DuPont™ Matrix® SG

herbicide

Rangeland Restoration West of the Mississippi River

Technical Bulletin

IDENTITY OF ACTIVE SUBSTANCE OF MATRIX® SG (RIMSULFURON)

Common Name
Rimsulfuron

Chemical Name
CAS: N-((4,6-dimethoxypyrimidin-2-yl)aminocarbonyl)-3-(ethylsulfonyl)-2-pyridibesulfonamide

IUPAC: 1-(4,6-dimethoxypyrimidin-2-yl)-3-(3-ethylsulfonyl-2-pyridysulfonyl)urea

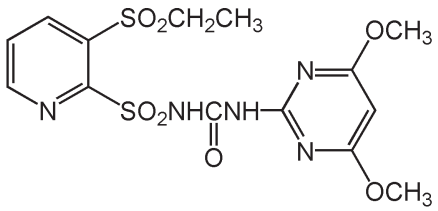
Chemical Family
Sulfonylurea

Molecular Weight
431.44 g/mole

Physical Form
White solid, paste-like odor

Stability
In aqueous solutions, Matrix® SG is most stable at pH 7 (half-life 7 days at 25°C), but is unstable under acidic and alkaline conditions.

Structural Formula:



Empirical Formula
$C_{14}H_{17}N_5O_7S_2$

CAS Registry Number
122931-48-0

CA DPR Chem Code
3835

U.S. EPA PC Code
129009

U.S. EPA Registration Nos.
352-556
352-671

PHYSICAL AND CHEMICAL PROPERTIES OF THE ACTIVE INGREDIENT — RIMSULFURON

State (solid or liquid)
Solid

Color
Off-white to tan

Odor
No distinct odor

Boiling Point
NA

Melting Point
176-178°C

Density
0.62-0.68 g/mL

Solubility in Water
Dispersible

Vapor Pressure
1.1 x 10^{-8} torr at 25°C

Octanol/Water Partition Coefficient (K_{ow}) Stability
Stable in normal conditions, in aqueous solutions, rimsulfuron is most stable at pH 7

Oxidizing/Reducing Activity
The active substance is not an oxidizer.

Flammability
Technical and formulated products are dry and non-flammable.

Explodability
The technical and formulated products are nonexplosive.

Storage Stability
Technical and formulated products are stable. Store product in original container.

Viscosity
NA

Miscibility
NA

Corrosion Characteristics
Technical and formulated products are non-corrosive

GENERAL INFORMATION

DuPont™ Matrix® SG herbicide is a water-soluble granule that is mixed in water and applied as a spray. Matrix® SG is non-corrosive to spray equipment, non-flammable and non-volatile. Do not use Matrix® SG in a spray solution or with spray additives that buffer the pH to below 4.0, or above 8.0, as degradation of Matrix® SG may occur.

A restoration management program that includes Matrix® SG herbicide may be used when rangeland has become severely infested with invasive weed species and deteriorated to where it is no longer suitable for grazing or forage production. To reclaim these lands, the invasive weed species must first be controlled to either allow native grasses to re-establish or to be replanted where practical with other desirable perennial grasses. The grasses must be allowed time to re-establish before grazing or forage production is resumed. A typical restoration management program will take one to two years.

To establish and/or release desirable perennial grass species for rangeland restoration west of the Mississippi river, Matrix® SG may be used to control the undesirable grasses and broadleaf weeds listed in the Weeds Controlled section of the label. The residual activity of Matrix® SG will also help prevent the re-emergence of many of these weeds while desirable grasses are being re-established. At the maximum application rate of 4.0 ounces of Matrix® SG per acre per year, desirable rangeland perennial grasses in the treated area may exhibit a temporary chlorosis following application. The use of an adjuvant with Matrix® SG can increase desirable perennial grass injury.

Do not graze treated sites or cut for forage or hay for a minimum of one year after application to allow newly emerged grasses sufficient time to become established. Where practical, fencing or other measures are to be used to prevent early grazing of re-established sites to help promote active grass restoration.

PREPARING FOR USE

Site-Specific Considerations
Understanding the risks associated with the application of Matrix® SG is essential to aid in preventing off-site injury to desirable vegetation and agricultural crops. The risk of off-site movement both during and after application may be affected by a number of site-specific factors such as the nature, texture and stability of the soil, the intensity and direction of prevailing winds, vegetative cover, site slope, rainfall, drainage patterns, and other local physical and environmental conditions.

A careful evaluation of the potential for off-site movement from the intended application site, including movement of treated soil by wind or water erosion, must be made prior to using Matrix® SG.

This evaluation is particularly critical where desirable vegetation or crops are grown on neighboring land for which the use of Matrix® SG is not labeled. If prevailing local conditions may be expected to result in off-site movement and cause damage to neighboring desirable vegetation or agricultural crops, do not apply DuPont™ Matrix® SG.

Before applying Matrix® SG, the user must read and understand all label directions, precautions and restrictions completely, including these requirements for a site-specific evaluation. If you do not understand any of the instructions or precautions on the label, or are unable to make a site-specific evaluation yourself, consult your local agricultural dealer, cooperative extension service, land managers, professional consultants or other qualified authorities familiar with the area to be treated. If you still have questions regarding the need for site-specific considerations, please call 1-888-6-DUPONT.

Mechanism of Action
Matrix® SG inhibits acetolactate synthase (ALS), also called acetohydroxyacid synthase (AHAS), a key enzyme in the biosynthesis of the branch-chain amino acids isoleucine, leucine and valine in plants. Movement within the plant is via both the xylem and phloem. Inhibition of ALS results in rapid cessation of growth at the tips of both roots and shoots of sensitive plants,

causing eventual plant death. The absence of this enzyme in man and other animals helps to explain the low toxicity of Matrix® SG.

Use Rates

For non-crop rangeland restoration sites west of the Mississippi river, the use rates range from 2.0 to 4.0 ounces per acre. In the western United States, excellent residual activity has been observed when Matrix® SG is applied from late fall to early winter when soil temperatures are cool and rainfall is available to activate the product. Best results are obtained when the soil is moist at the time of application, and one-half inch of rainfall or sprinkler irrigation occurs within 2 to 3 weeks after application. Matrix® SG may be applied alone or in a tank mixture.

WEEDS CONTROLLED

When applied at 2.0 ounces per acre in the spring, Matrix® SG suppresses the following weeds and when applied at 3.0 ounces per acre in the fall, Matrix® SG controls the following weeds:


Downy Brome
Photo by

Brome, downy	*Bromus tectorum*
Brome, Japanese	*Bromus japonicus*
Cheat	*Bromus secalinus*

When applied at 4.0 ounces per acre, Matrix® SG controls the following additional weeds:

Barnyardgrass	*Echinochloa crus-galli*
Crabgrass, large	*Digitaria sanguinalis*
Foxtail, giant	*Setaria faberi*
Foxtail, green	*Setaria viridis*
Foxtail, yellow	*Setaria glauca*
Filaree redstem	*Erodium cicutarium*
Fleabane, hairy	*Conyza bonariensis*
Mallow, common	*Malva neglecta*
Marestail/horseweed*	*Conyza canadensis*
Medusahead	*Taeniatherum caput-medusae*
Mustard, black	*Brassica nigra*
Pigweed, redroot	*Amaranthus retroflexus*
Pigweed, smooth	*Amaranthus hybridus*
Puncturevine	*Tribulus terrestris*

The degree and duration of control may depend on the infestation intensity, weed size at application, preemergence or postemergence application timing, soil type, organic matter content and environment conditions at and following application.


Marestail/horseweed

* Naturally occurring resistant biotypes of this weed are known to exist in some areas of the U.S. Matrix® SG will not control these biotypes.

Uptake, Absorption and Translocation Characteristics

Translocation is affected by temperature. Hot, dry, sunny conditions increase the plant's waxy protective layers and reduce herbicide uptake. However, the temperature does not significantly affect Matrix® SG absorption into the corn plant. High moisture conditions increase the soil activity of Matrix® SG.

Soil Activity and Degradation

Matrix® SG degrades rapidly in the soil. The half-life in laboratory studies is about 20 days under both aerobic and anaerobic conditions in a sandy loam soil. The half-life of Matrix® SG was 8 to 10 days in field studies in Greenville, Miss., and Madera, Calif. The rate of soil degradation is similar in sterile and nonsterile soil and in water. Degradation is strictly a chemical process, not microbial. DuPont™ Matrix® SG is considered pH- and temperature-dependent. Fastest degradation occurs at low and high pH and higher temperatures. The half-life of Matrix® SG in aqueous solutions is affected by pH and temperature. For example, at pH 7, it takes approximately 24 days for half of the applied chemical to degrade at 20°C (68°F), and it takes 144 days to degrade at 10°C (50°F). The amount of Matrix® SG remaining in the soil will vary according to the application rate, soil pH, time elapsed, organic content of the soil, temperature and rainfall.

Plant Selectivity and Sensitivity

Less sensitive plants rapidly metabolize Matrix® SG while sensitive weed plants, such as redroot pigweed *(Amaranthus retroflexus)* and johnsongrass *(Sorghum halepense),* slowly metabolize Matrix® SG. Rotation crops vary in sensitivity to Matrix® SG. The most sensitive crops are lentils, peas, rice, sorghum, sunflower, collards, cauliflower, broccoli, mustard, sugarbeets and turnips. The most tolerant crops are pome fruit, tree nuts, stone fruits, citrus, grapes, potatoes, tomatoes, soybeans, lima beans and field corn.

FATE AND BEHAVIOR IN THE ENVIRONMENT OF THE ACTIVE INGREDIENT — RIMSULFURON

Water Solubility (25°C)
pH 5=135 ppm; pH 7=7,300 ppm; pH 9=5,560 ppm

Soil Sorption Coefficient
< 150 ml/g^{-1}

Octanol/Water Partition Coefficient (K_{ow})
0.034 at pH 7.0 (25°C)

Dissociation Constant: pKa
4.0 (At pH 4.0, 50 percent of rimsulfuron is in the neutral form and 50 percent is in the ionic form. More ionization occurs at higher pH.)

Half-Life in Water
7 days at 25°C and pH 7

Soil Leachability
Leaching of Matrix® SG and its degradation products in soil are considered negligible. In radiolabeled field soil dissipation studies of Matrix® SG applied at 70 grams active ingredient per hectare, no detectable residues were observed below 7.5 centimeters.

Fate in Soil
Matrix® SG degrades rapidly in soil and water, predominantly via chemical pathways. Microbial degradation plays a minor role. Rates of rimsuolfuron degradation are influenced by pH. The compound is most stable in neutral soil pH and degrades more rapidly in alkaline and acidic soils. Half-lives in water at 25°C ranged from 4.6 days to 0.2 days between pH 5.0 and 9.0, respectively. The half-life of Matrix® SG in soil is 21 and 18 days at 25°C (77°F) under aerobic and anaerobic conditions, respectively. Adsorption of Matrix® SG differs among various soil types. The adsorption increases with the increasing amount of organic matter or clay content. Photolysis and volatilization are relatively minor processes.

Fate in Aquatic Environments (Surface Run-off, Water Bodies, Groundwater)
Studies have indicated that Matrix® SG degrades rapidly in aquatic systems via contraction of the sulfonylurea bridge. Field studies indicate that Matrix® SG poses very low risk of leaching into groundwater. Downward movement of the remaining Matrix® SG and its soil degradates is negligible; thus the potential for movement into the groundwater is minimal.

Potential to Bio-accumulate (Aquatic Organisms, Terrestrial Meat and Game)
Matrix® SG is metabolized to several breakdown products. Toxicology studies indicate that the primary metabolite in plants is nontoxic to rats and is non-mutagenetic. Matrix® SG residues in animal feed should be of no concern since neither Matrix® SG nor its primary metabolites were detected in grain, forage or fodder.

RESIDUES IN FOOD

Residues in Plants
Matrix® SG is currently registered in the U.S. for use in tomatoes, potatoes, field corn, citrus fruit, pome fruit, stone fruit, grapes, tree nuts and pistachios.

Residues in Animals
Matrix® SG is nonhazardous to animals, fish, honey bees and other wildlife, based on low toxicity demonstrated in several studies. The target enzyme, acetolactase synthase (ALS), is found only in plants. Animals lack ALS and this biosynthetic pathway, which undoubtedly contributes to this low toxicity.

METABOLISM

Plants
The rate of metabolism is related to the target plants. Tolerant plants metabolize DuPont™ Matrix® SG faster. For example, at 25°C metabolism of Matrix® SG to inactive products in corn shoots is more rapid (half-life=2 hours).

Animals
The metabolism of Matrix® SG in animals (rat, goat and hen) is adequately understood and is similar among the species evaluated. Matrix® SG was rapidly eliminated via urinary and fecal excretion in the rat. Approximately 60 percent to 70 percent of the administered dose to rats was excreted within 24 hours.

TOXICITY OF TECHNICAL ACTIVE INGREDIENT — RIMSULFURON

Acute Toxicity	
Acute oral toxicity — rat LD_{50}	> 5000 mg/kg bw
Acute dermal toxicity — rabbit LD_{50}	> 2000 mg/kg bw
4-hour inhalation toxicity — rat LC_{50}	> 5.4 mg/L
Skin irritation — rabbit	Not an irritant
Eye irritation — rabbit	Moderate, normal by 72 hours
Skin sensitization — guinea pig	Not a sensitizer (Buehler method)

Subchronic Toxicity	
Subchronic toxicity — rat	NOAEL 1500 ppm (in diet)
Subchronic toxicity — dog	NOAEL 250 ppm (in diet)
Subchronic toxicity — mouse	NOAEL 375 ppm (in diet)

Acute Toxicity — Formulated Product 25 DF	
Acute oral toxicity — rat LD_{50}	> 5000 mg/kg bw
Acute dermal toxicity — rabbit LD_{50}	> 2000 mg/kg bw
4-hour inhalation toxicity — rat LC_{50}	> 7.5 mg/L
Primary eye irritation — rabbit	Moderate, normal by 48 hours
Primary skin irritation — rabbit	Not an irritant
Skin sensitization — guinea pig	Not a sensitizer (maximization method)

Chronic toxicity & Carcinogenicity (Technical Material)	
2-year rat (combined chronic toxicity/ carcinogenicity study)	NOAEL 300 ppm (males) NOAEL 3000 ppm (females) Not carcinogenic
18-month mouse (carcinogenicity study)	NOAEL 2500 ppm Not carcinogenic
1-year dog (chronic toxicity study)	NOAEL 2500 ppm

Reproductive Toxicity (Technical Material)	
Teratology — rat	Not teratogenic, dam NOAEL mg/kg 2000 bw; conceptus NOAEL 6000 mg/kg bw
Teratology — rabbit	Not teratogenic, dam NOAEL 170 mg/kg bw; conceptus NOAEL 500 mg/kg bw
Multi-generation reproductive toxicity — rat	Not a reproductive toxin. NOAEL 3000 ppm (in diet)

Mutagenicity Testing (Technical Material)	Non-genotoxic
Ames	Negative
CHO/HPRT	Negative
Unscheduled DNA Synthesis	Negative
Human Lymphocyte	Negative
Mouse Micronucleous	Negative

HUMAN EXPOSURE, RISK AND SAFETY INFORMATION

Toxicity Criteria	
U.S. EPA RfD	0.82 mg/kg bw/day
U.S. EPA Cancer Classification	"Not likely to be a human carcinogen."
Occupational Exposure and Risk (mixer, loader and applicator)	Exposures are well within the acceptable limits when label directions are followed.
Consumer-Aggregate Exposure and Risk	EPA estimates aggregate exposures well within acceptable limits < 1.0% of RfD.

WILDLIFE SPECIES (Formulated Product 25 DF)

Avian oral — LD_{50}
Bobwhite quail > 2250 mg/kg
Mallard duck > 2250 mg/kg

Avian dietary — LC_{50}
Bobwhite quail > 5620 ppm
Mallard duck > 5620 ppm

Fish — LC_{50} (96-hour)
Bluegill sunfish > 1000 mg/kg
Rainbow trout > 1000 mg/kg

Invertebrate — EC_{50} (48-hour)
Daphnia magna > 1000 mg/kg

Invertebrate life cycle (21-day)
Daphnia magma
NOEC 0.82 mg/L
MATC 5.6 mg/L

Terrestrial Invertebrates — Bees (Technical)
LC_{50} > 100 µg/bee

ADDITIONAL TOPICS

Resistant Weed Management
ALS-inhibitor herbicides have achieved unprecedented advances in weed control performance, convenience and improved environmental compatibility. Biotypes of certain weeds included on the susceptible weed species list may be resistant to Matrix® SG and other herbicides with the same mode of action. Biotypes are naturally occurring individuals of a species that are identical in appearance but have slightly different genetic compositions. The mode of action of an herbicide is the chemical interaction that interrupts a biological process necessary for plant growth and development. As the use of ALS-inhibiting herbicides increases in weed control use, the potential for herbicide resistance can be reduced by tank mixing Matrix® SG with herbicides with other modes of action, such as diuron, oryzalin, pendimethalin, oxyfluorfen, glyphosate and paraquat.

Primary Industry Source: DuPont

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