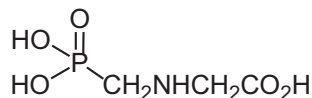


431 glyphosate

Herbicide

HRAC G WSSA 9; glycine derivative



For a general review, see *Glyphosate*.

NOMENCLATURE: *glyphosate*

Common name glyphosate (BSI, E-ISO, (m) F-ISO, ANSI, WSSA, JMAF)

IUPAC name *N*-(phosphonomethyl)glycine

Chemical Abstracts name *N*-(phosphonomethyl)glycine

Other names sulfosate* (for discontinued dimethylsulfonium salt) **CAS RN** [1071–83–6]

EC no. 213–997–4 **Development codes** MON-0573 (Monsanto); CP 67573 (Monsanto)

glyphosate-ammonium

CAS RN [40465–66–5] monoammonium salt; [114370–14–8] mono- or di- ammonium salt (unspecified) **Development codes** MON 8750 (Monsanto)

glyphosate-diammonium

CAS RN [69254–40–6]; [114370–14–8] mono- or di- ammonium salt (unspecified)

glyphosate-isopropylammonium

CAS RN [38641–94–0] **EC no.** 254–056–8 **Development codes** MON 0139 (Monsanto); MON 77209 (Monsanto)

glyphosate-potassium

CAS RN [39600–42–5] monopotassium salt; [70901–12–1] unspecified potassium salt

PHYSICAL CHEMISTRY: *glyphosate*

Composition Tech. is $\geq 95\%$ pure. Zwitterion structure (P. Knuutila & H. Knuutila, *Acta Chem. Scand.*, 1979, **33**, 623). **Mol. wt.** 169.1 **M.f.** C₃H₈NO₅P **Form** Odourless, white crystals.

M.p. Decomp. 200 °C **V.p.** 1.31×10^{-2} mPa (25 °C) **K_{ow} logP** < -3.2 (pH 2–5, 20 °C), (OECD 107; EEC A8) **Henry** $< 2.1 \times 10^{-7}$ Pa m³ mol⁻¹ (calc.) **S.g./density** 1.705 (20 °C) **Solubility** In water 10.5 g/l (pH 1.9, 20 °C). Practically insoluble in common organic solvents, e.g. acetone, ethanol and xylene. The alkali-metal and amine salts are readily soluble in water.

Stability Glyphosate and all its salts are non-volatile, do not photochemically degrade in buffered water and are stable in air. Glyphosate is stable to hydrolysis at pH 3, 6 and 9 (5–35 °C). **pKa** 2.34 (20 °C), 5.73 (20 °C), 10.2 (25 °C) **F.p.** Not flammable

glyphosate-ammonium

Composition Tech. is 95.2% pure. **Mol. wt.** 186.1 **M.f.** C₃H₁₁N₂O₅P **Form** Odourless, white powder. **M.p.** Decomp. > 190 °C, without melting **V.p.** 9×10^{-3} mPa (25 °C)

K_{ow} logP < -3.7 **Henry** 1.16×10^{-8} Pa m³ mol⁻¹ (calc.) **S.g./density** 1.433 (22 °C) **Solubility** In water 144 ± 19 g/l (pH 3.2). Essentially insoluble in organic solvents. **Stability** Stable over 5 days at 50 °C (pH 4, 7 and 9). **pKa** See isopropylammonium salt **F.p.** Not flammable

glyphosate-diammonium

Mol. wt. 203.1 **M.f.** C₃H₁₄N₃O₅P

glyphosate-isopropylammonium

Composition As a wet cake, contains c. 62% w/w isopropylammonium salt, c. 35% water.

glyphosate

Mol. wt. 228.2 **M.f.** C₆H₁₇N₂O₅P **Form** Odourless, white powder. **M.p.** Occurs in 2 steps, 143–164 °C and 189–223 °C **B.p.** Decomposes without boiling **V.p.** 2.1×10^{-3} mPa (25 °C) **K_{ow}** logP = -5.4 **Henry** 4.6×10^{-10} Pa m³ mol⁻¹ (25 °C, calc.) **S.g./density** 1.482 (20 °C) **Solubility** In water 1050 g/l (25 °C, pH 4.3). In dichloromethane <0.5, methanol 19.86 (both in g/l, 20 °C). **Stability** Stable 5 days at pH 4, 5, and 9 (50 °C). **pKa** 5.77±0.03, 2.18±0.02 (20±2 °C), (OECD 112)

glyphosate-potassium

Composition In products described as containing glyphosate-potassium, the CAS Registry Number for the salt with unspecified potassium content is usually quoted. **Mol. wt.** 207.2 (monopotassium salt) **M.f.** C₃H₇KNO₅P (monopotassium salt)

COMMERCIALISATION: **History** Herbicidal activity reported by D. D. Baird *et al.* (*Proc. North Cent. Weed Control Conf.*, 1971, **26**, 64). The isopropylammonium, sodium and ammonium salts introduced by Monsanto Co. in 1974; the trimesium (trimethylsulfonium) salt introduced in Spain (1989) by ICI Agrochemicals (now Syngenta AG, who no longer manufacture or market it). The potassium salt introduced in 2002. **Patents** US 3799758 (to Monsanto); EP 53871; US 4315765 (both to ICI) **Manufacturers** Monsanto; Agrochem; Anhui Huaxing; Anpon; Aragro; Atanor; Atul; Baocheng; Cheminova; Comlets; Dow AgroSciences; Drexel; Excel; Feinchemie Schwebda; Fertiagro; Hebei Golhil; Herbox; High Kite; Jiangsu Good Harvest; Jiangsu Kuaida; Jiangsu Yangnong; Jingma; Makhteshim-Agan; Nortox; Nufarm GmbH; Nufarm Ltd; Nufarm SAS; Nufarm UK; Pyosa; Red Sun; Reposo; Sabero; Sannong; Shandong Qiaochang; Sharda; Sundat; Xinan; Zhejiang Biok; Zhejiang Linghua

APPLICATIONS: **Biochemistry** Inhibits 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS), an enzyme of the aromatic acid biosynthetic pathway. This prevents synthesis of essential aromatic amino acids needed for protein biosynthesis. **Mode of action** Non-selective systemic herbicide, absorbed by the foliage, with rapid translocation throughout the plant. Inactivated on contact with soil. **Uses** Control of annual and perennial grasses and broad-leaved weeds, pre-harvest, in cereals, peas, beans, oilseed rape, flax and mustard, at c. 1.5–2 kg/ha; control of annual and perennial grasses and broad-leaved weeds in stubble and post-planting/pre-emergence of many crops; as a directed spray in vines and olives, at up to 4.3 kg/ha; in orchards, pasture, forestry and industrial weed control, at up to 4.3 kg/ha. As an aquatic herbicide, at c. 2 kg/ha. **Formulation types** SG; SL. **Compatibility** Mixing with other herbicides may reduce the activity of glyphosate.

glyphosate

Selected products 'Gladiator' (Devidayal); 'Glyphall' (Hermoo); 'Karda' (Lainco); 'Maxweed' (Crop Health); 'Nasa' (Agrida); 'Pilarsato' (Pilarquim); 'Rinder' (Inquiport); 'Rophosate' (Rotam); 'Seccherba' (Agrimix); 'Sharp' (Baocheng).

glyphosate-diammonium

Selected products 'Touchdown' (some Touchdown products contain glyphosate-potassium) (Syngenta).

glyphosate-isopropylammonium

Selected products 'Roundup' (Monsanto); 'Sting' (Monsanto); 'Asset' (Ancom); 'Cosmic' (Arysta LifeScience); 'Gallup' (Barclay); 'Glycel' (Excel); 'Glyphogan' (Makhteshim-Agan); 'Glyphomax Plus' (Dow AgroSciences); 'Glyphotox' (Aimco); 'Glysate' (Mobedco); 'Ground-Up' (Vapco); 'Nufosate' (Nufarm UK); 'Oxalis' (Arysta LifeScience); 'Rodeo' (Dow AgroSciences); 'Rondo' (Reposo); 'Sanos' (Sanonda); 'Taifun' (Feinchemie Schwebda); 'Vifosat' (Vipesco); 'Yerbimat' (Ingeniería Industrial); **mixtures** 'PrePass' (+ florasulam) (Dow AgroSciences); 'Illico' (+ amitrole) (Nufarm SAS).

ANALYSIS: Product analysis by hplc with u.v. detection (AOAC Methods, 17th Ed., 983.10; CIPAC Handbook, 1985, 1C, 2132; *ibid.*, 1998, H, 182) or by ion-exchange lc with u.v. detection (AOAC Methods, 17th Ed., 996.12). Residues determined by glc (Pestic. Anal. Man., 1979, II), by gc with MSD (also applicable to aminomethylphosphonic acid, AOAC Methods, 17th Ed., 2000.05) or by hplc with *o*-phthalaldehyde post-column reaction specific for primary amines (J. Agric. Food Chem., 1986, 34(6), 955–960). In environmental water, by hplc determination by *o*-phthalaldehyde post-column reaction system (AOAC Methods, 17th Ed., 991.08, 10.6.18).

TOXICOLOGICAL & ENVIRONMENTAL REVIEWS: EHC 159 (1994). JMPR Mtg. 103 (2005); JMPR Evaln. I 72 (1994), 81 (1997), 106 (2005); JMPR Evaln. II 49 (1986), 104 (2004); JMPR Evaln. I 81 (1997); JMPR Evaln. II 82 (1997) (for degradation product aminomethylphosphonic acid). 91/414/EC Annex I status Included, 2001/99/EC.

MAMMALIAN TOXICOLOGY: *glyphosate*

Oral Acute oral LD₅₀ for rats >5000, mice >10 000, goats 3530 mg/kg. **Skin and eye** Acute percutaneous LD₅₀ for rabbits >5000 mg/kg. Eye irritant; non-irritating to skin (rabbits). Not a skin sensitiser (guinea pigs). **Inhalation** LC₅₀ (4 h) for rats >4.98 mg/l air. **NOEL** In 2 y feeding trials, no ill-effects were observed in rats receiving 410 mg/kg diet daily (ave.) and, in 1 y feeding trials, no ill-effects were observed in dogs receiving 500 mg/kg daily (highest dose treated). Lowest relevant NOAEL (2 y) for rats 31 mg/kg b.w. daily (EU). **ADI** (JMPR) 1 mg/kg b.w. [2004].

Water GV Unnecessary to recommend a guideline value because not hazardous to health at concentrations normally found in drinking water. **Other** Not mutagenic, not carcinogenic, not teratogenic, not neurotoxic. No adverse effects on reproduction. **Toxicity class** WHO (a.i.) U; EPA (formulation) III. **EC classification** Xi; R41| N; R51, R53.

glyphosate-ammonium

Oral Acute oral LD₅₀ for rats 4613 mg/kg. **Skin and eye** Acute percutaneous LD₅₀ for rabbits >5000 mg/kg. Slight eye irritant; not a skin irritant (rabbits). **Inhalation** LC₅₀ for rats (whole body) >1.9 mg/l air. **ADI** See glyphosate. **Toxicity class** EPA (formulation) III. **EC classification** N; R51, R53.

glyphosate-diammonium

EC classification N; R51, R53.

glyphosate-isopropylammonium

Oral Acute oral LD₅₀ for rats >5000, goats 5700 mg/kg. **Skin and eye** Acute percutaneous LD₅₀ for rabbits >5000 mg/kg. Slight eye irritant; not a skin irritant (rabbits). **Inhalation** LC₅₀ (4 h) for rats >1.3 mg/l air. **NOEL** In a 6 mo capsule trial, no ill-effects were observed in dogs receiving 300 mg/kg daily (highest dose treated). **ADI** See glyphosate.

Toxicity class EPA (formulation) III. **EC classification** N; R51, R53.

glyphosate-potassium

Oral Acute oral LD₅₀ for rats >5000 mg/kg. **Skin and eye** Acute percutaneous LD₅₀ for rats >5000 mg/kg. Moderate eye irritant; not a skin irritant (rabbits). **Inhalation** LC₅₀ (4 h) for rats >5.27 mg/l air. **ADI** See glyphosate. **Toxicity class** EPA (formulation) III. **EC classification** N; R51, R53.

ECOTOXICOLOGY: *glyphosate*

Birds Acute oral LD₅₀ for bobwhite quail >3851 mg/kg. Dietary LC₅₀ (5 d) for quail and ducks >4640 mg/kg diet. **Fish** LC₅₀ (96 h) for trout 86, bluegill sunfish 120, harlequin fish 168, sheepshead minnows >1000 mg/l. **Daphnia** LC₅₀ (48 h) 780 mg/l. **Algae** E_bC₅₀ (72 h) for green algae (*Selenastrum capricornutum*) 485 mg/l, (7 d) 13.8 mg/l, E_cC₅₀ (72 h) 460 mg/l; EC₅₀ (96 h) for marine algae (*Skeletonema costatum*) 1.3 mg/l, (7 d) 0.64 mg/l; EC₅₀ (7 d) for diatom (*Navicula pelliculosa*) 42 mg/l; EC₅₀ (7 d) for blue-green algae (*Anabaena flos-aquae*) 15 mg/l.

Other aquatic spp. LC₅₀ (96 h) for mysid shrimps (*Mysidopsis bahia*) >1000, grass shrimps 281, fiddler crabs 934 mg/l. EC₅₀ (96 h) for sea urchins >1000 mg/l; (14 d) for *Lemna gibba* 25.5 mg/l. EC₅₀ (48 h) for *Litoria moorei* tadpoles 111 mg/l. **Bees** LD₅₀ (48 h) (contact) >100 µg/bee; (oral) 100 µg/bee. **Other beneficial spp.** Formulation of glyphosate had no effects on carabid beetles; harmless to slightly harmful to green lacewing, parasite species, mites/spiders and insects, except moderately harmful to *Bembidion lampros* (EU Guidelines).

glyphosate-isopropylammonium

Fish LC₅₀ (96 h) for trout and bluegill sunfish >1000, fathead minnows 97, channel catfish 130 mg/l. **Daphnia** LC₅₀ (48 h) 930 mg/l. **Algae** E_bC₅₀ (72 h) for *Scenedesmus subspicatus* 72.9 mg/l, E_rC₅₀ (72 h) 166 mg/l. **Other aquatic spp.** EC₅₀ (48 h) for midge larvae 5600, *Litoria moorei* tadpoles >343 mg/l. **Worms** LC₅₀ (14 d) for earthworms (*Eisenia foetida*) >5000 mg/kg soil. Reproductive toxicity NOEC (56 d) 28.79 mg/kg.

glyphosate-potassium

Birds Acute oral LD₅₀ for bobwhite quail >2241 mg a.e./kg. **Fish** LC₅₀ (96 h) for trout >1227 mg a.e./l. **Daphnia** LC₅₀ (48 h) >1227 mg a.e./l. **Algae** E_bC₅₀ (72 h) for green algae (*Selenastrum capricornutum*) 35 mg a.e./l, E_rC₅₀ (72 h) 54 mg a.e./l. **Bees** LD₅₀ (48 h) (contact and oral) >100 g a.e./bee.

ENVIRONMENTAL FATE: **Animals** In mammals, following oral administration, glyphosate is very rapidly excreted unchanged and does not bioaccumulate. **Plants** Slowly metabolised to aminomethylphosphonic acid ([1066–51–9]), which is the major plant metabolite.

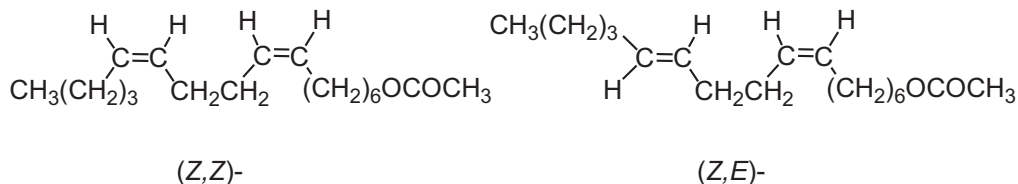
Soil/Environment In soil (field), DT₅₀ 1–130 d, depending on edaphic and climatic conditions. In water, DT₅₀ varies from a few to 91 d. Photodegradation in natural water occurs, DT₅₀ 33–77 d; no substantial photodegradation in soil was recorded over 31 d. In a lab. whole system with water and sediment, DT₅₀ 27–146 d (aerobic), 14–22 d (anaerobic). The major metabolite in soil and water is aminomethylphosphonic acid.

432 gossyplure

Insect pheromone

See also *The Manual of Biocontrol Agents*, 3rd Ed. of *The BioPesticide Manual*, entry: 4:319

pheromone



The mating pheromone of the pink bollworm moth (*Pectinophora gossypiella*).

NOMENCLATURE: IUPAC name a 1:1 mixture of (Z,Z)- and (Z,E)-hexadeca-7,11-dien-1-yl acetate

Chemical Abstracts name a 1:1 mixture of (Z,Z)- and (Z,E)-7,11-hexadecadien-1-ol acetate

Other names PBW; hexadecadienyl acetate; Z7Z11–16Ac; Z7E11–16Ac **CAS RN** [50933–33–0] unspecified stereochemistry; [53042–79–8] (7Z,11E)- isomer; [52207–99–5] (Z,Z)- isomer

Development codes PP761 (ICI)