

DuPont™ Lineage™ ClearStand™

herbicide

Technical Bulletin



IDENTITY OF ACTIVE INGREDIENTS

Chemical Names

- (a) 2-(4-methoxy-6-methyl-1,3,5-triazin-2-ylcarbamoylsulfamoyl) benzoic acid
- (b) 2-(4-isopropyl-4-methyl-5-oxo-2-imidazolin-2-yl)-nicotinic acid

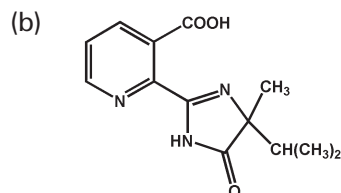
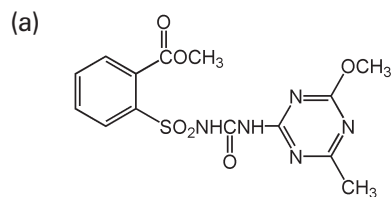
Common Names

- (a) Metsulfuron methyl
- (b) Imazapyr

Chemical Families

- (a) Sulfonylurea
- (b) Imidazolinone

Chemical Structure



CAS Registry Number

- (a) 74223-64-6
- (b) 813434-34-1

Molecular Weight

- (a) 381.36
- (b) 261.28

Empirical Formula

- (a) C₁₄H₁₅N₅O₆S
- (b) C₁₃H₁₅N₃O₃

PHYSICAL AND CHEMICAL PROPERTIES OF THE TECHNICAL INGREDIENT

State

- (a) Solid
- (b) Powder

Color

- (a) White to pale yellow
- (b) Off-white to tan

Odor

- (a) Faint, sweet ester-like odor
- (b) Slight odor

Melting Point

- (a) 158°C
- (b) 169 - 173°C

Density

- (a) 1.74 g/mL at 25°C
- (b) 0.34 g/ml

Solubility in Water at 25°C

- (a) 548 mg/L at pH 5; 2790 mg/L at pH 7; 213,000 mg/L at pH 9
- (b) 11,272 mg/L at pH 7

Octanol/Water Partition Coefficient (K_{ow})

- (a) 1 at pH 5; 0.018 at pH 7
- (b) 1.3

Vapor Pressure

- (a) 3.3 x 10⁻¹⁰ Pa; Henry's Law constant is 2.3 x 10⁻¹⁵ atm-m³/mole
- (b) <0.013 mPa (< 10⁻⁷ mm Hg) at 45°C

Oxidizing/Reducing Activity (a,b)

Not available

Flammability (a,b)

Technical and formulated products are dry and noncombustible.

Explosibility (a,b)

Not an explosion hazard

Storage Stability (a,b)

Stable at normal temperatures and storage conditions

BIOLOGICAL ACTIVITY AND USE

Conifer Plantations

DuPont™ Lineage™ ClearStand™ herbicide is a water soluble granule to be mixed with water and generally applied as a postemergent spray for the control of many broadleaf weeds, annual and perennial grasses, brush, vines and brambles in conifer plantations (site preparation and release) and wildlife management areas. For perennial species listed on the label, a postemergence application should be used. For best performance, an adjuvant should be added to the spray solution.

Lineage™ ClearStand™ may be applied by ground spray equipment (boom sprayers, backpack sprayers, tree injection etc.) and by aerial spray equipment. Fixed-wing aircraft and helicopters can be used to



apply Lineage™ ClearStand™; however, do not make applications by fixed-wing aircraft unless appropriate buffer zones can be maintained to prevent spray drift out of the target area or, when treating open tracts of land, spray drift as a result of fixed-wing aircraft application can be tolerated.

Wildlife Habitat Management

Lineage™ ClearStand™ herbicide may be used to control exotic and other undesirable vegetation for purposes of wildlife habitat management and enhancement within forests as well as terrestrial non-crop sites. Applications can be made to control undesirable vegetation prior to planting desirable vegetation species. Spot, directed foliar and cut stump and stem treatments can be made to selectively control unwanted plants for wildlife habitat management and enhancement.

Rangeland and Pasture

Lineage™ ClearStand™ herbicide may be used as a spot treatment for weed control in rangelands and grass pastures. Apply with ground equipment at the rate of 0.8 to 10 ounces per acre. Do not treat more than one tenth of the area to be cut for hay or grazed. Do not apply more than 10 ounces per acre per year. Do not cut forage grass until 7 days after a Lineage™ ClearStand™ application. There are no restrictions for grazing.

Non-Crop Uses

Lineage™ ClearStand™ herbicide is to be mixed with water and a surfactant, unless otherwise directed, and applied as a spray for the control of undesirable vegetation in terrestrial non-crop sites and unimproved turf.

Lineage™ ClearStand™ herbicide is to be applied as a spray solution for general weed and brush 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, nonirrigation ditch banks, barrier strips etc.); industrial sites — outdoor (such as lumberyards, pipeline and tank farms etc.).

This product may be applied to terrestrial non-crop sites and unimproved turf sites that contain areas of temporary surface water caused by collection of water, in equipment ruts or in other depressions created by management activities. It is permissible to treat intermittently flooded low-lying sites, seasonally dry flood plains and transitional areas between upland and lowland sites when no water is present. It also is permissible to treat marshes, swamps and bogs after water has receded, as well as seasonally dry flood deltas. It also may be used to control weeds along the banks of drainage canals or ditches. Only treat up to the outer edge of a drainage ditch or canal when it contains water. Do not apply on irrigation canals or ditches. Do not apply on dry irrigation canals or dry irrigation ditches.

Mode of Action

(a) Metsulfuron methyl and (b) imazapyr inhibit acetolactate synthase (ALS), also called acetohydroxyacid synthase (AHAS), a key enzyme needed in the biosynthesis of the branched amino acids isoleucine, leucine and valine in plants. Animals do not possess this enzyme to synthesize proteins.

Use Rate and Biological Activity

Lineage™ ClearStand™ is to be applied at use rates of 5.3 to 12 ounces of product per acre. When applied as a spray, Lineage™ ClearStand™ is absorbed by both roots and foliage of plants, rapidly inhibiting the growth of susceptible weeds. Warm, moist conditions following application accelerate the herbicidal activity of Lineage™ ClearStand™; cold, dry conditions delay the herbicidal activity. Weeds hardened off by drought or other plant stresses are less susceptible to Lineage™ ClearStand™.

Low rates of Lineage™ ClearStand™ can kill or severely injure most crops. Following a Lineage™ ClearStand™ application, the use of the spray equipment to apply other pesticides on crops for which Lineage™ ClearStand™ or its active ingredients are not registered may result in crop damage. The most effective way to reduce crop damage potential is to use dedicated mixing and application equipment.

Weeds Controlled

Lineage™ ClearStand™ controls many grasses and broadleaf weeds, including bahiagrass, Johnsongrass, ryegrass, Japanese stiltgrass, panicums, dandelion, goldenrod, pigweeds, sowthistle, vetch, blackberry, halogeton, field bindweed, multiflora rose and thistle species (refer to product label for a complete weed list).

The degree and duration of control may depend on the weed spectrum and infestation intensity, weed size at application, soil type, organic matter content and environmental conditions at and following application.

Uptake, Absorption and Translocation Characteristics

DuPont™ Lineage™ ClearStand™ is absorbed primarily through the foliage of plants, and by the roots to a lesser degree. Lineage™ ClearStand™ translocates extensively in the xylem following root absorption. Plant cell division is generally inhibited in sensitive plants within a few hours following uptake. 2 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 Lineage™ ClearStand™, while cold, dry conditions may reduce or delay activity. Weeds and brush hardened off by cold weather or drought stress may not be controlled. Lineage™ ClearStand™ is rainfast at one hour after application.

Soil Activity and Degradation

(a) Microbial degradation is slow. Non-microbial hydrolysis is slow at high pH, but relatively rapid at lower pH. Hydrolysis cleaves the sulfonamide bridge. Overall half-life varies from 1 week to 1 month, depending primarily on soil pH. Considered to be moderate residual with a typical half-life of 30 days, but ranging from 1 to 6 weeks. Degradation rate increases with higher temperatures and high soil moisture levels.

(b) Generally weakly bound to soil, but adsorption increases as organic matter (OM) and clay increase.

Decreasing pH below 6.5 increases adsorption, although pH increases above 6.5 have little effect. Adsorption increases with time and as soil dries. Sorption is reversible.

Plant Selectivity, Sensitivity and Residues

Lineage™ ClearStand™ herbicide is registered for use in non-crop situations only and care should be exercised when it is used in the vicinity of crop plants. Exposure to Lineage™ ClearStand™ may injure or kill most crops.

Metabolism in Plants

Plant species vary widely in their ability to metabolize (a) sulfonamide and (b) imidazolinone products. The ability to metabolize or detoxify these products is the basis for the selectivity shown by tolerant versus susceptible plant species. Tolerant plants convert or break down metsulfuron methyl to herbicidally inactive products much faster than do sensitive plants.

FATE AND BEHAVIOR IN THE ENVIRONMENT

(a) Metsulfuron methyl degrades at a moderate rate in soil, having half-lives in soil ranging from 9 to 43 days under laboratory conditions, with an average half-life of 23 days (13 soils). Half-lives in soil under field conditions ranged from 7 to 211 days, with an average half-life of 51 days (17 soils). The longer field half-lives can be attributed to fall applications for some of the field studies. Metsulfuron methyl degrades slowly in aquatic systems, having half-lives which ranged from 53 to 279 days in two water sediment systems. Metsulfuron methyl is stable to photolysis.

(b) Field half-lives for imazapyr range from 25 to 142 days depending on soil type and environmental conditions. Half-life in water is 1 to 2 days when exposed to a xenon arc lamp. Half-life in shallow ponds ranged from 2 to 3 days. Photolysis on the soil surface is limited and is a minor contributor to degradation in soil. Microbial degradation is the principal means of dissipation in soil. Anaerobic microbial degradation occurs at much slower rates.

Toxicity and Metabolism in Animals

(a) Metsulfuron methyl and (b) imazapyr have low toxicity to mammals, birds and insects. They do not bioaccumulate in warm- or cold-blooded animals. Both (a) metsulfuron methyl and (b) imazapyr are rapidly absorbed and eliminated by mammalian systems.

RESIDUES IN FOOD — Not Applicable

Lineage™ ClearStand™ is not labeled for use on food crops.

TOXICITY OF TECHNICAL ACTIVE INGREDIENT

Acute Toxicity		
	Metsulfuron methyl	Imazapyr
Acute oral toxicity — LD ₅₀ rat	>5000 mg/kg	>5000 mg/kg
Acute dermal toxicity — LD ₅₀ rabbit	>2000 mg/kg	>2000 mg/kg
Acute inhalation toxicity — LC ₅₀ rat	>5.3 mg/L/4-h	>1.3 mg/L/4-h
Skin irritation — rabbit	Not irritating	Not irritating
Eye irritation — rabbit	Moderately irritating	Irreversible
Skin sensitization — guinea pig	Not sensitizing	Not sensitizing

Subchronic Toxicity		
	Metsulfuron methyl	Imazapyr
90-day dietary — mouse	NOAEL: 814 mg/kg bw/d; highest dose tested (HDT)	NA
90-day dietary — rat	NOAEL: 68 mg/kg bw/d; based on body weight changes at higher doses	NOAEL: 1695 mg/kg bw/d
90-day dietary — dog	NOAEL: 129 mg/kg bw/d; (HDT)	NOAEL: 250 mg/kg bw/d
Repeated dose dermal toxicity — rat, rabbit, guinea pig	NOAEL: 125 mg/kg bw/d for local effects, based on dermal irritation at higher doses; NOAEL: 2000 mg/kg bw/d for systemic effects, (HDT)	NOAEL: 400 mg/kg bw/d

Chronic Toxicity		
	Metsulfuron methyl	Imazapyr
18 month dietary — mouse	NOAEL: 666 mg/kg bw/d, (HDT); Not oncogenic	NOAEL: 1500 mg/kg bw/d; Not oncogenic
24 month dietary — rat	NOAEL: 22/30 mg/kg bw/d males/ females, based on mild body weight effects at higher doses; Not carcinogenic up to the highest dose tested 226/300 mg/kg bw/d in males/females	NOAEL: 500 mg/kg bw/d; Not oncogenic
12 month dietary — dog	NOAEL: 125 mg/kg bw/d, (HDT)	NOAEL: 250 mg/kg bw/d

Teratogenicity		
	Metsulfuron methyl	Imazapyr
Rat	NOAEL maternal: 250 mg/kg/d, severe body weight changes and salivation at 1000 mg/kg/d; NOAEL developmental: 1000 mg/kg bw, (HDT); Not teratogenic or embryotoxic	NOAEL maternal: 300 mg/kg /d, NOAEL fetal: 1000 mg/kg bw/d; Not teratogenic
Rabbit	NOAEL maternal: 25 mg/kg/d, mortality and decreased body weight gain at > 100 mg/kg/d; NOAEL developmental: > 700 mg/kg bw/d (HDT); Not teratogenic or embryotoxic	NOAEL: 400 mg/kg bw/d; Not teratogenic

Multigeneration Reproductive Toxicity: RAT		
	Metsulfuron methyl	Imazapyr
Reproductive Toxicity	NOAEL: 5000 ppm (342 - 386 mg/kg in males, 406 - 474 in females); HDT	NOAEL: 10000 ppm 738 & 933 mg/kg bw/day
Paternal/Systemic	NOAEL: 500 ppm (34 and 35 mg/kg bw F0 and F1 males; 39 and 43 mg/kg bw F0 and F1B females); based on body weight effects at 5000 ppm	NOAEL: 500 ppm
Offspring	NOAEL: 5000 ppm (342 - 474 mg/kg bw); HDT	NA

Genotoxicity		
	Metsulfuron methyl	Imazapyr
Gene mutation bacterial: <i>Ames test</i>	Negative	Negative; E. coli, negative
Gene mutation mammalian cell culture: <i>CHO HPRT</i>	Negative	Negative
Structural chromosome aberration: <i>In vitro</i> cytogenetics — CHO <i>In vivo</i> rat chromosome aberration <i>In vivo</i> mouse micronucleus	Positive Negative Negative	Negative
DNA damage/repair: Primary rat hepatocytes/UDS	Negative	Negative
Other	NA	Negative rat dominant lethal
(a) Metsulfuron methyl does not cause genetic damage <i>in vivo</i> . The positive effect observed in a single <i>in vitro</i> cytogenetic assay was not reproduced <i>in vivo</i> .		

Neurotoxicity — (a) and (b)
No indication of neurotoxicity seen in the available studies.

HUMAN EXPOSURE, RISK AND SAFETY INFORMATION

Metsulfuron methyl	
Toxicity Criteria	U.S. EPA Chronic RfD — 0.25 mg/kg bw/day
U.S. EPA Cancer Classification	“Not likely to be a human carcinogen.”
Consumer — Aggregate Exposure and Risk	EPA estimates aggregate exposures well within acceptable limits, < 1.0% of cPAD.
Occupational Exposure and Risk (mixer, loader and applicator)	Exposures are well within the acceptable limits when label directions are followed.

Imazapyr	
Toxicity Criteria	U.S. EPA Chronic RfD — 2.5 mg/kg/day
U.S. EPA Cancer Classification	“Not likely to be carcinogenic.”
Consumer — Aggregate Exposure and Risk	EPA estimates aggregate exposures well within acceptable limits, < 0.1% of cPAD.
Occupational Exposure and Risk (mixer, loader and applicator)	Exposures are well within the acceptable limits when label directions are followed.

WILDLIFE AND OTHER NON-TARGET SPECIES

	Metsulfuron methyl	Imazapyr
Bobwhite quail — 8 day dietary LD ₅₀	>5620 ppm	>5000 ppm
Mallard duck — Oral LD ₅₀ 8 day dietary LC ₅₀	>2510 mg/kg >5620 ppm	>2150 mg/kg >5000 ppm
Bluegill sunfish — 96 hours LC ₅₀	>150 mg/L	>100 mg/L
Rainbow trout — 96 hours LC ₅₀	>150 mg/L	>100 mg/L
Daphnia — 48 hour LC ₅₀	>120 mg/L	>100 mg/L
Earthworm — LC ₅₀ in soil	>1000 mg/kg	NA
Honey bee — Topical LD ₅₀	>100 µg/bee	>100 µg/bee

INFORMATION SOURCES

(a) Metsulfuron methyl

Primary Industry Source: DuPont.

1. Doig, R.I. et al. 1983. *Proc. 10th Intern. Congr. Plant Prot.* 1:324.
2. Hershberger and Brennan. 1988. *Anal. Meth. Pestic. Plant Growth Regul.* 16:83.
3. LaRossa and Schloss. 1984. *J. Biol. Chem.* 259:8753.
4. Wauchope, R.D. et al. 1992. *Rev. Environ. Contam. Toxicol.* 123 :1.
5. Schmuckler, M.E. et al. 2000. *Pest Mangmt. Sci.* 56 :521-532.

(b) Imazapyr

Primary Industry Source: BASF.

1. Orwick, P.L. et al. 1983. *Proc. South. Weed Sci. Soc.*36:291.
2. Shaner, D. L. and S. L. O'Conner. 1991. *The Imidazolinone Herbicides.* CRC Press, Boca Raton, FL.
3. Wauchope, R. D. et al. 1992. *Rev. Environ. Contam. Toxicol.* 123 :1.

This reference guide is not intended as a substitute for the product label for the product(s) referenced herein. Product labels for the above product(s) contain important precautions, directions for use and product warranty and liability limitations that must be read before using the product. Applicators must be in possession of the product label(s) at the time of application. Always read and follow all label directions and precautions for use when using any pesticide alone or in tank mix combinations.

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