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READ THE ENTIRE LABEL BEFORE USING THIS PRODUCT.

USE ONLY IN ACCORDANCE WITH INSTRUCTIONS.

KEEP OUT OF REACH OF CHILDREN

HARD TWIST 60 WP

INGREDIENTS

Metsulfuron Methyl60%
Other ingredients40%

Metsulfuron-methyl is a residual sulfonylurea compound used as a selective pre- and postemergence herbicide for broadleaf weeds and some annual grasses. It contains as its active ingredient Metsulfuron-methyl 60% WP.

The most common uses of metsulfuron-methyl include wheat, barley, rye, and pastures. It can be used with other foliar herbicides, and is typically applied on cereals at 0.004 - 0.007 pounds active ingredient/acre, and on non-crop areas at 0.005-0.160 pounds active ingredient/acre. It is commercially available in the form of dry flowable formulations.

Because it has residual activity in soils, it is necessary to allow ample time for the chemical to break down before planting certain crops (22 months for sunflowers, flax, corn, or safflower, and 10 months before planting sorghum). It should not be used on ryegrass or on pastures containing alfalfa or clovers (38).

Trade Names Of Other Firms: Trade names for products containing Metsulfuron-methyl include Ally, Allie, Gropper, and Escort.

What is HARD TWIST 60 WP and how does it work?

It is a systemic compound with foliar and soil activity, and it works rapidly after it is taken up by the plant. Its mode of action is by inhibiting cell division in the shoots and roots of the plant, and it is biologically active at low use rates.

Key Benefits of HARD TWIST 60 WP:

1. Rapid Action, Excellent Action in Warm Moist conditions.

2. Selective pre and post emergent herbicide.
3. Wider use against broad leaved weeds as well as some annual grasses.

PRECAUTIONS

Causes eye irritation. Avoid contact with skin, eyes or clothing. Avoid breathing dust or spray mist. Harmful if swallowed or absorbed through the skin. Keep out of reach of children. Wear overalls over long pants, and a long-sleeved shirt, goggles or a face shield, apron and chemical resistant gloves during mixing, loading, clean-up and repair activities. Wear pants, a long-sleeved shirt and chemical resistant gloves during application.

Users should wash hands before eating, drinking, chewing gum, using tobacco or using the toilet.

SYMPTOMS OF POISONING

Irritation on skin or eyes.

MEDICAL TREATMENT

if ingested, induce emesis or lavage stomach. Treat symptomatically.

FIRST AID

If poisoning is suspected, immediately contact a physician or a poison control centre. Take container, label or product name and Pest Control Product Registration Number with you when seeking medical attention.

If skin contacts, wash exposed areas of skin with soap and warm water. This product may produce temporary allergic side effects characterised by redness of the eyes, mild bronchial irritation and redness or rash on exposed skin areas. Persons having allergic reaction should contact a physician immediately.

If eyes contact, flush for 15-20 minutes with large amount of water and seek medical attention immediately. If inhaled, remove patient to fresh air. In all cases, notify a physician and present this label.

DIRECTIONS OF USE

HARD TWIST 60 WP is recommended for the control of annual and perennial weeds and unwanted woody plants on private, public and military lands, on rights-of-way, industrial sites, non-crop areas, ditchbanks of dry drainage ditches, certain types of unimproved turf grass, and conifer and hardwood plantations, including grazed areas on these sites. Do not use on irrigation ditches.

HARD TWIST 60 WP controls weeds and woody plants primarily by postemergent activity. Although HARD TWIST 60 WP has pre-emergence activity, best results are generally

obtained when HARD TWIST 60 WP is applied to foliage after emergence or dormancy break. Generally, for the control of annual weeds, HARD TWIST 60 WP provides the best results when applied to young, actively growing weeds. For the control of perennial weeds, applications made at the bud/bloom stage or while the target weeds are in the fall rosette stage may provide the best results. The use rate depends upon the weed species and size at the time of application.

The degree and duration of control may depend on the following:

- weed spectrum and infestation intensity
- weed size at application
- environmental conditions at and following treatment

Metsulfuron-methyl is absorbed primarily through the foliage of plants, and by the roots to a lesser degree. Plant cell division is generally inhibited in sensitive plants within a few hours following uptake. Two to 4 weeks after application, leaf growth slows followed by discoloration and tissue death.

The final effects on annual weeds are evident about 4 to 6 weeks after application. The ultimate effect on perennial weeds and woody plants occurs in the growing season following application.

Warm, moist conditions following treatment promote the activity of HARD TWIST 60 WP, while cold, dry conditions may reduce or delay activity. Weeds and brush hardened off by cold weather or drought stress may not be controlled. The use of a surfactant is recommended to enhance the control of susceptible plants, except where noted. Apply at a minimum rate (concentration) of 1/4% volume/volume (1 quart per 100 gallons of spray solution), or at the manufacturer's recommended rate. Use only EPA approved surfactants containing at least 80% active ingredient. Certain types of surfactants, such as those incorporating acetic acid (i.e. LI- 700), may not be compatible with HARD TWIST 60 WP and may result in decreased performance. Certain surfactants may not be suitable for use on desirable plants, such as turf and conifers, listed on this label. Consult the surfactant manufacturer's label for appropriate uses.

Weed and brush control may be reduced if rainfall occurs soon after application.

Application Information

HARD TWIST 60 WP is recommended for the control of many species of weeds and deciduous trees on sites where conifers are growing or are to be planted. Apply by ground equipment or by

air (helicopter only). Refer to the "Weeds Controlled" and "Brush Species Controlled" for a listing of susceptible species.

Application Timing

Apply HARD TWIST 60 WP after weeds have emerged or after undesirable hardwoods have broken winter dormancy and have reached the point of full leaf expansion.

Conifer Site Preparation --Application Before Transplanting

After consulting the "Weeds Controlled" and "Brush Species Controlled" tables, apply the rates of HARD TWIST 60 WP recommended for the most difficult to control species on the site.

Southeast—Apply up to 4 ounces per acre for loblolly and slash pines. Transplant the following planting season.

Northeast and Lake States—Apply up to 2 ounces per acre for red pine. Transplant the following planting season. Apply up to 2 ounces per acre for black, white and Norway spruce. Transplant the following spring.

West—Apply up to 2 ounces per acre prior to planting Douglas Fir, Sitka Spruce, Western Red Cedar, Western Hemlock, Ponderosa Pine, and Grand Fir in the Coast Rangeland and western slope of the Cascades in Oregon and Washington. These conifer species listed can be planted anytime after application. Other conifer species can be planted providing the user has prior experience indicating acceptable tolerance to HARD TWIST 60 WP soil residues.

AGRICULTURAL USE REQUIREMENTS

Do not enter or allow worker entry into treated areas during the restricted-entry interval (REI) of 4 hours. PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water is:

- Coveralls
- Shoes plus socks

Without prior experience, it is recommended that other species be planted on a small scale to determine selectivity before large-scale plantings are made as unacceptable injury may occur. DuPont will not assume responsibility for injury to any conifer species not listed on this label.

Tank Mix Combinations—

For broader spectrum control, the following products are recommended in combination with HARD TWIST 60 WP.

Glyphosate (4 pound active per gallon)

Tank mix 1 to 2 ounces of HARD TWIST 60 WP with 2 to 10 quarts of glyphosate per acre. Refer to the product container for a list of species controlled.

Imazapyr (4 pound active per gallon)

Tank mix 1 to 2 ounces of HARD TWIST 60 WP with 10 to 24 fluid ounces of imazapyr per acre. Loblolly and slash pines may be transplanted the planting season following application. This combination controls ash, black gum, cherry, hawthorn, honeysuckle, hophornbeam, persimmon, oaks (red, white and water), sassafras, sweetgum, Vaccinium species, and suppresses blackberry, dogwood, elms, myrtle dahoon, hickories, and red maple.

Glyphosate (4 pound active per gallon) + Imazapyr (4 pound active per gallon)

Tank mix 1/2 to 1 ounce of HARD TWIST 60 WP with 16 to 64 fluid ounces of glyphosate and 10 to 12 fluid ounces of imazapyr per acre. Slash and loblolly pines may be transplanted the planting season following application. This combination controls cherry, dogwood, elms, oaks (red and water), persimmon, sassafras, sweetgum and suppresses hickory.

Hexazinon 25%

Tank mix 1 to 2 ounces of HARD TWIST 60 WP per acre with Hexazinon 25% at the rates recommended on the container for various soil textures. Loblolly and slash pines may be transplanted the planting season following application. Refer to the product container for a list of species controlled.

SULFOMETURON METHYL 56%

Tank mix 1/2 to 1 1/2 ounces of HARD TWIST 60 WP with 2 to 3 ounces of SULFOMETURON METHYL 56% per acre for herbaceous weed control. Refer to the product container and the "Weeds Controlled" section of this label for a listing of the weeds controlled. Loblolly and slash pines may be transplanted the planting season following application. Tank mix 2 ounces of HARD TWIST 60 WP with 3 ounces of SULFOMETURON METHYL 56% per acre for herbaceous weed control and early spring suppression of bull thistle and Canada thistle in the Coast Rangeland and western slope of the Cascade Mountains. Douglas fir may be transplanted at least 90 days following application.

Release--Hardwood Control and Suppression

HARD TWIST 60 WP is recommended for application over the top of established slash and loblolly pine to control the species listed in "Weeds Controlled" and "Brush Species Controlled" section of this label. Apply 1 to 4 ounces per acre to control the species indicated,

including kudzu.

Tank Mix Combinations—

For broader spectrum control the following products are recommended in combination with HARD TWIST 60 WP.

Imazapyr (4 pound active per gallon)

Tank mix 1 to 2 ounces of HARD TWIST 60 WP with 8 to 16 fluid ounces of imazapyr per acre for application to loblolly pine. Refer to the imazapyr label regarding the use of surfactants and the appropriate application timing with respect to the age and development stage of the pines. This combination controls ash, black gum, cherry, hawthorn, honeysuckle, hophornbeam, oaks (red, white and water), sassafras, sweetgum, Vaccinium species, and suppresses blackberry, dogwood, elms, myrtle dahoon, hickories, persimmon, and red maple.

Hexazinon 25%

Tank mix 1 to 2 ounces of HARD TWIST 60 WP with Hexazinon 25% at the rates recommended on the container for various soil textures. This combination may be applied to loblolly and slash pines.

Release--Herbaceous Weed Control

HARD TWIST 60 WP may be applied to transplanted loblolly and slash pine for the control of herbaceous competition. Consult the "Weeds Controlled" for a listing of the susceptible species and recommended application rates. Best results are obtained when HARD TWIST 60 WP is applied just before weed emergence until shortly after weed emergence.

Tank Mix Combinations—

For broader spectrum control the following products are recommended in combination with HARD TWIST 60 WP.

Imazapyr (4 pound active per gallon)

Tank mix 1/2 to 1 ounce of HARD TWIST 60 WP with 4 fluid ounces of imazapyr per acre. The tank mix may be used on loblolly pine.

Hexazinon 25%

Tank mix 1/2 to 1 ounce of HARD TWIST 60 WP with Hexazinon 25% at the rates recommended on the container for various soil textures. This combination may be applied to loblolly and slash pines.

Release - Directed Spray in Conifers Western US

To release conifers from competing brush species, such as, blackberry, salmonberry, snowberry, thimbleberry and wild roses, mix 2 to 4 ounces of HARD TWIST 60 WP per 100 gallons of spray solution. Direct spray onto the

foliage of competing brush species using a knapsack or backpack sprayer. For best results, apply any time after the brush species have reached full leaf stage but before autumn coloration. At application, the majority of the brush species should be less than six feet in height to help ensure adequate spray coverage. Thorough coverage of the target foliage is necessary to optimize results. Care should be taken to the HARD TWIST 60 WP spray solution away from the conifer foliage.

NOTE:

HARD TWIST 60 WP may cause temporary yellowing and or growth suppression when the spray solution contacts conifer foliage. The use of a surfactant with HARD TWIST 60 WP may improve brush control results. When using a surfactant with HARD TWIST 60 WP, extra precaution must be taken to avoid contact with conifer foliage. Excessive drift onto conifers may result in severe injury.

IMPORTANT PRECAUTIONS - CONIFER PLANTATIONS ONLY

- Applications of HARD TWIST 60 WP made to conifers that are suffering from loss of vigor caused by insects, diseases, drought, winter damage, animal damage, excessive soil moisture, planting shock, or other stresses may injure or kill the trees.
- Applications of HARD TWIST 60 WP made for herbaceous release should only be made after adequate rainfall has closed the planting slit and settled the soil around the roots following transplanting.
- Do not apply HARD TWIST 60 WP to conifers grown as ornamentals.
- HARD TWIST 60 WP applications may result in damage and mortality to other species of conifers when they are present on sites with those listed in the preceding recommendations for conifer plantations.

HARDWOOD PLANTATIONS

Application Information

HARD TWIST 60 WP is recommended at rates of up to 2 ounces per acre for the control of many weed species on sites where yellow poplar is growing or is to be planted, and on sites where red alder is to be planted. Apply by ground equipment or by air (helicopter only). Refer to the "Weeds Controlled" sections of this label for a listing of susceptible species.

Application Timing

HARD TWIST 60 WP may be applied as a site preparation treatment prior to planting red alder or yellow poplar. As a prior to planting site

preparation treatment for red alder, HARD TWIST 60 WP may be tank mixed with other herbicides labeled for this use. HARD TWIST 60 WP may also be applied over-the-top of planted yellow poplar seedlings after the soil has settled around the root system, but before the seedlings have broken dormancy (prior to bud break).

Release--Herbaceous Weed Control

HARD TWIST 60 WP may be applied to yellow poplar for the control of herbaceous competition. Consult the "Weeds Controlled" for a listing of the susceptible species and recommended application rates. Best results are obtained when HARD TWIST 60 WP is applied just before weed emergence until shortly after weed emergence.

Tank Mix Combinations—

Tank mix 1/2 ounce of HARD TWIST 60 WP with 4 to 6 pints of Hexazinon 25% as recommended for "RELEASE--HERBACEOUS WEED CONTROL" in pine plantations in the eastern U.S. Follow the Hexazinon 25% label recommendations regarding altering the application rate by soil texture.

IMPORTANT PRECAUTIONS - HARDWOOD PLANTATIONS ONLY

- Application of Hexazinon 25% and HARD TWIST 60 WP made to yellow poplar that are suffering from loss of vigor caused by insects, disease, drought, winter damage, animal damage, excessive soil moisture, planting shock or other stresses may injure or kill the seedlings.
- Applications of HARD TWIST 60 WP made for release should only be made after adequate rainfall has closed the planting slit and settled the soil around the roots following transplanting.
- The use of surfactant is not recommended for applications made over the tops of trees.
- Careful consideration must be given by an experienced and knowledgeable forester to match the requirements of yellow poplar and/or red alder to the conditions of the site. Treatment of yellow poplar and/or red alder planted on a site inadequate to meet its requirements may injure or kill the seedlings.

NON-AGRICULTURAL USES

NON-CROP SITES

Application Information

HARD TWIST 60 WP is recommended for general weed control on private, public and military lands as follows: Uncultivated nonagricultural areas (such as airports, highway, railroad and utility rights-of-way, sewage disposal

areas, etc.); uncultivated agricultural areas - non-crop producing (such as farmyards, fuel storage areas, fence rows, soil bank land, barrier strips, etc.); industrial sites - outdoor (such as lumberyards, pipeline and tank farms, etc.) including grazed areas on these sites. It is also recommended for the control of certain noxious and troublesome weeds. Consult the "Weeds Controlled" and "Brush Species Controlled" tables to determine the appropriate application rate. HARD TWIST 60 WP may be applied in tank mixture with other herbicides labeled for use on non-crop sites. Fully read the labels and follow all directions and restrictions on each label. Applications may be made by ground or air. Use a sufficient volume of water to ensure thorough coverage of the target vegetation with the application equipment being used.

NATIVE GRASSES

HARD TWIST 60 WP is recommended for weed control and suppression in the establishment and maintenance of native grasses. It may be used where blue grama, bluestems (big, little, plains, sand, ww spar) bromegrasses (meadow), buffalograss, green sprangletop, indiagrass, kleingrass, lovegrasses (atherstone, sand, weeping, wilman), orchardgrass, sideoats grama, switchgrass (blackwell), wheatgrass (bluebunch, intermediate, pubescent Siberian, slender, streamband, tall, thickspike, western), and Russian wildrye are established. It may also be applied over these species in the seedling stage, except for orchardgrass and Russian wildrye.

Application Information

Apply HARD TWIST 60 WP at the rate of 1/10 ounce per acre for the control and suppression* of bur buttercup (testiculate), common purslane, common sunflower*, cutleaf eveningprimrose*, flixweed*, lambsquarters* (common and slimleaf), marehail*, pigweed (redroot and tumble), snow speedwell, tansymustard* and tumble mustard (Jim Hill mustard).

* Suppression is a visual reduction in weed competition (reduced population or vigor) as compared to untreated areas. Degree of suppression will vary with the size of weed and environmental conditions following treatment.

Application Timing

For established grasses, apply when weeds are in the seedling stage.
For grasses in the seedling stage, apply preplant or preemergence where the soil (seed bed) has been cultivated.

IMPORTANT PRECAUTIONS - NATIVE GRASSES

- Grass species or varieties may differ in their response to various herbicides. If no information is available, limit the

initial use of HARD TWIST 60 WP to a small area. Components in a grass seed mixture will vary in tolerance to HARD TWIST 60 WP, so the final stand may not reflect the seed ratio.

- Under certain conditions such as heavy rainfall, high pH, prolonged cold weather, or wide fluctuations in day/night temperatures prior to or soon after HARD TWIST 60 WP application, temporary discoloration and/or grass injury may occur.
- HARD TWIST 60 WP should not be applied to grass that is stressed by severe weather conditions, drought, low fertility, water-saturated soils, disease, or insect damage as grass injury may result. Severe winter stress, drought, disease, or insect damage before or following application also may result in grass injury.

ADDITIONAL GRASS INFORMATION APPLICATION INFORMATION FOR GRASS ESTABLISHMENT

HARD TWIST 60 WP is recommended for the control or suppression of broadleaf weeds to aid in the establishment of the following perennial native or improved grasses:

Blue Grama	Sideoats grama
Bluestems	Switchgrass
Buffalograss	Wheatgrasses
Green sprangletop	Siberian
Kleingrass	Wildrye grass
Lovegrasses	Russian
Orchardgrass	

Maximize potential for grass establishment by consulting with the Natural Resource and Conservation Service of other government agencies or local experts concerning planting techniques and other cultural practices. Performance from HARD TWIST 60 WP may not always be satisfactory due to the inability of newly planted grass stands to sufficiently compete with weeds, and the severity of weed pressure in new grass stands. An additional herbicide application or mowing may be needed.

Use Rates and Application Timing for Grass Establishment Preplant (prior to planting) or Preemergence (after planting but before grass emergence)

Do not use more than 1/10 ounce per acre of HARD TWIST 60 WP for grass establishment. Apply HARD TWIST 60 WP at 1/10 ounce per acre on all labeled grasses except orchardgrass and Russian wildrye grass. Do not apply HARD TWIST 60 WP preplant or preemergence to

orchardgrass and Russian wildrye grass as severe crop injury may result.

Early postemergence to new plantings

Apply HARD TWIST 60 WP at 1/10 ounce per acre, plus a nonionic surfactant at the rate of 2 to 4 pints per 100 gallons of spray solution on all labeled grasses anytime after grass emergence. Do not use a spray adjuvant other than non-ionic surfactant.

Because grass species differ in time of emergence, apply only after the majority of grasses are in the 3 to 4 leaf stage.

Postemergence to stands with 1 – 5 leaf grasses planted the previous season

Apply HARD TWIST 60 WP at 1/10 ounce per acre plus a nonionic surfactant at the rate of 2 to 4 pints per 100 gallons of spray solution, on all labeled grasses when the majority of the grasses have one or more leaves.

Do not use a spray adjuvant other than non-ionic surfactant.

Crop/grass species	Maximum rate (oz per A)	Minimum rotation interval (months)
Alfalfa, red clover, white clover, sweet clover, bermudagrass, bluegrass, ryegrass, tall fescue	1/10 – 3/10	4
Wheat (except durum)	1/10 – 3/10	1
Durum, barley, oat	1/10 – 3/10	10
Russian wildrye	1/10 - 1/2	1
Green needlegrass, switchgrass, sheep fescue	1/10 - 1	1
Meadow brome, smooth brome, alta fescue, red fescue, meadow foxtail, orchardgrass, timothy	1/10 - 1	2

Rate (oz per acre)	Weeds controlled
1/3 to 1/2	Annual sowthistle Goldenrod Aster Lambsquarters Bahagrass Marestail/horseweed**** Beebalm Maximillion sunflower Bittercress Miners lettuce Bitter sneezeweed Pennsylvania smartweed Blackeyed-susan Plains coreopsis

	Blue mustard Plantain Bur buttercup Redroot pigweed Chicory Redstem filaree Clover Rough fleabane Cocklebur Shepherd's purse Common chickweed Silky crazyweed (locoweed) Common groundsel Smallseed falseflax Common purslane Smooth pigweed Common yarrow Sweet clover Conical catchfly Tansymustard Corn cockle Treacle mustard Cow cockle Tumble mustard Crown vetch Wild carrot Dandelion Wild garlic Dogfennel Wild lettuce False chamomile Wild mustard Fiddleneck tarweed Wooly croton Field pennycress Wood sorrel Flixweed Yankeweed
1/2 to 1	Blackberry Honeysuckle Black henbane Multiflora rose and other Broom snakeweed* wild roses Buckhorn plantain Musk thistle*** Bull thistle Oxeye daisy Common crupina Plumeless thistle Common sunflower Prostrate knotweed Curly dock Rosering gaillardia Dewberry Seaside arrowgrass Dyer's woad Sericea lespedeza Garlic mustard Tansy ragwort Gorse Teasel Halogeton Wild caraway Henbit
1 to 2	Common mullein Purple loosestrife Common tansy Purple scabious Field bindweed** Scotch thistle

	Greasewood Scouringrush Gumweed Salsify Houndstongue Snowberry Lupine St. Johnswort Old world climbing fern Sulphur cinquefoil (Lygodium) Western salsify Perennial pepperweed Whitetop (hoary cress) Poison hemlock Wild Iris
1 ½ to 2	Canada thistle** Tall larkspur Dalmation toadflax** Wild parsnip Duncecap larkspur Yellow toadflax** Russian knapweed**
3 to 4	Kudzu

* Apply fall through spring.

** Suppression, which is a visual reduction in weed competition (reduced population or vigor) as compared to untreated areas. Apply as a full coverage spray for best performance.

*** Certain biotypes of musk thistle are more sensitive to HARD TWIST 60 WP and may be controlled with rates of 1/4 to ½ ounce per acre. Treatments of HARD TWIST 60 WP may be applied from rosette through bloom stages of development.

**** Certain biotypes of maretail/horsetail are less sensitive to HARD TWIST 60 WP and may be controlled by tank mixes with herbicides with a different mode of action.

DISPOSAL METHODS

Do not contaminate water, food or feed by storage or disposal. If recycling, replace cap and return clean containers to recycler or designated collection point. If not recycling, completely empty bag into application equipment. Dispose of empty bag and box in a sanitary landfill or by incineration, or if allowed by state or local authorities, by burning. Stay out of smoke from burning containers.

STORAGE CONDITION

Store in the closed, original container in a cool, well-ventilated area. Do not store for prolonged periods in direct sunlight. Store in a locked room or place away from children, animals, flood, feedstuffs, seed and fertilizers. Triple or

preferably pressure rinse containers before disposal. Add rinsing to spray tank.

For More Details including effects on environment email contact@ivorychem.com with Subject "HARD TWIST 60 WP DETAILS"

More Details:

TOXICOLOGICAL EFFECTS

- **Acute Toxicity:** This chemical has very low toxicity in mammals. Based on laboratory tests, the oral dose of metsulfuron-methyl that causes mortality in half of the test animals (LD50) is > 5,000 mg/kg in rats. It has low dermal toxicity in tests with rabbits, with an LD50 > 2,000 mg/kg, and low inhalation toxicity in rats, with a median lethal concentration in air of greater than 5 mg/liter air. Moderate but reversible eye irritation has been seen in rabbits, and mild skin irritation has been observed in guinea pigs. No skin sensitization has been observed in guinea pigs (7).
- **Signs and Symptoms of Poisoning:** Systemic poisoning by sulfonylurea based compounds is unlikely, unless large quantities have been ingested. No accounts of poisoning by metsulfuron-methyl are currently available. (39).
- **Chronic Toxicity:** A 2-year feeding study in rats resulted in a No Observable Effects Level (NOEL) of 25.0 mg/kg/day (or 500 ppm in feed), based on decreased body weights seen at 250 mg/kg/day (5,000 ppm) which was the highest dose tested. EPA has based its reference dose (0.25 mg/kg/day) on this study (31).
- **Reproductive Effects:** Multigeneration studies in rats did not result in any reproductive effects at the highest doses tested of 250 mg/kg/day (31).
- **Teratogenic Effects:** Metsulfuron-methyl did not cause developmental abnormalities to offspring of rats and rabbits fed 1000 mg/kg/day and 700 mg/kg/day respectively during gestation. These doses represent the highest dose tested for each experiment (31).
- **Mutagenic Effects:** The weight of evidence presented by a battery of tests to measure mutagenicity and other adverse effects on DNA indicates that metsulfuron-methyl is neither mutagenic nor genotoxic (40).
- **Carcinogenic Effects:** Negative for rats and mice in laboratory tests, but studies

may not have been at maximum tolerated dose (40).

- **Organ Toxicity:** Metsulfuron-methyl is a moderate eye irritant (40).
- **Fate in Humans and Other Animals:** The chemical is broken down quickly and eliminated from the body. In tests with radiolabeled metsulfuron-methyl in rats, the excretion half-lives ranged from 9 to 16 hours and 23 to 29 hours for rats administered low and high doses, respectively. It did not bioaccumulate in fish (40).

ECOLOGICAL EFFECTS

- **Effects on Birds:** Metsulfuron-methyl has very low avian toxicity. The oral LD50 value for mallard ducks is greater than 2510 mg/kg, and dietary LC50 values for mallard ducks and bobwhite quail are greater than 5620 ppm (40).
- **Effects on Aquatic Organisms:** The chemical has very low toxicity to aquatic organisms. 96-hour LC50 values are greater than 150 mg/l in rainbow trout and bluegill. Forty-eight hour toxicity tests with the freshwater invertebrate *Daphnia magna* resulted in a LC50 of greater than 150 mg/l (40). A 21-day life-cycle test with *Daphnia magna* also exhibited very low toxicity. The NOEL for survival and reproduction was >150 mg/l.
- **Effects on Other Animals (Nontarget species):** Metsulfuron-methyl has low acute toxicity to honey bees with a topical LD50 of greater than 25 ug/bee (40). The LC50 for earthworms is greater than 1,000 mg/kg soil.

ENVIRONMENTAL FATE

- **Breakdown of Chemical in Soil and Groundwater:** The breakdown of metsulfuron-methyl in soils is largely dependant on soil temperature, moisture content, and pH. The chemical will degrade faster under acidic conditions, and in soils with higher moisture content and higher temperature (41). The chemical has a higher mobility potential in alkaline soils than in acidic soils, as it is more soluble under alkaline conditions. Metsulfuron-methyl is stable to photolysis, but will break down in ultraviolet light. Half-life estimates for metsulfuron-methyl in soil are wide ranging from 14 - 180 days, with an overall average of reported values of 30 days (42). Reported half-life values (in

days) for soil include: clay - 178 (41); sandy loam - 102 (41); clay loam - 70 (41), 14-28 (42), 14-105 (42); silty loam - 120-180 (43).

- **Breakdown of Chemical in Surface Water:** The dissipation time for metsulfuron-methyl was investigated in a mixed wood/boreal forest lake. The DT50 or length of time required for half of the material to dissipate in water was >84 days when high concentrations of metsulfuron-methyl were applied, and 29.1 days at concentrations that might be expected if the chemical is applied for forestry uses (43). The chemical is stable to hydrolysis at neutral and alkaline pHs, and has a half-life of 3 weeks at pH 5.0, 25 degrees C and >30 days at 15 degrees C (44).
- **Breakdown of Chemical in Vegetation:** Metsulfuron-methyl is rapidly taken up by plants at the roots and on foliage. The chemical is translocated throughout the plant, but is not persistent. It is broken down to non-herbicidal products in tolerant plants (40).
- **Analytical Methods:** Methods for the detection of metsulfuron-methyl exist for soil and water. Liquid chromatography/mass spectroscopy and bioassay methods are used for soils, and gas chromatography/electron capture detection is used for measuring trace levels of the chemical in water (45).

PHYSICAL PROPERTIES AND GUIDELINES

Physical Properties:

- **Appearance:** faint, sweet ester-like white to pale yellow solid
- **Chemical Name:** Methyl 2-[[[(4-methoxy-6-methyl-1,3,5-triazin-2-yl)amino]carbonyl]amino]sulfonyl]benzoate (CA) Methyl 2-[3-(4-methoxy-6-methyl-1,3,5-triazin-2-yl)ureidosulphonyl]benzoate (IUPAC)
- **CAS Number:** 74223-64-6
- **Molecular Weight:** 381.4
- **Water Solubility:** Water @ 25 degrees C, pH 4.6 270 mg/l; Water @ 25 degrees C, pH 5.4 1,750 mg/l; Water @ 25 degrees C, pH 7.0 2,790 mg/l; Water @ 25 degrees C, pH 9.0 213,000 mg/l
- **Solubility in Other Solvents:** Acetone @ 20 degrees C 36,000 mg/l; n-Hexane @ 20 degrees C 0.79 mg/l; Methanol @

- 20 degrees C 7,300 mg/l; Methylene chloride @ 20 degrees C 121,000 mg/l;
- **Melting Point:** 158 degrees C
 - **Vapor Pressure:** 2.5 X 10 to the minus 12 mm Hg @ 25 degrees C
 - **Partition Coefficient:** Not Available
 - **Adsorption Coefficient:** Not Available

Exposure Guidelines:

- **ADI:** Not Available
- **MCL:** Not Available
- **RFD:** 0.25 mg/kg/day
- **PEL:** Not Available
- **HA:** Not Available
- **TLV:** Not Available

REGULATORY STATUS: Metsulfuron-methyl is classified by EPA in acute Toxicity Category III, and must bear the signal word "Caution" on commercial products (37). There are tolerances for residues of metsulfuron-methyl in or on raw commodities ranging from 0.05 ppm for sugar cane and milk, to 20.0 ppm for barley hay.



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