

Education

Revised Classification of Herbicides by Site of Action for Weed Resistance Management Strategies¹

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Abstract: The classification of herbicides by site of action, published in 1997, has been revised. The classification system uses a numbering system for a herbicide's site of action, chemical family, and common name. Regulatory agencies in the United States and Canada have published labeling guidelines based on the classification to aid in herbicide resistance management.

Abbreviations: EPA, Environmental Protection Agency; HRAC, Herbicide Resistance Action Committee; PMRA, Pest Management Regulatory Agency.

INTRODUCTION

Retzinger and Mallory-Smith (1997) developed a Weed Science Society of America (WSSA)-approved classification of herbicides by site of action. The classification system was developed with the idea that if the site of action of a herbicide was easily and readily available, recommendations for herbicide resistance management would be easier. Herbicides with the same site of action were assigned a group number. The international Herbicide Resistance Action Committee (HRAC) published a similar classification system; however, that system used letters instead of numbers for group designations (Schmidt 1998). As with the previous classification, we do not include references for the site of action for individual herbicide but rather refer the reader to the *Herbicide Handbook* (WSSA 2002). We also refer the reader to recent reviews on herbicide resistance (Devine and Eberlein 1997; Devine and Preston 2000; Preston and Mallory-Smith 2001; Smeda and Vaughn 1997).

The updated herbicide classification list is presented in Table 1. The updated version includes some herbicides that are not sold in North America but are listed in the *Weed Science Society of America 2002 Herbicide Handbook*. Two additional changes were made to align this classification of herbicides with the classification published by HRAC. Difenzoquat, placed in group 8 (inhibitors of lipid synthesis—not ACCase inhibition) in the original classification, has been moved to group 26 (Various Unknown). Quinclorac's site of action in dicots places it in group 4 (synthetic auxins—action like indole acetic acid), but its site of action in monocots is un-

known, so it is also placed in group 26 (Various Unknown). Appendix 1 includes tank mixtures listed by group number and active ingredient. Appendix 2 is an alphabetical list by chemical name. Appendix 3 provides an alphabetical list by common name and group number.

In 1999, the Canadian Pest Management Regulatory Agency (PMRA) published the Regulatory Directive, DIR99-06, "Voluntary Pesticide Resistance-Management Labelling Based on Target Site/Mode of Action" (Pest Management Regulatory Agency 1999). In 2001, the Office of Pesticide Programs of the United States Environmental Protection Agency (U.S. EPA) announced purely voluntary pesticide resistance management labeling guidelines based on mode or target site of action (United States Environmental Protection Agency 2001). The guidelines were published as Pesticide Registration Notice 2001—OPP-00646A "Guidance for Pesticide Registrants on Pesticide Resistance Management Labeling." The guidelines that were developed were a joint effort between the two agencies under the North American Free Trade Agreement. An example of a label containing the guidelines is presented as Appendix 4. The Canadian and U.S. guidelines were based on the classification of herbicides and the resistance management recommendations as published (Retzinger and Mallory-Smith 1997).

One of the most frequent recommendations to prevent or manage resistance is to rotate herbicides with different sites of action. Therefore, knowing a herbicide's site of action is the key to planning a herbicide rotation strategy. The notation of the herbicide site of action on the label is a simple and practical approach that will allow quicker recognition of the site of action by educators, consultants, and growers. The site of action on the label will make communication about the subject of resistance management easier and should increase consistency and simplicity of recommendations. The classification sys-

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Table 1. Herbicide classification according to primary site of action.

Group	Site of action	Chemical family	Common name	Trade name ^a
1 (A)	Inhibitors of acetyl CoA carboxylase (ACCase)	Aryloxyphenoxy propionate	Clodinafop	Discover (USA), Horizon (Canada)
			Cyhalofop-butyl	Clincher (registration pending)
			Diclofop	Hoelon, Various
			Fenoxaprop	Whip, Acclaim, Various
			Fluazifop-P	Fusilade 2000, Fusilade DX
			Haloxifop	Not sold in North America
			Propaquizafop	Not sold in North America
			Quizalofop-P	Assure
			Alloxydim	Not sold in North America
			Butoxydim	Not sold in North America
			Clethodim	Select, Prism
			Cycloxydim	Not sold in North America
			Sethoxydim	Poast, Poast Plus
			Tralkoxydim	Achieve
2 (B)	Inhibitors of acetolactate synthase (ALS), also called acetohydroxyacid synthase (AHAS)	Imidazolinone	Imazamethabenz	Assert
			Imazamox	Beyond, Raptor
			Imazapic	Cadre, Plateau
			Imazapyr	Arsenal
			Imazaquin	Scepter, Image
			Imazethapyr	Pursuit
		Pyrimidinylthio-benzoate	Bispyribac-sodium	Not sold in North America
			Pyriithiobac	Staple
			Pyribenzoxim	Not sold in North America
		Sulfonylamino-carbonyltriazolinone	Flucarbazone-sodium	Everest
			Propoxycarbazone	Olympus, Attribute
		Sulfonylurea	Amidosulfuron	Not sold in North America
			Azimsulfuron	Not sold in North America
			Bensulfuron	Londax
			Chlorimuron	Classic
			Chlorsulfuron	Glean, Telar
			Cinosulfuron	Not sold in North America
			Cyclosulfamuron	Not sold in North America
			Ethametsulfuron	Muster
			Ethoxysulfuron	Not sold in North America
			Flazasulfuron	Not sold in North America
			Flupyrasulfuron-methyl-sodium	Not sold in North America
			Foramsulfuron	Not sold in North America
			Halosulfuron	Permit, Battalion
			Iodosulfuron	Not sold in North America
			Mesosulfuron	Osprey
			Metsulfuron	Ally, Escort
			Nicosulfuron	Accent
			Primisulfuron	Beacon
			Prosulfuron	Peak, Exceed
			Pyrazosulfuron-ethyl	Not sold in North America
			Rimsulfuron	Titus
			Sulfometuron	Oust
			Sulfosulfuron	Maverick, Maverick Pro
			Thifensulfuron	Pinnacle, Harmony
			Triasulfuron	Amber, Logran
			Tribenuron	Express
			Trifloxysulfuron sodium	Enfield
		Triazolopyrimidine	Triflusulfuron	Debut, Safari, Upbeet
			Cloransulam-methyl	First Rate
			Diclosulam	Strongarm
			Florasulam	Primus
3 (K1)	Inhibitors of microtubule assembly	Dinitroaniline	Flumetsulam	Broadstrike
			Benefin	Balan
			Ethalfuralin	Sonalan
			Oryzalin	Surflan
			Pendimethalin	Prowl, Stomp
			Prodiamine	Barricade (only sold to distributors, fertilizer mix)
		Pyridine	Trifluralin	Treflan, Various
			Dithiopyr	Dimension
			Thiazopyr	Visor
		None	DCPA	Dacthal

Table 1. Continued.

Group	Site of action	Chemical family	Common name	Trade name ^a
4 (O)	Synthetic auxins	Phenoxy	2,4-D 2,4-DB Dichlorprop, 2,4-DP MCPA MCPB Mecoprop, PP	Various Various Various Various Various Various
		Benzoic acid	Dicamba	Various
		Carboxylic acid	Clopyralid Fluroxypyr Picloram Triclopyr	Reclaim, Stinger, Various Starane Tordon, Grazon, Various Garlon, Various
5 (C1)	Inhibitors of photosynthesis at photosystem II site A	Quinaline carboxylic acid	Quinclorac (dicots)	Drive, Facet, Paramount
		Phenyl-carbamate	Desmedipham Phenmedipham	Betanex Spin-Aid
		Pyridazinone	Pyrazon	Pyramin
		Triazine	Ametryn Atrazine Cyanazine Desmetryn Prometon Prometryn Propazine Simazine Simetryn Terbumeton Terbuthylazine Trietazine	Evik AAtrex, Various Bladex Not sold in North America Pramitol Caparol, Various Milo Pro Princep, Various Not sold in North America Not sold in North America Not sold in North America Not sold in North America
		Triazinone	Hexazinone	Velpar
			Metamitron	Not sold in North America
			Metribuzin	Sencor, Lexone
		Triazolinone	Amicarbazone	BAY MKH 3586, BAY 314666
		Uracil	Bromacil Terbacil	Hyvar X Sinbar
6 (C3)	Inhibitors of photosynthesis at photosystem II site B	Benzothiadiazole	Bentazon	Basagran, Various
		Nitrile	Bromoxynil Ioxynil	Buctril, Brominal, Various Various
7 (C2)	Inhibitors of photosynthesis at photosystem II site A; different binding behavior from group 5	Phenyl-pyridazine	Pyridate	Lentagran, Tough
		Amide	Propanil	Propanil, Stam, Various
		Urea	Chlorotoluron Dimefuron Diuron Fluometuron Isoproturon Linuron Methibenzuron Metoxuron Monolinuron Siduron Tebuthiuron	Not sold in North America Not sold in North America Karmex, Direx Cotoran, Meturon Not sold in North America Lorox, Linex Not sold in North America Not sold in North America Not sold in North America Tupersan
8 (N)	Inhibitors of lipid synthesis; not ACCase inhibition	Thiocarbamate	Butylate Cycloate EPTC Esprocarb Molinate Pebulate Prosulfocarb Thiobencarb Triallate Vernolate Bensulide Glyphosate	Spike, Preflan Genate+ Ro-Neet Eptam, Eradicane Not sold in North America Ordram Tillam, Edge Boxer, Defi, Arcade Bolero Avadex, Fargo Vernam Prefar, Betasan, Various Roundup, Touchdown, Various
9 (G)	Inhibitor of 5-enolpyruvyl-shikimate-3-phosphate synthase (EPSP)	None		
10 (H)	Inhibitor of glutamine synthetase	None	Glufosinate	Ignite, Liberty, Rely
11 (F3)	Inhibitors of carotenoid biosynthesis (unknown target)	Triazole	Amitrole	Amitrol T, Amizol
12 (F1)	Inhibitors of the phytoene desaturase (PDS)	Pyridazinone	Aclonifen	Not sold in North America
		Pyridinecarboxamide	Norflurazon Diflufenican Picolinafen	Zorial, Evital, Solicam Not sold in North America Not sold in North America
		Other	Beflufutamid	UBH-820

Table 1. Continued.

Group	Site of action	Chemical family	Common name	Trade name ^a
13 (F4)	Inhibitor of 1-deoxy-D-xylose 5-phosphate synthetase (DOXP synthase)	Isoxazolidinone	Fluridone Fluorochloridone Flurtamone Clomazone	Sonar Not sold in North America Not sold in North America Command
14 (E)	Inhibitors of protoporphyrinogen oxidase (Protox)	Diphenylether	Acifluorfen Bifenox Fomesafen Fluoroglycofen Lactofen Oxyfluorfen CGA-248757 Flumiclorac Flumioxazin	Blazer Not sold in North America Reflex, Flexstar Not sold in North America Cobra Goal Action Resource Valor
		<i>N</i> -phenylphthalimide	Oxadiazon Oxadiazyl Pyraflufen-ethyl Butafenacil Fluthiacet-methyl Carfentrazone-ethyl Sulfentrazone Azafenidin Flufenpyr-ethyl	Ronstar Not sold in North America Not sold in North America Inspire, CGA-276854 KIH-9201, CGA-248757 Aim, Teamwork Authority Milestone V-3153
15 (K3)	Inhibitors of synthesis of very long-chain fatty acids	Triazinone Other Acetamide Chloroacetamide	Napropamide Acetochlor Alachlor Butachlor Dimethenamid Metolachlor Metazachlor Pretilachlor Propachlor Thenylchlor Mefenacet Flufenacet Fentrazamide Anilofos Ethofumesate	Devrinol Harness, Surpass, TopNotch Lasso Machete Frontier, Outlook Dual Not sold in North America Not sold in North America Ramrod Not sold in North America Not sold in North America Define Not sold in North America Not sold in North America Norton
16 (N)	Unknown	Oxyacetamide	Flufenacet	Define
17 (Z)	Unknown	Tetrazolinone Other Benzofuran Organoarsenical	Fentrazamide Anilofos Ethofumesate DSMA MSMA Asulam	Not sold in North America Not sold in North America Norton Various Various Asulox
18 (I)	Inhibitor of 7,8-dihydro-pterolate synthetase (DHP)	Carbamate	Naptalam	Alanap
19 (P)	Inhibitors of indoleacetic acid transport	Phthalamate Semicarbazone	Diflufenzopyr	
20 (L)	Inhibitor of cell wall synthesis site A	Nitrile	Dichlobenil	Casoron, Norosac, Various
21 (L)	Inhibitor of cell wall synthesis site B	Benzamide	Isoxaben	Gallery
22 (D)	Photosystem I electron diverters	Bipyridylum	Diquat Paraquat	Reglone, Diquat Gramoxone, Cyclone, Starfire
23 (K2)	Inhibitor of mitosis	Carbanilate	Carbetamide	Not sold in North America
24 (M)	Membrane disruptors (uncouplers)	Dinitrophenol	Dinoterb	Not sold in North America
25 (Z)	Unknown	Arylamino propionic acid	Flamprop	Mataven
26 (Z)	Unknown	Various	Cinmethylin Dazomet Difenzoquat Fosamine Metham Pelargonic acid Quinclorac (monocots)	Not sold in North America Not sold in North America Avenge Not sold in North America Not sold in North America Scythe Facet, Drive
HRAC (L)			Isoxaflutole Benzofenap Pyrazolynate Pyraroxifen Mesotrione Sulcotrione	Balance Not sold in North America Not sold in North America Not sold in North America Callisto Not sold in North America
27 (F2)	Inhibitors of 4-hydroxyphenyl-pyruvate-dioxygenase (4-HPPD)	Isoxazole Pyrazole Triketone		

^a For manufacturer see Weed Science Society of America Herbicide Handbook 8th edition and www.greenbook.net.

tem or its modifications are already being used in the training materials of university extension and private industry educators in Canada and the United States (Anonymous 1996, 2002; DeFelice 1998; Mallory-Smith et al. 1993, 1999; Sprague and Hager 2002).

The classification system will be of most value in addressing target site resistance and target site cross-resistance. Target site resistance occurs when a mutation occurs in the target site and prevents the herbicide from binding. Target site cross-resistance is the resistance in a biotype to herbicides from different chemical classes but with the same target site. This classification system is conservative in that all inhibitors of a target site are in one group. Variable levels of cross-resistance have been reported among different classes of herbicides within a group (Devine and Eberlein 1997).

The labeling statements as listed in the PMRA and U.S. EPA notices do not adequately address herbicide resistance that is not target site resistance. Educational materials must be developed that clearly explain the differences between target site of action resistance and metabolism-based resistance. In addition, there will be exceptions to the recommendations of rotating herbicides based on weed spectrum of the herbicide. For example, in some groups, there are herbicides that are selective only for specific weed species so there would not be selection pressure for resistance on the other weed species that are present. Again, this information needs to be developed in educational materials at the local or regional level.

This classification of herbicides should not be construed as a ranking of chemical families of herbicides by their potential to result in a herbicide-resistant weed biotype. This classification system is only a tool for development of resistance management strategies, including educational materials. It is important that those involved with resistance education and with herbicide recommendations for the prevention or management of resistance realize that the classification system is just one component of a larger resistance management program.

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LITERATURE CITED

- Anonymous. 1996. *Herbicide Resistance: New Developments and Management Strategies*. Winnipeg, MB, Canada: Manitoba Weed Supervisors Association, Manitoba Agriculture. 6 p.
- Anonymous. 2002. *Herbicide Groups*. Calgary, AB, Canada: Westco. 2 p.
- DeFelice, M. 1998. *Managing Weed Resistance to Herbicides*. Pioneer Hi-Bred International, Crop Insights 8.
- Devine, M. D. and C. V. Eberlein. 1997. Physiological, biochemical and molecular aspects of herbicide resistance based on altered target sites. In R. M. Roe, J. D. Burton, and R. J. Kuhr, eds. *Herbicide Activity: Toxicology, Biochemistry and Molecular Biology*. Amsterdam, The Netherlands: IOS Pp. 159–185.
- Devine, M. D. and C. Preston. 2000. The molecular basis of herbicide resistance. In A. H. Cobb and R. C. Kirkwood, eds. *Herbicides and Their Mechanisms of Action*. Boca Raton, FL: CRC. Pp. 72–104.
- Mallory-Smith, C., D. Thill, and D. Morishita. 1993. *Herbicide-Resistant Weeds and Their Management*. Pacific Northwest Extension Publication PNW 437. 4 p.
- Mallory-Smith, C., D. Thill, and D. Morishita. 1999. *Herbicide-Resistant Weeds and Their Management*. Pacific Northwest Extension Publication PNW 437 (Revised). 6 p.
- Pest Management Regulatory Agency. 1999. *Voluntary Pesticide Resistance-Management Labeling Based on Target Site/Mode of Action*. Ottawa, ON, Canada: Health Canada. 24 p.
- Preston, C. and C. A. Mallory-Smith. 2001. Biochemical mechanisms, inheritance, and molecular genetics of herbicide resistance in weeds. In S. B. Powles and D. L. Shaner, eds. *Herbicide Resistance and World Grains*. Boca Raton, FL: CRC. Pp. 23–60.
- Retzinger, E. J. and C. Mallory-Smith. 1997. Classification of herbicides by site of action for weed resistance management strategies. *Weed Technol.* 11:384–393.
- Schmidt, R. R. 1998. *Classification of Herbicides According to Mode of Action*. Leverkusen, Germany: Bayer Ag. 8 p.
- Smeda, R. J. and K. C. Vaughn. 1997. Mechanisms of resistance to herbicides. In V. Sjut, ed. *Chemistry of Plant Protection*. Volume 13. *Molecular Mechanisms of Resistance to Agrochemicals*. Berlin Heidelberg, Germany: Springer-Verlag. Pp. 79–123.
- Sprague, C. and A. Hager. 2002. *Utilizing Herbicide Site of Action to Combat Weed Resistance to Herbicides*. University of Illinois Extension. 4p.
- United States Environmental Protection Agency. 2001. *Pesticide Registration (PR) Notice 2001-5*. EPA 730-N-01-005. Washington, DC. 30 p.
- Weed Science Society of America. 2002. *Herbicide Handbook*. 8th ed. W. K. Vencill, ed. Lawrence, KS: Weed Science Society of America. 493 p.

Appendix 1. Package mixtures listed by active ingredient.

Trade name ^a	Active ingredient A	Group	Active ingredient B	Group	Active ingredient C	Group	Active ingredient D	Group
United States								
Accent Gold	Clopyralid	4	Flumetsulam	2	Nicosulfuron	2	Rimsulfuron	2
Ally Extra	Thifensulfuron	2	Tribenuron	2	Metsulfuron	2		
Authority Broadleaf	Sulfentrazone	14	Chlorimuron	2				
Axiom	Flufenacet	15	Metribuzin	5				
Backdraft	Imazaquin	2	Glyphosate	9				
Basis Gold	Nicosulfuron	2	Rimsulfuron	2	Atrazine	5		

Appendix 1. Continued.

Trade name ^a	Active ingredient A	Group	Active ingredient B	Group	Active ingredient C	Group	Active ingredient D	Group
Basis	Rimsulfuron	2	Thifensulfuron	2				
Betamix	Phenmedipham	5	Desmedipham	5				
Bicep II Magnum	Atrazine	5	Metolachlor	15				
Bicep II Magnum FC	Atrazine	5	Metolachlor	15				
Bicep Lite II Magnum	Atrazine	5	Metolachlor	15				
Bison	Bromoxynil	6	MCPA	4				
Boundary	Metolachlor	15	Metribuzin	5				
Brash	Dicamba	4	2,4-D	4				
Broadstrike + Treflan	Trifluralin	3	Flumetsulam	2				
Bronate Advanced	Bromoxynil	6	MCPA	4				
Bronate Herbicide	Bromoxynil	6	MCPA	4				
Bronate Pro	Bromoxynil	6	MCPA	4				
Buckle	Triallate	8	Trifluralin	3				
Buctril + Atrazine	Bromoxynil	6	Atrazine	5				
Bullet	Alachlor	15	Atrazine	5				
Canopy XL	Sulfentrazone	14	Chlorimuron	2				
Canvas	Thifensulfuron	2	Tribenuron	2	Metsulfuron	2		
Celebrity Plus	Dicamba	4	Diflufenzopyr	19	Nicosulfuron	2		
Cheyenne FM	Fenoxaprop	1	MCPA	4				
Cheyenne X-tra	Fenoxaprop	1	MCPA	4	Thifensulfuron	2		
Commence	Clomazone	13	Trifluralin	3				
Conclude XACT B	Bentazon	6	Acifluorfen	14	Sethoxydim	1		
Crossbow	2,4-D	4	Triclopyr	4				
Curtail Herbicide	Clopyralid	4	2,4-D	4				
Curtail M	Clopyralid	4	MCPA	4				
Dakota	Fenoxaprop	1	MCPA	4				
Degree XTRA	Acetochlor	15	Atrazine	5				
Distinct	Diflufenzopyr	19	Dicamba	4				
Domain	Flufenacet	15	Metribuzin	5				
Doubleplay	EPTC	8	Acetochlor	15				
Epic DP	Flufenacet	15	Isoxaflutole	28				
Exceed	Prosulfuron	2	Primisulfuron	2				
Extreme	Imazethapyr	2	Glyphosate	9				
Fallow Master	Glyphosate	9	Dicamba	4				
Fire Power	Glyphosate	9	Oxyfluorfen	14				
Freedom	Alachlor	15	Trifluralin	3				
Fultime	Acetochlor	15	Atrazine	5				
Fusion	Fluazifop	1	Fenoxaprop	1				
Grazon	Picloram	4	2,4-D	4				
Guardsman	Dimethenamid	15	Atrazine	5				
Guardsman Max	Dimethenamid	15	Atrazine	5				
Harmony Extra	Thifensulfuron	2	Tribenuron	5				
Harness Extra	Acetochlor	15	Atrazine	5				
Harness Extra 5.6 L	Acetochlor	15	Atrazine	5				
Hornet	Flumetsulam	2	Clopyralid	4				
Hornet WDG	Flumetsulam	2	Clopyralid	4				
Krovar I DF	Bromacil	5	Diuron	7				
Laddok	Bentazon	6	Atrazine	5				
Landmaster	Glyphosate	9	2,4-D	4				
Lariat	Alachlor	15	Atrazine	5				
Leadoff	Dimethenamid	15	Atrazine	5				
Liberty ATZ	Atrazine	5	Glufosinate	10				
Lightning	Imazethapyr	2	Imazapyr	2				
Marksman	Dicamba	4	Atrazine	5				
Moxy + Atrazine	Bromoxynil	6	Atrazine	5				
Northstar	Primisulfuron	2	Dicamba	4				
Progress	Phenmedipham	5	Desmedipham	5	Ethofumesate	16		
Pursuit Plus	Imazethapyr	2	Pendimethalin	3				
Rave	Triasulfuron	2	Dicamba	4				
Ready Master ATZ	Glyphosate	9	Atrazine	5				
Shotgun Flowable	Atrazine	5	2,4-D	4				
Snapshot 2.5 TG	Trifluralin	3	Isoxaben	21				
Spirit	Prosulfuron	2	Primisulfuron	2				
Stam Pro	Propanil	7	Bensulfuron	2				
Starane + Saber	Fluroxypyr	4	2,4-D	4				
Starane + Salvo	Fluroxypyr	4	2,4-D	4				
Starane + Sword	Fluroxypyr	4	MCPA	4				

WEED TECHNOLOGY

Appendix 1. Continued.

Trade name ^a	Active ingredient A	Group	Active ingredient B	Group	Active ingredient C	Group	Active ingredient D	Group
Steadfast	Nicosulfuron	2	Rimsulfuron	2	Pendimethalin	3		
Steel	Imazethapyr	2	Imazapyr	2				
Stellar	Flumiclorac	14	Lactofen	14				
Sterling Plus	Dicamba	4	Atrazine	5				
Storm	Bentazon	6	Acifluorfen	14				
Synchrony STS	Chlorimuron	2	Thifensulfuron	2				
Tiller EC	2,4-D	4	MCPA	4				
Typhoon	Fluazifop	1	Fomesafen	14				
Weedmaster	Dicamba	4	2,4-D	4				
Canada								
Betamix	Phenmedipham	5	Desmedipham	5	2,4-D	4		
Champion FM	MCPA	4	Fenoxaprop	1				
Hoegrass II	Diclofop-methyl	1	Bromoxynil	6				
Inter-AG Interprop	2,4-D	4	Dichlorprop	4				
Laser	MCPA	4	Fenoxaprop	1	Bromoxynil	6		
Triumph-FM	MCPA	4	Fenoxaprop	1				
Liberty AT	Glufosinate	10	Atrazine	5				
Laddock	Bentazon	6	Atrazine	5				
CMPP/2,4-D	Mecoprop	4	2,4-D	4	Dicamba	4		
Distinct	Dicamba	4	Diflufenzopyr	19				
Dyvel	Mecoprop	4	2,4-D	4				
Flaxmax	MCPA	4	Clopyralid	4				
Marksman	Dicamba	4	Atrazine	5				
Odyssey	Imazomox	2	Imazethapyr	2				
Patriot	Imazethapyr	2	Atrazine	5				
Valor	Pendimethalin	3	Imazethapyr	2				
Axiom	Flufenacet	15	Metribuzin	5				
Broadstrike Dual					2,4-D	4		
Magnum	Flumetsulam	2	S-metolachlor	15				
Broadstrike Dual	Flumetsulam	2	Metolachlor	15				
Broadstrike Treflan	Flumetsulam	2	Trifluralin	3				
Curtail	MCPA	4	Clopyralid	4				
Fieldstar	Flumetsulam	2	Clopyralid	4				
Prestige	MCPA	4	Clopyralid	4				
Prevail	MCPA	4	Clopyralid	4				
Striker	Flumetsulam	2	Clopyralid	4	2,4-D	4		
Tordon 101	Picloram	4	2,4-D	4				
Tordon 202C	Picloram	4	2,4-D	4				
Harmony	Thifensulfuron	2	Tribenuron	2				
Extra	Thifensulfuron	2	Tribenuron	2				
Extrazine	Cyanazine	5	Atrazine	5				
Krovar I	Diuron	7	Bromacil	5				
Max	Flumetsulam	2	Clopyralid	4				
Refine Extra	Thifensulfuron	2	Tribenuron	2	2,4-D	4		
Reliance STS	Thifensulfuron	2	Chlorimuron-ethyl	2				
Ultim 25%	Nicosulfuron	2	Rimsulfuron	2				
Ultim 37.4%	Nicosulfuron	2	Rimsulfuron	2				
Ultim 75%	Nicosulfuron	2	Rimsulfuron	2				
IPCO Clovitox Plus	MCPB	4	MCPA	4				
IPCO Dichlorprop-D	2,4-D	4	Diclorprop	4				
IPCO Premium 2-Way Turf	Mecoprop	4	2,4-D	4				
IPCO Premium 3-Way Turf	Mecoprop	4	2,4-D	4	Dicamba	4		
IPCO Sterilant	Sodium metaborate	nc	Sodium chlorate	nc				
IPCO Tracker	Mecoprop	4	MCPA	4				
Weedaway Clovitox Plus	MCPB	4	MCPA	4				
Weedaway Dichlorprop-D	2,4-D	4	Diclorprop	4	Dicamba	4		
Weed-Away Premium 3-Way Turf	Mecoprop	4	2,4-D	4				
Monobor-chlorate + Diuron	Sodium metaborate	nc	Sodium chlorate	nc				
Monobor-chlorate Non-Selective	Sodium metaborate	nc	sodium chlorate	nc				
Ureabor Non-Selective	Sodium metaborate	nc	Sodium chlorate	nc	Bromacil	5		
Focus Water Soluble	Glyphosate	9	2,4-D	4				
Fortress	Triallate	8	Trifluralin	3				
Mocan 943	Glyphosate	9	Dicamba	4				

Appendix 1. Continued.

Trade name ^a	Active ingredient A	Group	Active ingredient B	Group	Active ingredient C	Group	Active ingredient D	Group
MON 77759	Glyphosate	9	Glufosinate	10				
MON 78027	Glyphosate	9	Glufosinate	10				
MON 7985	Triallate	8	Trifluralin	3				
Roundup Fastforward	Glyphosate	9	Glufosinate	10				
Rustler Summerfallow	Glyphosate	9	2,4-D	4				
Rustler	Glyphosate	9	Dicamba	4				
Expedite	Mecoprop	4	2,4-D	4				
Primextra II Magnum	Atrazine	5	S-metolachlor	15				
Target DS	Mecoprop	4	2,4-D	4	Dicamba	4		
Target Liquid Systemic	Mecoprop	4	MCPA	4	Dicamba	4		
Desormone	2,4-D	4	Diclorprop	4				
Mecoturf Plus 2,4-D	Mecoprop	4	2,4-D	4				
NUFARM Calmix	2,4-D	4	Bromacil	4				
NUFARM Estaprop	2,4-D	4	Diclorprop	4				
NUFARM Mextrol 400M	MCPA	4	Bromoxynil	6				
NUFARM Tropotox Plus 400	MCPB	4	MCPA	4				
Weedone CB	2,4-D	4	Diclorprop	4				
Wilson Tri-Kil Turf	Mecoprop	4	2,4-D	4	Dicamba	4		
Wilson Turf-Rite 2 + 2	Mecoprop	4	2,4-D	4				
Killex WSP	Mecoprop	4	2,4-D	4	Dicamba	4		
Trillion Liquid Turf	Mecoprop	4	2,4-D	4	Dicamba	4		
Brominal M	MCPA	4	Bromoxynil	6				
Bromox 450M	MCPA	4	Bromoxynil	6				
Bromox 560M	MCPA	4	Bromoxynil	6				
Buctril M	MCPA	4	Bromoxynil	6				
IPCO Buctril M	MCPA	4	Bromoxynil	6				
Platinum 560EC	MCPA	4	Bromoxynil	6				
Super BX	MCPA	4	Bromoxynil	6				
Thumper	2,4-D	4	Bromoxynil	6				
Stampede CM	Propanil	7	MCPA	4				
Green Cross Killex 500	Mecoprop	4	2,4-D	4	Dicamba	4		
Killex Liquid	Mecoprop	4	2,4-D	4	Dicamba	4		
Killex Summer Formula	Mecoprop	4	2,4-D	4	Dicamba	4		
Green Cross MECO-D	Mecoprop	4	2,4-D	4				
Summit WG	Primisulfuron-methyl	2	Dicamba	4				
Clean Crop Diphenoprop BK 700	2,4-D	4	Diclorprop	4				
Clean Crop Diphenoprop Plus	2,4-D	4	Diclorprop	4				
Clean Crop Mecoprop Plus 2,4-D	Mecoprpp	4	2,4-D	4				
Clean Crop Premium Weed & Pave	2,4-D	4	Bromacil	5				
Clean Crop Shotgun Flowable	2,4-D	4	Atrazine	5				
Clean Crop Sword	Mecoprop	4	MCPA	4	Dicamba	4		
Clean Crop Topside	MCPB	4	MCPA	4				
Par III	Mecoprop	4	2,4-D	4	Dicamba	4		
TurboProp 600	2,4-D	4	Diclorprop	4				
Assualt Liquid	2,4-D	4	Bromacil	5				

^a For manufacturer see Weed Science Society of America Herbicide Handbook 8th edition and www.greenbook.net.

Appendix 2. Alphabetical list by common name with corresponding chemical name.

Common name	Chemical name
2,4-D	(2,4-dichlorophenoxy)acetic acid
2,4-DB	4-(2,4-dichlorophenoxy)butanoic acid
Acetochlor	2-chloro-N-(ethoxymethyl)-N-(2-ethyl-6-methylphenyl)acetamide
Acifluorfen	5-[2-chloro-4-(trifluoromethyl)phenoxy]-2-nitrobenzoic acid
Aclonifen	2-chloro-6-nitro-3-phenoxybenzenamine
Acrolein	2-propenal
Alachlor	2-chloro-N-(2,6-diethylphenyl)-N-(methoxymethyl)acetamide
Alloxydim	methyl 2,2-dimethyl-4,6-dioxo-5-[1-[(2-propenyloxy)amino]butylidene]cyclohexanecarboxylate
Ametryn	N-ethyl-N'-(1-methylethyl)-6-(methylthio)-1,3,5-triazine-2,4-diamine
Amicarbazone	4-amino-N-tert-butyl-3-isopropyl-5-oxo-D ² -1,2,4-triazolinone-1-carboxamide

Appendix 2. Continued.

Common name	Chemical name
Amidosulfuron	<i>N</i> -[[[(4,6-dimethoxy-2-pyrimidinyl)amino]carbonyl]amino]sulfonyl]- <i>N</i> -methylmethanesulfonamide
Amitrole	1 <i>H</i> -1,2,4-triazol-3-amine
Anilofos	5-4-chloro- <i>N</i> -isopropylcarbaniloylmethyl <i>O,O</i> -dimethyl phosphorodithioate
Asulam	methyl[(4-aminophenyl)sulfonyl]carbamate
Atrazine	6-chloro- <i>N</i> -ethyl- <i>N'</i> -(1-methylethyl)-1,3,5-triazine-2,4-diamine
Azafenidin	2-[2,4-dichloro-5-(2-propynyloxy)phenyl]-5,6,7,8-tetrahydro-1,2,4-triazolo[4,3- <i>a</i>]pyridin-3(2 <i>H</i>)-one
Azimsulfuron	<i>N</i> -[[[(4,6-dimethoxy-2-pyrimidinyl)amino]carbonyl]-1-methyl-4-(2-methyl-2 <i>H</i> -tetrazol-5-yl)-1 <i>H</i> -pyrazole-5-sulfonamide
Beflubutamid	2-[4-fluoro-3-(trifluoromethyl)phenoxy]- <i>N</i> -(phenylmethyl)butanamide
Benazolin	4-chloro-2-oxo-3(2 <i>H</i>)-benzothiazoleacetic acid
Benefin	<i>N</i> -butyl- <i>N</i> -ethyl-2,6-dinitro-4-(trifluoromethyl)benzenamine
Benoxacor	4-(dichloroacetyl)-3,4-dihydro-3-methyl-2 <i>H</i> -1,4-benzoxazine
Bensulfuron	2-[[[(4,6-dimethoxy-2-pyrimidinyl)amino]carbonyl]amino]sulfonyl]methyl]benzoate
Bensulide	<i>O,O</i> -bis(1-methylethyl)S-[2-[(phenylsulfonyl)amino]ethyl]phosphorodithioate
Bentazon	3-(1-methylethyl)-(1 <i>H</i>)-2,1,3-benzothiadiazin-4(3 <i>H</i>)-one 2,2-dioxide
Benzocefnap	2-[[4-(2,4-dichloro-3-methylbenzoyl)-1,3-dimethyl-1 <i>H</i> -pyrazol-5-yl]oxy]-1-(4-methylphenyl)ethanone
Bifenox	methyl 5-(2,4-dichlorophenoxy)-2-nitrobenzoate
Bispyribac-sodium	2,6-bis[(4,6-dimethoxy-2-pyrimidinyl)oxy]benzoic acid
Bromacil	5-bromo-6-methyl-3-(1-methylpropyl)-2,4(1 <i>H</i> ,3 <i>H</i>)pyrimidinedione
Bromoxynil	3,5-dibromo-4-hydroxybenzonitrile
Butachlor	<i>N</i> -(butoxymethyl)-2-chloro- <i>N</i> -(2,6-diethylphenyl)acetamide
Butafenacil	2-chloro-5-(3-methyl-2,6-dioxo-4-trifluoromethyl-3,6-dihydro-2 <i>H</i> -pyrimidyl)-benzoic acid 1-allyloxycarbonyl-1-methyl-ethyl-ester
Butoxydim	2-[1-(ethoxylmino)propyl]-3-hydroxy-5-[2,4,6-trimethyl-3-(1-oxobutyl)phenyl]-2-cyclohexen-1-one
Butylate	<i>S</i> -ethyl bis(2-methylpropyl)carbamothioate
Cacodylic acid	dimethyl arsinic acid
Carbetamide	(<i>R</i>)- <i>N</i> -ethyl-2-[(phenylamino)carbonyl]oxy]propanamide
Carfentrazone-ethyl	α ,2-dichloro-5[4-difluoromethyl)-4,5-dihydro-3-methyl-5-oxo-1 <i>H</i> -1,2,4-triazol-1-yl]-4-fluorobenzenepropanoic acid
Chlorimuron	2-[[[(4-chloro-6-methoxy-2-pyrimidinyl)amino]carbonyl]amino]sulfonyl]benzoic acid
Chlorotoluron	<i>N'</i> -(3-chloro-4-methylphenyl)- <i>N,N</i> -dimethylurea
Chlorsulfuron	2-chloro- <i>N</i> -[(4-methoxy-6-methyl-1,3,5-triazin-2-yl)amino]carbonyl]benzenesulfonamide
Cinmethylin	<i>exo</i> -1-methyl-4-(1-methylethyl)-2-[(2-methylphenyl)methoxy]-7-oxabicyclo[2.2.1]heptane
Cinosulfuron	<i>N</i> -[(4,6-dimethoxy-1,3,5-triazin-2-yl)amino]carbonyl]-2-(2-methoxyethoxy)benzenesulfonamide
Clethodim	(<i>E,E</i>)-($\pm$)-2-[1-[(3-chloro-2-propenyl)oxy][imino]propyl]-5-[2-(ethylthio)propyl]-3-hydroxy-2-cyclohexen-1-one
Clodinafop-propargyl	2-[4-(5-chloro-3-fluoro-2-pyridinyl)oxy]-phenoxy]-2-propynyl ester
Clomazone	2-[(2-chlorophenyl)methyl]-4,4-dimethyl-3-isoxazolidinone
Clopyralid	3,6-dichloro-2-pyridinecarboxylic acid
Cloquintocet-mexyl	1-methylhexyl 5-chloro-8-quinolinoxy-acetic acid
Cloransulam-methyl	3-chloro-2-[[5-ethoxy-7-fluoro[1,2,4]triazolo[1,5- <i>c</i>]pyrimidin-2-yl)sulfonyl]amino]benzoic acid
Copper chelate	ethylenediamine
Copper sulfate	copper (II) sulfate
Cyanazine	2-[[4-chloro-6-(ethylamino)-1,3,5-triazin-2-yl]amino]-2-methylpropanenitrile
Cycloate	<i>S</i> -ethyl cyclohexylethylcarbamothioate
Cyclosulfamuron	<i>N</i> -[[[2-(cyclopropylcarbonyl)phenyl]amino]sulfonyl]- <i>N'</i> -(4,6-dimethoxy-2-pyrimidinyl)urea
Cycloxydim	2-[1-(ethoxyimino)butyl]-3-hydroxy-5-(2 <i>H</i> -tetrahydrothiopyran-3-yl)-2-cyclohexen-1-one
Cyhalofop	(<i>R</i>)-2-[4-(4-cyano-2-fluorophenoxy)phenoxy]propanoic acid
DCPA	dimethyl 2,3,5,6-tetrachloro-1,4-benzenedicarboxylate
Dazomet	tetrahydro-3,5-dimethyl-2 <i>H</i> -1,3,5-thiadiazine-2-thione
Desmedipham	ethyl 3-[[[(phenylamino)carbonyl]oxy]phenyl]carbamate
Desmetryn	<i>N</i> -methyl- <i>N'</i> -(1-methylethyl)-6-(methylthio)-1,3,5-triazine-2,4-diamine
Dicamba	3,6-dichloro-2-methoxybenzoic acid
Dichlobenil	2,6-dichlorobenzonitrile
Dichlormid	2,2-dichloro- <i>N,N</i> -di-2-propenylacetamide
Dichlorprop	($\pm$)-2-(2,4-dichlorophenoxy)propanoic acid
Diclofop	($\pm$)-2-[4-(2,4-dichlorophenoxy)phenoxy]propanoic acid
Diclosulam	<i>N</i> -(2,6-dichlorophenyl)5-ethoxy-7-fluoro[1,2,4]triazolo[1,5- <i>c</i>]pyrimidine-2-sulfonamide
Difenzoquat	1,2-dimethyl-3,5-diphenyl-1 <i>H</i> -pyrazolium
Diflufenican	<i>N</i> -(2,4 difluorophenyl)-2-[3-(trifluoromethyl)phenoxy]-3-pyridinecarboxamide
Diflufenopyr	2-[1-[[[(3,5-difluorophenyl)amino]carbonyl]hydrazono]ethyl]-3-pyridinecarboxylic acid
Dimetfuron	<i>N'</i> [3-chloro-4-[5-(1,1-dimethylethyl)-2-oxo-1,3,4-oxadiazol-3(2 <i>H</i>)-yl]phenyl]- <i>N,N</i> -dimethylurea
Dimethenamid	2-chloro- <i>N</i> -[(1-methyl-2-methoxyethyl)- <i>N</i> -(2,4-dimethyl-thien-3-yl)-acetamide
Dimethipin	2,3-dihydro-5,6-dimethyl-1,4-dithiin 1,1,4,4-tetraoxide
Dinoterb	2-(1,1-dimethylethyl)-4,6-dinitrophenol
Diquat	6,7-dihydrodipyrido[1,2- α :2',1'- <i>c</i>]pyrazinedilium ion
Dithiopyr	<i>S,S</i> -dimethyl 2-(difluoromethyl)-4-(2-methylpropyl)-6-(trifluoromethyl)-3,5-pyridinedicarbothioate
Diuron	<i>N'</i> -(3,4-dichlorophenyl)- <i>N,N</i> -dimethylurea
DSMA	disodium methanearsonate
Endothall	7-oxabicyclo[2.2.1]heptane-2,3-dicarboxylic acid
EPTC	<i>S</i> -ethyl dipropyl carbamothioate
Esprocarb	<i>S</i> -(phenylmethyl)(1,2-dimethylpropyl)ethylcarbamothioate

Appendix 2. Continued.

Common name	Chemical name
Ethalfuralin	<i>N</i> -ethyl- <i>N</i> -(2-methyl-2-propenyl)-2,6-dinitro-4-(trifluoromethyl)benzenamine
Ethametsulfuron	2-[[[(4-ethoxy-6-(methylamino)-1,3,5-triazin-2-yl)amino]carbonyl]amino]sulfonyl]benzoate
Ethofumesate	(±)-2-ethoxy-2,3-dihydro-3,3-dimethyl-5-benzofuranyl methanesulfonate
Ethoxysulfuron	2-ethoxyphenyl[[[(4,6-dimethoxy-2-pyrimidinyl)amino]carbonyl]sulfamate
Fenchlorazole-ethyl	ethyl 1-(2,4-dichlorophenyl)-5-(trichloromethyl)-1 <i>H</i> -1,2,4-triazole-3-carboxylate
Fenclozime	4,6-dichloro-2-phenyl-pyrimidine
Fenoxaprop	(±)-2-[4-[(6-chloro-2-benzoxazolyl)oxy]phenoxy]propanoic acid
Fentrazamide	4-(2-chlorophenyl)-5-oxo-4,5-dihydro-tetrazole-1-carboxylic acid cyclohexyl-ethyl-amide
Flamprop	<i>N</i> -benzoyl- <i>N</i> -(3-chloro-4-fluorophenyl)- <i>DL</i> -alanine
Flazasulfuron	<i>N</i> -[[[(4,6-dimethoxy-2-pyrimidinyl)amino]carbonyl]-3-(trifluoromethyl)-2-pyridinesulfonamide
Florasulam	<i>N</i> -(2,6-difluorophenyl)-8-fluoro-5-[5-methyl-6-oxo-4-(trifluoromethyl)-1(6 <i>H</i>)-pyridazinyl]phenoxy-ethyl ester
Fluazifop-P-butyl	(<i>R</i>)-2-[4-[[5-(trifluoromethyl)-2-pyridinyl]oxy]phenoxy]propanoic acid
Flucarbazone-sodium	4,5-dihydro-3-methoxy-4-methyl-5-oxo- <i>N</i> -(2-(trifluoromethoxyphenyl)sulfonyl)-1 <i>H</i> -1,2,4-triazole-1-carboxamide sodium salt
Flufenacet	<i>N</i> -(4-fluorophenyl)- <i>N</i> -(1-methylethyl)-2-[[5-(trifluoromethyl)-1,3,4-thiadiazol-2-yl]oxy]acetamide
Flufenpyr-ethyl	1-acetic acid,[2-chloro-4-fluoro-5-[5-methyl-6-oxo-4-(trifluoromethyl)-1(6 <i>H</i>)-pyridazinyl]phenoxy]-ethyl ester
Flumetsulam	<i>N</i> -(2,6-difluorophenyl)-5-methyl [1,2,4]triazolo[1,5- <i>a</i>]pyrimidine-2-sulfonamide
Flumiclorac	[2-chloro-4-fluoro-5-(1,3,4,5,6,7-hexahydro-1,3-dioxo-2 <i>H</i> -isoindo1-2-yl)phenoxy]acetic acid
Flumioxazin	2-[7-fluoro-3,4-dihydro-3-oxo-4-(2-propenyl)-2 <i>H</i> -1,4-benzoxazin-6-yl]-4,5,6,7-tetrahydro-1 <i>H</i> -isoindo1-1,3(2 <i>H</i>)-dione
Flumeturon	<i>N,N</i> -dimethyl- <i>N'</i> -[3-(trifluoromethyl)phenyl]urea
Fluorochloridone	3-chloro-4-(chloromethyl)-1-[3-(trifluoromethyl)phenyl]-2-pyrrolidinone
Fluoroglycofen	carboxymethyl 5-[2-chloro-4-(trifluoromethyl)phenoxy]-2-nitrobenzoate
Flupyr-sulfuron-methyl-sodium	2-[[[(4,6-dimethoxy-2-pyrimidinyl)amino]carbonyl]amino]sulfonyl]-6-(trifluoromethyl)-3-pyridinecarboxylic acid
Fluridone	1-methyl-3-phenyl-5-[3-(trifluoromethyl)phenyl]-4(1 <i>H</i>)-pyridinone
Fluroxypyr	[(4-amino-3,5-dichloro-6-fluoro-2-pyridinyl)oxy]acetic acid
Flurtamone	5-(methylamino)-2-phenyl-4-[3-(trifluoromethyl)phenyl]-3(2 <i>H</i>)-furanone
Fluthiacet-methyl	methyl 2-[chloro-4-fluoro-5-[(tetrahydro-3-oxo-1 <i>H</i> ,3 <i>H</i> -[1,3,4]thiadiazolo[3,4- <i>a</i>]pyridazin-1-ylidene)amino]phenyl]thio]acetate
Fluxofenim	1-(4-chlorophenyl)-2,2,2-trifluoro-1-ethanone <i>O</i> -(1,3-dioxolan-2-ylmethyl)oxime
Fomesafen	5-[2-chloro-4-(trifluoromethyl)phenoxy]- <i>N</i> -(methylsulfonyl)-2-nitrobenzamide
Foramsulfuron	2-[[[(4,6-dimethoxy-2-pyrimidinyl)amino]carbonyl]amino]sulfonyl]-4-(formylamino)- <i>N,N</i> -dimethylbenzamide
Fosamine	ethyl hydrogen (aminocarbonyl)phosphonate
Glufosinate	2-amino-4-(hydroxymethylphosphinyl)butanoic acid
Glyphosate	<i>N</i> -(phosphonomethyl)glycine
Halosulfuron	3-chloro-5-[[[(4,6-dimethoxy-2-pyrimidinyl)amino]carbonyl]amino]sulfonyl]-1-methyl-1 <i>H</i> -pyrazole-4-carboxylic acid
Haloxypfop	(±)-2-[4-[[3-chloro-5-(trifluoromethyl)-2-pyridinyl]oxy]phenoxy]propanoic acid
Hexazinone	3-cyclohexyl-6-(dimethylamino)-1-methyl-1,3,5-triazine-2,4(1 <i>H</i> ,3 <i>H</i>)-dione
Imazamethabenz	(±)-2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1 <i>H</i> -imidazol-2-yl]-4-(and 5)-methylbenzoic acid (3:2)
Imazamox	2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1 <i>H</i> -imidazol-2-yl]-5-(methoxymethyl)-3-pyridinecarboxylic acid
Imazapic	(±)-2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1 <i>H</i> -imidazol-2-yl]-5-methyl-3-pyridinecarboxylic acid
Imazapyr	(±)-2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1 <i>H</i> -imidazol-2-yl]-3-pyridinecarboxylic acid
Imazaquin	2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1 <i>H</i> -imidazol-2-yl]-3-quinolinecarboxylic acid
Imazethapyr	2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1 <i>H</i> -imidazol-2-yl]-5-ethyl-3-pyridinecarboxylic acid
Iodosulfuron	4-iodo-2-[[[(4-methoxy-6-methyl-1,3,5-triazin-2-yl)amino]carbonyl]amino]sulfonyl]benzoic acid
Ioxynil	4-hydroxy-3,5-diiodobenzonitrile
Isoproturon	3-(4-isopropylphenyl)-1,1-dimethylurea
Isoxaben	<i>N</i> -[3-(1-ethyl-1-methylpropyl)-5-isoxazolyl]-2,6-dimethoxybenzamide
Isoxaflutole	(5-cyclopropyl-4-isoxazolyl)[2-(methylsulfonyl)-4-(trifluoromethyl)phenyl]methanone
Lactofen	(±)-2-ethoxy-1-methyl-2-oxoethyl 5-[2-chloro-4-(trifluoromethyl)phenoxy]-2-nitrobenzoate
Linuron	<i>N'</i> -(3,4-dichlorophenyl)- <i>N</i> -methoxy- <i>N</i> -methylurea
MCPA	(4-chloro-2-methylphenoxy)acetic acid
MCPB	4-(4-chloro-2-methylphenoxy)butanoic acid
Mecoprop	2-(4-chloro-2-methylphenoxy)propanoic acid
Mefenacet	2-(2-benzothiazolyl)oxy)- <i>N</i> -methyl- <i>N</i> -phenylacetamide
Mefenpyr-diethyl	1-(2,4-dichlorophenyl)-4,5-dihydro-5-methyl-1 <i>H</i> -pyrazole-3,5-dicarboxylic acid
Mefluidide	<i>N</i> -[2,4-dimethyl-5-[[[(trifluoromethyl)sulfonyl]amino]phenyl]acetamide
Mesosulfuron	methyl 2-[[[(4,6-dimethoxy-2-pyrimidinyl)amino]carbonyl]amino]sulfonyl]-4-[[[(methylsulfonyl)amino]methyl]benzoate
Mesotrione	2-[4-(methylsulfonyl)-2-nitrobenzoyl]-1,3-cyclohexanedione
Metaborate	sodium metaborate dodecahydrate
Metamitron	4-amino-3-methyl-6-phenyl-1,2,4-triazin-5(4 <i>H</i>)-one
Metazachlor	2-chloro- <i>N</i> -(2,6-dimethylphenyl)- <i>N</i> -(1 <i>H</i> -pyrazol-1-ylmethyl)acetamide
Metham	methylcarbamidithioic acid
Methazole	2-(3,4-dichlorophenyl)-4-methyl-1,2,4-oxadiazolidine-3,5-dione
Methibenzuron	<i>N</i> -2-benzothiazolyl- <i>N,N'</i> -dimethylurea
Metolachlor	2-chloro- <i>N</i> -(2-ethyl-6-methylphenyl)- <i>N</i> -(2-methoxy-1-methylethyl)acetamide
Metoxuron	3-(3-chloro-4-methoxyphenyl)-1,1-dimethylurea
Metribuzin	4-amino-6-(1,1-dimethylethyl)-3-(methylthio)-1,2,4-triazin-5(4 <i>H</i>)-one
Metsulfuron	methyl 2-[[[(4-methoxy-6-methyl-1,3,5-triazin-2-yl)amino]carbonyl]amino]sulfonyl]benzoate
Molinate	5-ethyl hexahydro-1 <i>H</i> -azepine-1-carbothioate
Monolinuron	<i>N'</i> -(4-chlorophenyl)- <i>N</i> -methoxy- <i>N</i> -methylurea
MSMA	monosodium methanearsonate

Appendix 2. Continued.

Common name	Chemical name
Napropamide	<i>N,N</i> -diethyl-2-(1-naphthalenyloxy)propanamide
Naptalam	2-[(1-naphthalenylamino)carbonyl]benzoic acid
Nicosulfuron	2-[[[(4,6-dimethoxy-2-pyrimidinyl)amino]carbonyl]amino]sulfonyl]- <i>N,N</i> -dimethyl-3-pyridinecarboxamide
Norflurazon	4-chloro-5-(methylamino)-2-(3-(trifluoromethyl)phenyl)-3(2 <i>H</i>)-pyridazinone
Oryzalin	4-(dipropylamino)-3,5-dinitrobenzenesulfonamide
Oxaziclomefone	3-[1-(3,5-dichlorophenyl)-1-methylethyl]-2,3-dihydro-6-methyl-5-phenyl-4 <i>H</i> -1,3-oxazin-4-one
Oxadiazol	5- <i>tert</i> -butyl-3-(2,4-dichloro-5-propargyloxyphenyl)-1,3,4-oxadiazol-2(3 <i>H</i>)-one
Oxadiazon	3-[2,4-dichloro-5-(1-methylethoxy)phenyl]-5-(1,1-dimethylethyl)-1,3,4-oxadiazol-2-(3 <i>H</i>)-one
Oxyfluorfen	2-chloro-1-(3-ethoxy-4-nitrophenoxy)-4-(trifluoromethyl)benzene
Paraquat	1,1'-dimethyl-4,4'-bipyridinium ion
Pebulate	5-propyl butylethylcarbamothioate
Pelargonic acid	Nonanoic acid
Pendimethalin	<i>N</i> -(1-ethylpropyl)-3,4-dimethyl-2,6-dinitrobenzenamine
Phenmedipham	3-[(methoxycarbonyl)amino]phenyl(3-methylphenyl)carbamate
Picloram	4-amino-3,5,6-trichloro-2-pyridinecarboxylic acid
Picolinafen	<i>N</i> -(<i>p</i> -fluorophenyl)-6-[3-(trifluoromethyl)phenoxy]-2-pyridinecarboxamide
Pretilachlor	2-chloro- <i>N</i> -(2,6-diethylphenyl)- <i>N</i> -(2-propoxyethyl)acetamide
Primisulfuron	methyl 2-[[[(4,6-bis(difluoromethoxy)-2-pyrimidinyl)amino]carbonyl]amino]sulfonyl]benzoate
Prodiamine	2,4-dinitro- <i>N</i> ³ , <i>N</i> ³ -dipropyl-6-(trifluoromethyl)-1,3-benzenediamine
Prometon	6-methoxy- <i>N,N'</i> -bis(1-methylethyl)-1,3,5-triazine-2,4-diamine
Prometryn	<i>N,N'</i> -bis(1-methylethyl)-6-(methylthio)-1,3,5-triazine-2,4-diamine
Propachlor	2-chloro- <i>N</i> -(1-methylethyl)- <i>N</i> -phenylacetamide
Propanil	<i>N</i> -(3,4-dichlorophenyl)propanamide
Propaquizafop	2-(4-aryloxyphenoxy) propionic acid
Propoxycarbazone	methyl 2-[[[(4-methyl-5-oxo-3-propoxy-4,5-dihydro-1 <i>H</i> -1,2,4-triazol-1-yl) carbonyl]amino]sulfonyl] benzoate sodium salt
Prosulfocarb	<i>S</i> -(phenylmethyl) dipropylcarbamothioate
Prosulfuron	1-(4-methoxy-6-methyl-triazin-2-yl)-3-[2-(3,3,3-trifluoropropyl)-phenylsulfonyl]-urea
Pyraflufen-ethyl	[2-chloro-5-[4-chloro-5-(difluoromethoxy)-1-methyl-1 <i>H</i> -pyrazol-3-yl]-4-fluorophenoxy]acetic acid
Pyrazolynate	(2,4-dichlorophenyl)[1,3-dimethyl-5-[[[(4-methylphenyl)sulfonyl]oxy]-1 <i>H</i> -pyrazol-4-yl]methanone
Pyrazon	5-amino-4-chloro-2-phenyl-3(2 <i>H</i>)-pyridazinone
Pyrazosulfuron-ethyl	5-[[[(4,6-dimethoxy-2-pyrimidinyl)amino]carbonyl]amino]sulfonyl]-1-methyl]-1 <i>H</i> -pyrazole-4-carboxylic acid
Pyrazoxyfen	2-[[[4-(2,4-dichlorobenzoyl)-1,3-dimethyl-1 <i>H</i> -pyrazol-5-yl]oxy]-1-phenylethanone
Pyribenzoxim	benzophenone <i>O</i> -[2,6-bis(4,6-dimethoxypyrimidin-2-yloxy)benzoyl]oxime
Pyridate	<i>O</i> -(6-chloro-3-phenyl-4-pyridazinyl) <i>S</i> -octyl carbonothioate
Pyriithiobac	2-chloro-6-[(4,6-dimethoxy-2-pyrimidinyl)thio]benzoic acid
Quinclorac	3,7-dichloro-8-quinolinecarboxylic acid
Quizalofop-P	(<i>R</i>)-2-[4-[(6-chloro-2-quinoxalinyloxy]phenoxy]propanoic acid
Rimsulfuron	<i>N</i> -[[[(4,6-dimethoxy-2-pyrimidinyl)amino]carbonyl]-3-(ethylsulfonyl)-2-pyridinesulfonamide
Sethoxydim	2-[1-(ethoxyimino)butyl]-5-[2-(ethylthio)propyl]-3-hydroxy-2-cyclohexen-1-one
Siduron	<i>N</i> -(2-methylcyclohexyl)- <i>N'</i> -phenylurea
Simazine	6-chloro- <i>N,N'</i> -diethyl-1,3,5-triazine-2,4-diamine
Simetryn	<i>N,N'</i> -diethyl-6-(methylthio)-1,3,5-triazine-2,4-diamine
Sodium chlorate	sodium chlorate
Sulcotrione	2-[2-chloro-(4-methylsulfonyl)benzoyl]cyclohexane-1,3-dione
Sulfentrazone	<i>N</i> -[2,4-dichloro-5-[4-(difluoromethyl)-4,5-dihydro-3-methyl-5-oxo-1 <i>H</i> -1,2,4-triazol-1-yl]phenyl]methanesulfonamide
Sulfometuron	methyl 2-[[[(4,6-dimethyl-2-pyrimidinyl)amino]carbonyl]amino]sulfonyl]benzoate
Sulfosulfuron	1-(4,6-dimethoxypyrimidin-2-yl)-3-[[2-(ethanesulfonyl-imidazo[1,2- <i>a</i>]pyridine-3-yl)sulfonyl]urea
Tebuthiuron	<i>N</i> -[5-(1,1-dimethylethyl)-1,3,4-thiadiazol-2-yl]- <i>N,N'</i> -dimethylurea
Terbacil	5-chloro-3-(1,1-dimethylethyl)-6-methyl-2,4(1 <i>H</i> ,3 <i>H</i>)-pyrimidinedione
Terbumeton	<i>N</i> -(1,1-dimethyl)- <i>N'</i> -ethyl-6-methoxy-1,3,5-triazine-2,4-diamine
Terbuthylazine	6-chloro- <i>N</i> -(1,1 dimethylethyl)- <i>N'</i> -ethyl-1,3,5-triazine-2,4-diamine
Thenylchlor	2-chloro- <i>N</i> -(2,6-dimethylphenyl)- <i>N</i> -[(3-methoxy-2-thienyl)methyl]acetamide
Thiazopyr	methyl 2-(difluoromethyl)-5-(4,5-dihydro-2-thiazolyl)-4-(2-methylpropyl)-6-(trifluoromethyl)-3-pyridinecarboxylate
Thifensulfuron	3-[[[(4-methoxy-6-methyl-1,3,5-triazin-2-yl)amino]carbonyl]amino]sulfonyl]-2-thiophenecarboxylic acid
Thiobencarb	5-[(4-chlorophenyl)methyl]diethylcarbamothioate
Tralkoxydim	2-[1-(ethoxyimino)propyl]-3-hydroxy-5-(2,4,6-trimethylphenyl)-2-cyclohexen-1-one
Triallate	5-(2,3,3-trichloro-2-propenyl)bis(1-methylethyl)carbamothioate
Triasulfuron	2-(2-chloroethoxy)- <i>N</i> -[[[(4-methoxy-6-methyl-1,3,5-triazin-2-yl)amino]carbonyl]benzenesulfonamide
Tribenuron	methyl 2-[[[(4-methoxy-6-methyl-1,3,5-triazin-2-yl)methylamino]carbonyl]amino]sulfonyl]benzoate
Triolopyr	[(3,5,6-trichloro-2-pyridinyl)oxy]acetic acid
Tritazine	6-chloro- <i>N,N,N'</i> -triethyl-1,3,5-triazine-2,4-diamine
Trifloxysulfuron sodium	<i>N</i> -[[[(4,6-dimethoxy)-2-pyrimidinyl]carbamoyl]-3-(2,2,2-trifluoroethoxy)-pyridin-2-sulfonamide sodium salt
Trifluralin	2,6-dinitro- <i>N,N</i> -dipropyl-4-(trifluoromethyl)benzenamine
Triflusulfuron	methyl 2-[[[(4-dimethylamino)-6-(2,2,2-trifluoroethoxy)-1,3,5-triazin-2-yl]amino]carbonyl]amino]sulfonyl]-3-methylbenzoate
Vernolate	<i>S</i> -propyl dipropylcarbamothioate

Appendix 3. Alphabetical listing of common herbicide names with Site of Action Groupings.^a

Chemical name	WSSA	HRAC
2,4-D	4	O
2,4-DB	4	O
A		
Acetochlor	15	K3
Acifluorfen	14	E
Aclonifen	11	F3
Acrolein	NC ^a	NC
Alachlor	15	K3
Alloxydim	1	A
Ametryn	5	C1
Amicarbazone	5	C1
Amidosulfuron	2	B
Amitrole	11	F3
Anilofos	15	K3
Asulam	18	I
Atrazine	5	C1
Azafenidin	14	E
Azimsulfuron	2	B
B		
Beflubutamid	12	F1
Benazolin	NC	NC
Benefin	3	K1
Benoxacor	NC	NC
Bensulfuron	2	B
Bensulide	8	N
Bentazon	6	C3
Benzofenap	27	F2
Bifenox	14	E
Bispyribac-sodium	2	B
Bromacil	5	C1
Bromoxynil	6	C3
Butachlor	15	K3
Butafenacil	15	K3
Butroxydim	1	A
Butylate	8	N
C		
Cacodylic acid	NC	NC
Carbetamide	23	K2
Carfentrazone-ethyl	14	E
Chlorimuron	2	B
Chlorotoluron	7	C2
Chlorsulfuron	2	B
Cinmethylin	26	Z
Cinosulfuron	2	B
Clethodim	1	A
Clodinafop-propargyl	1	A
Clomazone	13	F4
Clopyralid	4	O
Cloquintocet-mexyl	NC	NC
Cloransulam-methyl	2	B
Copper chelate	NC	NC
Copper sulfate	NC	NC
Cyanazine	5	C1
Cycloate	8	N
Cyclosulfamuron	2	B
Cycloxydim	1	A
Cyhalofop-butyl	1	A
D		
DCPA	3	K1
Dazomet	26	Z
Desmedipham	5	C1
Desmetryn	5	C1
Dicamba	4	O
Dichlobenil	20	L
Dichlormid	NC	NC

Appendix 3. Continued.

Chemical name	WSSA	HRAC
Dichlorprop	4	O
Diclofop	1	A
Diclosulam	2	B
Difenzoquat	26	Z
Diflufenican	12	F1
Diflufenopyr	19	P
Dimefuron	7	C2
Dimethenamid	15	K3
Dimethipin	NC	NC
Dinoterb	24	M
Diquat	22	D
Dithiopyr	3	K1
Diuron	7	C2
DSMA	17	Z
E		
Endothall	NC	NC
EPTC	8	N
Esprocarb	8	N
Ethalfuralin	3	K1
Ethametsulfuron	2	B
Ethofumesate	16	N
Ethoxysulfuron	2	B
F		
Fenchlorazole-ethyl	NC	NC
Fenclozime	NC	NC
Fenoxaprop	1	A
Fentrazamide	15	K3
Flamprop	25	Z
Flazasulfuron	2	B
Florasulam	2	B
Fluazifop-P-butyl	1	A
Flucarbazone-sodium	2	B
Flufenacet	15	K3
Flufenpyr-ethyl	14	E
Flumetsulam	2	B
Flumiclorac	14	E
Flumioxazin	14	E
Fluometuron	7	C2
Fluoroglyphosate	14	E
Flupyrifos-methyl-sodium	2	B
Fluridone	12	F1
Flurochloridone	12	F1
Fluroxypyr	4	O
Flurtamone	12	F1
Fluthiacet-methyl	14	E
Fluxofenim	NC	NC
Fomesafen	14	E
Foramsulfuron	2	B
Fosamine	26	Z
G		
Glufosinate	10	H
Glyphosate	9	G
H		
Halosulfuron	2	B
Haloxypyr	1	A
Hexazinone	5	C1
I		
Imazamethabenz	2	B
Imazamox	2	B
Imazapic	2	B
Imazapyr	2	B
Imazaquin	2	B
Imazethapyr	2	B
Iodosulfuron	2	B
Ioxynil	6	C3

Appendix 3. Continued.

Chemical name	WSSA	HRAC
Isoproturon	7	C2
Isoxaben	21	L
Isoxaflutole	27	F2
L		
Lactofen	14	E
Linuron	7	C2
M		
MCPA	4	O
MCPB	4	O
Mecoprop	4	O
Mefenacet	15	K3
Mefenpyr-diethyl	NC	NC
Mefluidide	NC	NC
Mesotrione	27	F2
Metaborate	NC	NC
Metamitron	5	C1
Metazachlor	15	K3
Metham	26	Z
Methibenzuron	7	C2
Metolachlor	15	K3
Metoxuron	7	C1
Metribuzin	5	C1
Metsulfuron	2	B
Molinate	8	N
Monolinuron	7	C2
MSMA	17	Z
N		
Napropamide	15	K3
Naptalam	19	P
Nicosulfuron	2	B
Norflurazon	12	F1
O		
Oryzalin	3	K1
Oxaziclonofone	NC	NC
Oxadiargyl	14	E
Oxadiazon	14	E
Oxyfluorfen	14	E
P		
Paraquat	22	D
Pebulate	8	N
Pelargonic acid	26	Z
Pendimethalin	3	K1
Phenmedipham	5	C1
Picloram	4	O
Picolinafen	12	F1
Pretilachlor	15	K3
Primisulfuron	2	B
Prodiamine	3	K1
Prometon	5	C1
Prometryn	5	C1
Propachlor	15	C3
Propanil	7	C2
Propaquizafop	1	A
Propoxycarbazone	2	B
Prosulfocarb	8	N
Prosulfuron	2	B
Pyraflufen-ethyl	14	E
Pyrazolynate	27	F2
Pyrazon	5	C1
Pyrazosulfuron-ethyl	2	B
Pyrazoxyfen	27	F2
Pyribenzoxim	2	B
Pyridate	6	C3
Pyriothiobac	2	B

Appendix 3. Continued.

Chemical name	WSSA	HRAC
Q		
Quinclorac (dicots)	4	O
Quinclorac (monocots)	26	L
Quizalofop-P	1	A
R		
Rimsulfuron	2	B
S		
Sethoxydim	1	A
Siduron	7	C2
Simazine	5	C1
Simetryn	5	C1
Sodium chlorate	NC	NC
Sulcotrione	27	F2
Sulfentrazone	14	E
Sulfometuron	2	B
Sulfosulfuron	2	B
T		
Tebuthiuron	7	C2
Terbacil	5	C1
Terbumeton	5	C1
Terbuthylazine	5	C1
Thenylchlor	15	K3
Thiazopyr	3	K1
Thifensulfuron	2	B
Thiobencarb	8	N
Tralkoxydim	1	A
Triallate	8	N
Triasulfuron	2	B
Tribenuron	2	B
Triclopyr	4	O
Trietazine	5	C1
Trifloxysulfuron sodium	2	B
Trifluralin	3	K1
Triflusulfuron	2	B
V		
Vernolate	8	N

^a Abbreviations: WSSA, Weed Science Society of America; HRAC, Herbicide Resistance Action Committee; NC, not classified.

AXIOM DF

CANADIAN LABELReason to Issue: To show registered label text.Date of Label: 05/24//2002Date of Supersedes Label: 01/15/2002 (REG),
10/06/99 (REG)**AXIOM[®] DF****68% WATER DISPERSIBLE GRANULAR HERBICIDE****GROUP 5 15 HERBICIDES****FOR CONTROL OF ANNUAL GRASSES AND CERTAIN BROADLEAF
WEEDS IN FIELD CORN AND SOYBEANS****FOR SALE FOR USE IN EASTERN CANADA ONLY****AGRICULTURAL**

GUARANTEE:	Flufenacet	54.4%
	Metribuzin	13.6%

REGISTRATION NO. **26,233** PEST CONTROL PRODUCTS ACT**READ THE LABEL AND BOOKLET BEFORE USING
KEEP OUT OF REACH OF CHILDREN****WARNING****POISON****POTENTIAL SKIN SENSITIZER****Bayer**

Bayer Inc.
Agriculture Division, Crop Protection
77 Belfield Road
Toronto, Ontario, Canada M9W 1G6

AXIOM DF Herbicide

RESISTANCE-MANAGEMENT RECOMMENDATIONS

For resistance management, please note that AXIOM DF Herbicide is both a Group 5 and a Group 15 herbicide. Any weed population may contain or develop plants naturally resistant to AXIOM DF Herbicide and other Group 5 and/or Group 15 herbicides. The resistant biotypes may dominate the weed population if these herbicides are used repeatedly in the same fields.

Other resistance mechanisms that are not linked to site of action, but specific for individual chemicals, such as enhanced metabolism, may also exist. Appropriate resistance-management strategies should be followed.

To delay herbicide resistance:

- Where possible, rotate the use of AXIOM DF Herbicide or other Group 5 and Group 15 herbicides with different herbicide groups that control the same weeds in a field.
- Use tank mixtures with herbicides from a different group when such use is permitted.
- Herbicide use should be based on an IPM program that includes scouting, historical information related to herbicide use and crop rotation, and considers tillage (or other mechanical), cultural, biological and other chemical control practices.
- Monitor treated weed populations for resistance development.
- Prevent movement of resistant weed seeds to other fields by cleaning harvesting and tillage equipment and planting clean seed.
- Contact your local extension specialist or certified crop advisors for any additional pesticide resistance-management and/or integrated weed-management recommendations for specific crops and weed biotypes.
- For further information or to report suspected resistance, contact the Bayer Agriculture Division via Internet at www.bayercropscience.ca or phone 1-877-938-3737.

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