for pathological evaluation. The remaining two males and two females from each group were sacrificed and evaluated pathologically following a two week recovery period. Clinical signs observed in rabbits from all test groups including controls were sporadic weight loss and diarrhea. Histopathological and clinical pathological examination showed no compound-related effects. One rabbit died after the eighth dose from causes not related to the test substance. (123)

Groups of 80 male and 80 female CrI:CD (SD) BR rats were fed diets containing 0, 50, 500 or 5,000 ppm (0, .8, 28.5, or 285 mg/kg) sulfometuron methyl for approximately two years. Hematological, clinical chemistry and urological testing was conducted at 3, 6, 9, 12, 18, and 24 months. After 12 months, ten male and ten female rats per group were randomly selected, sacrificed and pathologically examined. At 24 months, all surviving rats were sacrificed, necropsied, and examined pathologically.

In the female 5,000 ppm group, food consumption throughout the study was slightly depressed and overall mean weight gain during the first year and mean body weights during the second year were significantly depressed. There were no abnormalities in appearance or behavior observed during the study.

Decreased erythrocyte count and hematocrit in the male 500 and 5,000 ppm groups were observed at the 24 month clinical evaluation suggesting a minimal dose-related hemolytic effect. There were no other compound related hematological, clinical chemistry or urological abnormalities observed. Mean absolute brain weights were significantly lower in the male 5,000 ppm group at both one and two sacrifice times. However, no abnormal gross or histological observations were noted. Mean relative and absolute thymus weight of the 500 and 5,000 ppm males was decreased compared to controls at terminal sacrifice. Mean testes weights of rats in the 500 and 5,000 ppm groups were less than controls.

Histological examinations revealed dose-dependent increases in the incidence of bile duct hyperplasia and fibrosis in the female 500 and 5,000 ppm groups at the two year sacrifice. Severity of the lesions were minimal to mild, suggesting a slightly toxic effect of sulfometuron methyl on the livers of these female rats.

The NOEL in this strain of rat under these study conditions was 50 ppm (2.8 mg/kg/D). (125)

### **Oncogenicity Studies**

Oncogenic endpoints were evaluated in the chronic mouse and rat studies for sulfometuron methyl. CrI: CD-1 (1 CR) BR mice received 0, 5, 20, 100, or 1,000 ppm sulfometuron in the diet for 18 months. There were no compound related increases in tumor incidence (124). CrI:CD (SD) BR rats received 0, 50, 500, or 5,000 ppm sulfometuron in the diet for two years. There was

no increase in frequency of occurrence of tumors in these rats (125). Sulfometuron methyl is not carcinogenic in rats and mice under these conditions November 26, 2003 5

#### **Mutagenicity Testing**

The Ames Salmonella/microsome assay tested the ability of Sulfometuron methyl to revert four strains of Salmonella typhimurium from histidine dependence to histidine independence. The assay was performed both with and without a rat liver homogenate (S-9) activation system. The test substance was found not to be mutagenic for these strains of bacteria under the test conditions at doses from 2.5 to 1,000 mg/plate. (129)

Frequency of chromosome aberrations was tested in CHO cells both with and without metabolic activation (S-9). The doses tested ranged from 300 ug/ml to 10 ng/ml in a half log series. No increase in chromosome aberrations was observed in culture exposed under the test conditions to these concentrations of the test material. (130)

The CHO cell line was used to test mutations in the gene coding for the enzyme hypoxanthineguanine phosphoribosyl transferase (HGPRT) both in the presence and absence of an activation (S-9) system. Concentration of the test material ranged from 0 to .1 mM. No mutagenic activity was detected. (131)

The ability of sulfometuron methyl to induce unscheduled DNA (UDS) synthesis in freshly isolated rat hepatocytes was tested. Concentrations of test material ranged for  $1 \times 10^{-5}$  to 1.0 mM in half log increments. Under these test conditions, no induction of UDS was detected. (132)

#### **Developmental Studies**

Groups of 17 female artificially inseminated rabbits were gavaged with test material on days 6 to 18 of gestation. Dosage levels were 0, 30, 100, and 300 mg/kg suspended in 0.5% methylcellulose in water. Animals were sacrificed on day 29 of gestation and fetuses were removed by cesarean section. No treatment-related effects were observed in the maternal clinical observations or gross pathology. There were no statistically significant differences between control and treatment groups in any of the other parameters measured (maternal body weight changes, clinical observations, survival, gross pathology pregnancy rates, numbers and percentages of corpora lutea, implantations, resorptions in each maternal animal, fetal sex, viability and development). Under the conditions of this study, sulfometuron methyl was not considered to be teratogenic in New Zealand white rabbits. (127)

A teratology study was conducted using female Crl:CD (SR) BR rats which were fed a diet containing sulfometuron methyl. Concentrations of 0, 50, 1,000, and 5,000 ppm were used. Thirty-five rats were used as controls, 25 rats were assigned to the 50 and 1,000 ppm group and 15 rats were assigned to the 5,000 ppm group. Rats were fed the test diet on days 6 to 15 of gestation and sacrificed on day 21 of gestation for gross and histological examination. (128)

Rats on the highest dose level gained significantly less weight and ate significantly less feed than controls. The fetuses of this exposure group weighed significantly less than those of the control dams. No other adverse effects were noted in the lower exposure groups. No teratogenicity was demonstrated in this study. The minimum effect level of maternal toxicity and embryofetal toxicity was 5,000 ppm (286 mg/kg) and the NOEL under these study conditions was 1,000 ppm (57 mg/kg). (128) Reproductive studies were performed in conjunction with the 90 day feeding study in rats and the two year feeding study in rats.

In the 90 day feeding study (122), six male and six female rats which had been fed diets obtaining 0, 100, 1,000, and 5,000 ppm of sulfometuron methyl (for 90 days) were mated and delivered litters. No adverse effects were observed as indicated by fertility, gestation, viability and lactation indices. In addition, there were no differences between treatment and controls in the mean body weights and survival of weaning pups.

In the two year feeding study (125), 20 rats per group were used in a two generation, four litter reproduction study, initiated 90 days after the start of the long-term feeding study. Fo rats were mated. Females were allowed to

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give birth and F1a pups were followed until weaning (21 days) at which time they were sacrificed. Fo females were again mated, but to different Fo males. F1b pups were delivered and observed. At weaning, 20 males and 20 females were selected from each dietary level (0, 50, 500, and 5,000 ppm) and continued on the treatment for 90 days. F1b rats were bred twice within their respective group, producing F2a and F2b litters. Ten males and ten females from the F2b litters were sacrificed and examined histologically. (125)

During the 90 day feeding period for F1b rats, body weight and diet consumption were decreased in the female 5,000 ppm group. The number of pups born and the number of pups born alive to the 5,000 ppm groups was consistently lower in both the F1 and F2 generations and was statistically significant for F2b litters. Decreased pup counts may reflect the general health status of the mother as evidenced by decreased body weight and diet consumption of the F1b 5,000 ppm group. No gross or histopathological changes or effects on organ weights were observed in the weaned F2b rats. The NOEL established, based on this sub-study was 500 ppm (28 mg/kg). (125)

#### **Avian Toxicity**

Sulfometuron methyl has been tested in the bobwhite quail and the mallard duck. The 8 day dietary LC50's were greater than 5,620 and 5,000 ppm respectively. The acute oral LD50 in the mallard duck was greater than 5,000 mg/kg. (101)

#### **Invertebrate Toxicity**

The aquatic invertebrate, *Daphnia magna* was tested and the 48 hour LOSO was greater than 12.5 ppm sulfometuron methyl. (15)

#### **Aquatic Toxicity**

Species tested on the aquatic toxicity studies include bluegill sunfish (96 hour) and rainbow trout (96 hour). In both cases the LC50 was greater than 12.5 ppm.

A life stage study was done using the fathead minnow. There were no effects observed on embryo hatch, larval survival or growth at concentrations of 1.2 mg/L or less. (15)

#### **SUMMARY**

Sulfometuron methyl is a material both moderately mobile and moderately persistent. A closer look at the material however, reveals that the Oust is applied at the average rate of five ounces of product (3.75 oz a.i./acre or 106 grams per acre. These studies were conducted with applications of 1 lb a.i./acre. The lower application rates both minimize the persistence of sulfometuron methyl in soil and thereby diminish the amount of material which is available to leach through the soil. Therefore, sulfometuron may be used if the application rates are kept sufficiently low. This is because the soil organic material and soil microorganisms are able to absorb and degrade lower rates of pesticides.

The oral LD50 in rats for sulfometuron methyl is greater than 5,000 mg/kg and the dermal LD50 is greater than 2,000 mg/kg in rabbits.

The sub-chronic and chronic NOELS are 50 ppm (2.8 mg/kg/D) in rats; 200 ppm (1 mg/kg/D) in dogs; and 5 ppm (0.66 mg/kg/D) at 90 days for the reversible hemolytic effect and 100 ppm (13.3 mg/kg/D) at two years in the mouse. This makes the mouse at 90 days the most sensitive species with a transient hemolytic effect, to sulfometuron methyl exposure.

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**HERBICIDE FACT SHEET APPROVED BT DAR**

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## METSULFURON METHYL

Common Trade Names: Escort, Escort XP (2)

Chemical Name: Methyl 2 E[C[(4-Methoxy—6-methyl-1,3,5-Triazifl—2-yl) aminolcarbonyl] amino] sulfonyl.]benzoate] (9)

CAS NO.: 74223-64-6

### GENERAL INFORMATION

Metsulfuron methyl is a sulfonyl urea herbicide initially registered by E.I. DuPont in 1986. It is a foliar herbicide registered for use on wheat and barley and non-cropland sites such as Right of Way (9).

### ENVIRONMENTAL FATE

#### Mobility

Metsulfuron methyl is a relatively new herbicide. The studies reviewed here have been provided by the registrant, EI DuPont.

The soil water partition coefficients (Kd) of Metsulfuron Methyl have been determined in four different soils: Cecil sand, Flanagan silt loam, Fallsington silt loam, and keyport silt loam. The Kd values range from 0.36 for Cecil sand to 1.40 for Flanagan silt loam, and Kom values ranged from 29 for Fallsington silt loam to 120 for Cecil sand (100). The values for Kd and Kom indicate that metsulfuron methyl is not adsorbed well to soil and that the organic content of the soil is not the only adsorption component. The silt and clay contents appear to influence adsorption, but there are probably other factors also involved.

The previous study also determined the Rf values for soil. Thin layer chromatography was performed on four soils for metsulfuron methyl. The Rf values ranged from 0.64 to 1.00; only one value was less than 0.90 (100). This result confirms the validity of the Kd values, indicating that metsulfuron methyl is mobile and that the organic matter content of the Soil is a significant component of adsorption.

Metsulfuron methyl was applied to tops of 12 inch columns [containing four different soils], and eluted with 20 inches of water in 20 hours. Following the percolation of the total volume of water, 106% of the metsulfuron methyl was eluted from the Fallsington sandy loam, 96% from the Flanagan silt loam, 81% for Keyport silt loam and 93% for Myakka sand (100). The breakthrough volumes for the Fallsington, Flangan, Keyport and Myakka soils were 6.5, 4.5, 6.9 and 5.8 inches of water respectively (101).

Metsulfuron methyl is relatively mobile in most soils, but will be retained longer in soils with higher percentages of organic matter.

#### Persistence

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There are two studies which have reviewed the persistence of metsulfuron methyl in the soil. One study was conducted in the southern United States and the second was in the northern United States and Canada. The results of the studies indicate a somewhat contradictory picture of the persistence of metsulfuron methyl.

The soil half-lives in Delaware, North Carolina, Mississippi and Florida were 1 week, 4 weeks, 3 weeks and 1 week respectively following an application in mid to late summer (102). The results are varied and indicate that either climatic or soil factors determine the persistence. The climate is sufficiently similar to be able to discount that as a factor. However, both of the locations where the shortest half-lives were observed had the highest organic matter content in the soils.

Furthermore, the half—lives correspond with the organic matter content.

The half—lives following spring applications were 4 and 56 weeks for two sites in Colorado, 6 weeks in North Dakota and 28 weeks in Idaho (103). In contrast to the southern United States study there does not appear to be any correlation with climatic or soil characteristics. There appears to be a slightly shorter half—life in acidic soils in the same location.

Metsulfuron methyl was also applied in the fall and the half-lives determined in two sites in Colorado, North Dakota and Idaho. These half—lives were 8 weeks, 12 weeks, 42 weeks and 28 weeks respectively. As was expected there were longer half—lives following fall applications in North Dakota (6 weeks vs. 42 weeks) however, in Idaho there was no change at all, which is unexpected.

In Canada following spring applications the reported half-lives were 10 weeks, 4 weeks, 4 weeks and 6 weeks for Alberta, 2 locations in Saskatchewan and Manitoba (103). One would expect longer half lives in Northern locations due to the effects of temperature on degradation rates. The results from Canada are generally shorter than those in the U.S. locations, which is unexpected. Therefore, the half-life of Metsulfuron methyl in the soil is variable and dependent on the location. It is shorter when applied in the spring but appears independent of other environmental factors in most locations.

#### TOXICITY REVIEW

##### Acute (Mammalian)

The toxicology database for Metsulfuron methyl has been reviewed and accepted by the EPA (9). DuPont supplied excerpts from their monograph on Ally herbicide (112). Summaries of studies were supplied by DuPont for subchronic, chronic and reproductive studies.

Technical metsulfuron methyl has been tested in two acute oral LD50 studies in Crl:CD Rats. In the first study the LD50 was greater than 5,000 mg/kg and in the second it was greater than 25,000 mg/kg (the maximum feasible dose) (112). Clinical signs included salivation, chromodacryorrhea, stained face, stained perineal area and weight loss (112).

In a 10—dose subacute study using male rats, a single repeated dose of 3,400 mg/kg/day for 10 days over a 2 week period was administered. This was followed by a two week recovery period. No deaths occurred and slight weight loss was the only clinical sign observed. In addition, no gross or microscopic changes were observed (112). The dermal LD50 is greater than 2,000 mg/kg in male and female rabbits (112). Technical metsulfuron methyl caused mild erythema as a 40% solution in guinea pigs. There was no reaction observed at the 4% concentration. No response occurred when treated animals were challenged (112).

In rabbits, moderate areas of slight corneal clouding and severe to moderate conjunctivitis were observed in both washed and unwashed eyes following treatment with technical metsulfuron methyl. The unwashed eyes were normal in 3 days and the washed eyes in 14 days (112).

##### Metabolism

Elimination of metsulfuron methyl in the rat is rapid, with 91% of a radioactive dose excreted over 96 hours (9). The routes of elimination were not specified within the report.

Subchronic/Chronic (Mammalian)

Ninety day feeding studies have been done with metsulfuron methyl in rats and mice. The rat study was done in conjunction with a one generation reproduction study (see Developmental Study Section). In this study rats received 0, 100, 1000, or 7500 ppm (0, 5.7, 57, 428 mg/kg/d) (a) in their diets. Effects observed at the high dose were: a decrease in body weight and an increase in total serum protein in the females, and a decrease in liver weight and a decrease in cytoplasmic clearing of hepatocytes in the males the NOEL in this study was 1000 ppm (104).

The 90 day mouse study was done in conjunction with the 18 month mouse study. Groups of 90 mice per sex per dose received 0, 5, 25, 500, 2500 or 5000 ppm (0, 0.66, 3.3, 66.6, 333.3, 666.6 mg/kg/d) in their diets. Clinical evaluations were made at 1, 2, 3, 6, 12 and 18 months. Ten animals per group were sacrificed at the 90 day time point for pathological evaluation. The 2500 ppm group was sacrificed at 12 months. Sporadic effects were observed on the body weight, food consumption, and organ weights. These were not dose related, resulting in a NOEL of 5000 ppm in diet for mice (111).

In the twenty-one day dermal rabbit study, the intact skin of male and female New Zealand White Rabbits received doses of 0, 125, 500 and 2,000 mg/kg for 6 hrs/day for 21 days. Clinical signs observed were sporadic weight loss and diarrhea in a few rabbits. These effects were not dose related. Non dose related histological effects were observed in male rabbits. This effect was characterized as mild testicular atrophy occurring sporadically at all doses (112, 108).

Feeding studies in dogs have been done with purebred beagles. The animals received metsulfuron methyl in diets at dose levels of 0, 50, 500 and 5000 ppm (0, 0.2, 2, 20 mg/kg/d) for one year. There was a decrease in food consumption in the high dose males. There was a decrease in serum lactate dehydrogenase in all groups of both sexes at two or more doses these values were within the historical controls. The NOEL was 500 ppm in the males and 5000 ppm in females (112).

In a chronic feeding study in rats, the animals received metsulfuron methyl at doses of 0, 5, 25, 500, 2500 or 5000 ppm (0, 0.28, 1.4, 28.6, 143 or 286 mg/kg/d. Interim sacrifices were done at 13 and 52 weeks (105).

At the 13 week sacrifice there was a decrease in body weight in the 2500 and 5000 ppm groups; there was a decrease in absolute liver weight at 2500 and 5000 ppm males. There was a decrease in the relative liver weights in the 2500 and 5000 ppm females.

(a) In these discussions the assumptions made for estimated conversion of ppm (diet) to mg/kg/D were:

Species Body weight (kg) Intake (kg)

Rat 0.35 0.020 Mouse 0.03 0.004 Dog 10 0.4

When data were presented as ppm, the dose was estimated in mg/kg and is presented in parenthesis.

Findings at the 52 week sacrifice included increase in kidney weight (2500 ppm males) and increased absolute brain weights (at doses of 25, 500, 2500 and 5000 ppm) in males and at doses of 2,500 and 5000 ppm in females. There was an increase in absolute heart weight at 2500 ppm in males and at 2500 and 5000 ppm in females. The absolute organ weights were back to normal at termination. Relative brain weights of the 2500 and 5000 ppm groups were increased (105)

Oncogenicity Studies

There were no gross or histopathological changes observed in mice receiving up to 5000 ppm metsulfuron methyl in their diets (112, 111). Similar results were obtained in the 104 week rat study; there were no histopathological changes observed which were attributable to metsulfuron methyl (105, 112). EPA concludes that there were no oncogenic effects in rats or mice at the highest dose tested; 5000 ppm in both cases (9).

Mutagenicity Testing

Metsulfuron methyl was negative in the unscheduled DNA synthesis assay; in vivo bone marrow

cytogenic assay in rats (doses were 500, 1,000, and 5,000 mg/kg bw); CHO/HGPRT Assay; Salmonella typhimurium reverse mutation assay four strains with and without S9 metabolic activation; and also in the *in vivo* mouse micronucleus assay at doses of 166, 500, 1666, 3000 and 5000 mg/kg (112). The only positive mutagenicity assay was in the *in vitro* assay for chromosome aberrations in Chinese Hamster Ovary at high doses (greater than 2.63 mM, 1.0 mg/mL). In this assay no increases in structural aberrations were observed at 0.13 or 1.32 mM (0.05 or 0.5 mg/mL) (112).

#### Developmental Studies

Several studies have been done to investigate the effects of Metsulfuron methyl on reproduction and development in rats and rabbits.

Pregnant Cr1: COBS CD(SD) BR rats received metsulfuron methyl at doses of 0, 40, 250 or 1000 mg/kg by the oral route on days 5 to 14 of gestation. There were 25 rats per group. Maternal toxicity was observed at doses of 250 and 1000 mg/kg/d. The maternal toxicity NOEL was 40 mg/kg/d. There was no evidence of "teratogenic" response or embryo fetal toxicity (112).

In the rabbit study, New Zealand white rabbits received 0, 25, 100, 300 or 700 mg/kg/d on days 6 to 18 gestation. There was a dose related increase in maternal deaths; 1, 2 and 12 deaths at doses of 100, 300 and 700 mg/kg respectively. The maternal toxicity NOEL was 25 mg/kg/d and there was no evidence of teratogenic or embryo lethal effects observed in this study (112).

Several multigenerational studies have been done with Metsulfuron methyl. A four litter reproduction study was done concurrently with the chronic bioassay. Rats from each treatment were separated from the main study and bred. The doses were 0, 5, 25, 500, 2500, and 5000 ppm (0, 0.28, 1.4, 28.6, 143 and 286 mg/kg/d). There was a dose dependent decrease in body weight in the parental (P1) generation at doses of 25 ppm and greater in males and females. This effect was not present in dams during gestation or lactation (106).

Overall fertility in the P1 and filial (F1) matings was low in both control and treated groups with no apparent cause. There was a decrease in pup size in the F1a but not the F1b, F2a, or F2b litters. The gestation index was 100% for all groups in both filial generations with the exception of F2a when it was 90%. On the basis of the lower body weights and lower growth rates, the NOEL was 25 ppm for this study (106).

In a 90 day, 2 generation 4 litter protocol, rats received 0, 25, 500 or 5000 ppm (0, 1.4, 28.6, 286 mg/kg/d) Metsulfuron methyl in their diets for 90 days prior to mating. In this protocol the parental generation was bred twice first to produce the F1a and then the F1b. The F1b rats were then fed the appropriate diet for 90 days (after weaning). There was a decrease in litter size in the 5000 ppm group in the F2a generation, but not in any other generation. The NOEL for this study was 500 ppm (107).

In a 90 day feeding, one generation rat study, 16 male and 16 female rats received 0, 100, 1000 or 7500 ppm in their diet prior to mating. There were no differences observed in reproduction and lactation performance or litter survival among groups. There was an overall low fertility in the control and treated groups. This result made the effects of metsulfuron methyl on fertility difficult to assess from this study (104).

#### Tolerances and Guidelines

Tolerances have been set for metsulfuron methyl in barley wheat (from 0.05 to 20 ppm, depending on the commodity) and in meat and meat byproducts (0.1 ppm). The tolerance in milk is 0.05 ppm (8, 9). The acceptable daily intake is 0.0125 mg/kg/d based on a one year dog NOEL of 1.25 mg/kg/d using a safety factor of 100 (9).

#### Avian

Metsulfuron methyl has been tested in two species of birds, the mallard duck and the bobwhite quail. The acute oral LD50 is greater than 2150 mg/kg in the duck. Two, 8 day dietary studies have been done. The 8 day LC50 is greater than 5620 ppm in both the duck and the quail (9).

#### Invertebrates

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The 48 hour LC50 for Daphnia is greater than 150 ppm and the acute toxicity in the honeybee is greater than 25 mg/bee (9).

#### Aquatic

Metsulfuron methyl has acute LC50 of greater than 150 ppm in both the rainbow trout and the bluegill sunfish (9).

#### Summary

Metsulfuron methyl has a moderate to high mobility in the soil profile and is relatively persistent in the environment, especially when applied in the fall. These factors would be of concern under most circumstances. However, metsulfuron methyl is applied at very low rates (3-4 ozs./A) and therefore the amounts which reach the soil are quite low. Consequently, Metsulfuron methyl should not impact groundwater as a result of leaching or migrate from the target area.

Metsulfuron methyl has low toxicity (EPA Toxicity Category III) for acute dermal exposure and primary eye irritation and is category IV for all other acute exposures. The chronic studies indicate no oncogenicity response and the systemic NOEL's are 500 ppm in rats and 5000 ppm in mice. There was no evidence of teratological effects in the rat or the rabbit at the highest dose tested in both species. While there was evidence of maternal toxicity at 40 mg/kg/d in the rat and 100 mg/kg/d in the rabbits.

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