

## Classification of Herbicides According to Site of Action

Farmers, advisors and researchers should know which herbicides are best suited to combat specific resistant weeds. To support the use of herbicides suitable for resistance management the enclosed classification of herbicides is proposed.

The herbicides are classified alphabetically according to their target sites, sites of action, similarity of induced symptoms or chemical classes.

If different herbicide groups share the same site of action only one letter is used. In the case of photosynthesis inhibitors subclasses C<sub>1</sub>, C<sub>2</sub> and C<sub>3</sub> indicate different binding behaviour at the binding protein D<sub>1</sub> or different classes. Bleaching can be caused by different ways. Accordingly subgroups F<sub>1</sub>, F<sub>2</sub> and F<sub>3</sub> are introduced. Growth inhibition can be induced by herbicides from subgroups K<sub>1</sub>, K<sub>2</sub> and K<sub>3</sub>. Herbicides with unknown sites of action are classified in group Z as "unknown" until they can be grouped exactly.

### Classification of Herbicides

In order to avoid confusion with I and O categories J and Q are omitted. New herbicides will be classified in the respective groups or in new groups (R, S, T...).

Since the system was in part developed in co-operation with the "Weed Science Society of America (WSSA)" new herbicides should be categorised jointly by HRAC and WSSA.

For reference the numerical system of the WSSA is listed, too.

The aim of HRAC is to create a uniform classification of herbicide sites of action in as many countries as possible.

Such a classification system can be useful for many instances but there are cases where weeds exhibit multiple resistance across many of the groups listed and in these cases the key may be of limited value.

The system itself is not based on resistance risk assessment but can be used by the farmer or advisor as a tool to choose herbicides in different sites of action groups, so that mixtures or rotations of active ingredients can be planned.

For a figure of the chemical groups involved each HRAC Group, click on the letter in the table below. A synoptic graphic of the HRAC groups is also available.

**The WSSA and HRAC systems differ in minor ways. Herbicides in *italics* are listed on the HRAC classification system but are not listed on the WSSA classification.**

#### HRAC: Herbicide classification

HRAC Group	Site of Action	Chemical Family	Active Ingredient	WSSA Group
A	Inhibition of acetyl CoA carboxylase (ACCase)	Aryloxyphenoxy-propionate 'FOPs'	clodinafop-propargyl cyhalofop-butyl diclofop-methyl fenoxaprop-P-ethyl fluzafop-P-butyl haloxyfop-R-methyl propaquizafop quizalofop-P-ethyl	1
		Cyclohexanedione 'DIMs'	alloxydim butroxydim clethodim cycloxydim <i>profoxydim</i> sethoxydim <i>tepraloxym</i> tralkoxydim	
		Phenylpyrazoline 'DEN'	pinoxaden	
B	Inhibition of acetolactate synthase ALS (acetohydroxyacid synthase AHAS)	Sulfonylurea	amidosulfuron azimsulfuron bensulfuron-methyl chlorimuron-ethyl chlorsulfuron cinosulfuron cyclosulfamuron ethametsulfuron-methyl ethoxysulfuron flazasulfuron flupyralsulfuron-methyl-Na foramsulfuron halosulfuron-methyl <i>imazosulfuron</i> iodosulfuron mesosulfuron metsulfuron-methyl nicosulfuron <i>oxasulfuron</i> primisulfuron-methyl prosulfuron pyrazosulfuron-ethyl rimsulfuron sulfometuron-methyl sulfosulfuron thifensulfuron-methyl triasulfuron tribenuron-methyl trifloxysulfuron triflusulfuron-methyl <i>tritosulfuron</i>	2
		Imidazolinone	imazapic imazamethabenz-methyl imazamox imazapyr imazaquin imazethapyr	
		Triazolopyrimidine		

			cloransulam-methyl diclosulam florasulam flumetsulam metosulam penoxsulam	
		Pyrimidinyl(thio)benzoate	bispyribac-Na pyribenzoxim <i>pyriftalid</i> pyrithiobac-Na <i>pyriminobac-methyl</i>	
		Sulfonylaminocarbonyl-triazolinone	flucarbazone-Na propoxycarbazone-Na	
<b>HRAC Group</b>	<b>Site of Action</b>	<b>Chemical Family</b>	<b>Active Ingredient</b>	<b>WSSA Group</b>
C1	Inhibition of photosynthesis at photosystem II	Triazine	ametryne atrazine cyanazine desmetryne <i>dimethametryne</i> prometon prometryne propazine simazine simetryne terbumeton terbutylazine <i>terbutryne</i> trietazine	5
		Triazinone	hexazinone metamitron metribuzin	
		Triazolinone	amicarbazone	
		Uracil	bromacil <i>lenacil</i> terbacil	
		Pyridazinone	pyrazon = chloridazon	
		Phenyl-carbamate	desmedipham phenmedipham	
C2	Inhibition of photosynthesis at photosystem II	Urea	<i>chlorobromuron</i> chlorotoluron <i>chloroxuron</i> dimefuron diuron <i>ethidimuron</i> <i>fenuron</i> fluometuron (see F3) isoproturon <i>isouron</i> linuron methabenzthiazuron <i>metobromuron</i> metoxuron monolinuron <i>neburon</i> siduron tebuthiuron	7
		Amide	propanil <i>pentanochlor</i>	
C3	Inhibition of photosynthesis at photosystem II	Nitrile	<i>bromofenoxim</i> bromoxynil ioxynil	6
		Benzothiadiazinone	bentazon	
		Phenyl-pyridazine	pyridate <i>pyridafol</i>	
D	Photosystem-I-electron diversion	Bipyridylum	diquat paraquat	22
<b>HRAC Group</b>	<b>Site of Action</b>	<b>Chemical Family</b>	<b>Active Ingredient</b>	<b>WSSA Group</b>
E	Inhibition of protoporphyrinogen oxidase (PPO)	Diphenylether	acifluorfen-Na bifenox <i>chlomethoxyfen</i> <i>fluoroglycofen-ethyl</i> fomesafen <i>halosafen</i> lactofen oxyfluorfen	14
		Phenylpyrazole	<i>fluazolate</i> pyraflufen-ethyl	
		N-phenylphthalimide	cinidon-ethyl flumioxazin flumiclorac-pentyl	
		Thiadiazole	fluthiacet-methyl <i>thidiazimin</i>	

		Oxadiazole	oxadiazon oxadiargyl	
		Triazolone	azafenidin carfentrazone-ethyl sulfentrazone	
		Oxazolidinedione	pentoxazone	
		Pyrimidindione	benzfendione butafenacil	
		Other	pyraclonil profluzol flufenpyr-ethyl	
F1	Bleaching: Inhibition of carotenoid biosynthesis at the phytoene desaturase step (PDS)	Pyridazinone	norflurazon	12
		Pyridinecarboxamide	diflufenican picolinafen	
		Other	beflubutamid fluridone flurochloridone flurtamone	
F2	Bleaching: Inhibition of 4-hydroxyphenyl-pyruvate-dioxygenase (4-HPPD)	Triketone	mesotrione sulcotrione	27
		Isoxazole	isoxachlortole isoxaflutole	
		Pyrazole	benzofenap pyrazolynate pyrazoxyfen	
		Other	benzobicyclon	
F3	Bleaching: Inhibition of carotenoid biosynthesis (unknown target)	Triazole	amitrole (in vivo inhibition of lycopene cyclase)	11
		Isoxazolidinone	clomazone	13
		Urea	fluometuron (see C2)	
		Diphenylether	aclonifen	
G	Inhibition of EPSP synthase	Glycine	glyphosate sulfosate	9
H	Inhibition of glutamine synthetase	Phosphinic acid	glufosinate-ammonium bialaphos = bilanaphos	10
<b>HRAC Group</b>	<b>Site of Action</b>	<b>Chemical Family</b>	<b>Active Ingredient</b>	<b>WSSA Group</b>
I	Inhibition of DHP (dihydropteroate) synthase	Carbamate	asulam	18
K1	Microtubule assembly inhibition	Dinitroaniline	benefin = benfluralin butralin dinitramine ethalfluralin oryzalin pendimethalin trifluralin	3
		Phosphoroamidate	amiprofos-methyl butamiphos	
		Pyridine	dithiopyr thiazopyr	
		Benzamide	propyzamide = pronamide tebutam	
		Benzoic acid	DCPA = chlorthal-dimethyl	3
K2	Inhibition of mitosis / microtubule organisation	Carbamate	chlorpropham propham carbetamide	23
K3	Inhibition of VLCFAs ( see Remarks) (Inhibition of cell division)	Chloroacetamide	acetochlor alachlor butachlor	15
			dimethachlor dimethanamid metazachlor metolachlor pethoxamid	

			pretilachlor propachlor propisochlor thénylchlor	
		Acetamide	diphenamid napropamide naproanilide	
		Oxyacetamide	flufenacet mefenacet	
		Tetrazolinone	fentrazamide	
		Other	anilofos cafenstrole piperophos	
L	Inhibition of cell wall (cellulose) synthesis	Nitrile	dichlobenil chlorthiamid	20
		Benzamide	isoxaben	21
		Triazolocarboxamide	flupoxam	
		Quinoline carboxylic acid	quinclorac (for monocots) (also group O)	26
<b>HRAC Group</b>	<b>Site of Action</b>	<b>Chemical Family</b>	<b>Active Ingredient</b>	<b>WSSA Group</b>
M	Uncoupling (Membrane disruption)	Dinitrophenol	DNOC dinoseb dinoterb	24
N	Inhibition of lipid synthesis - not ACCase inhibition	Thiocarbamate	butylate cycloate dimepiperate EPTC esprocarb molinate orbencarb pebulate prosulfocarb thiobencarb = benthicarb tiocarbazil triallate vernolate	8
		Phosphorodithioate	bensulide	
		Benzenofuran	benfuresate ethofumesate	
		Chloro-Carbonic-acid	TCA dalapon flupropanate	26
O	Action like indole acetic acid (synthetic auxins)	Phenoxy-carboxylic-acid	clomeprop 2,4-D 2,4-DB dichlorprop = 2,4-DP MCPA MCPB mecoprop = MCPP = CMPP	4
		Benzoic acid	chloramben dicamba TBA	
		Pyridine carboxylic acid	clopyralid fluroxypyr picloram triclopyr	
		Quinoline carboxylic acid	quinclorac (also group L) quinmerac	
		Other	benazolin-ethyl	
P	Inhibition of auxin transport	Phthalamate Semicarbazone	naptalam diflufenzopyr-Na	19
<b>HRAC Group</b>	<b>Site of Action</b>	<b>Chemical Family</b>	<b>Active Ingredient</b>	<b>WSSA Group</b>
R	....	...	...	
S	...	...	...	
.	...	...	...	
Z	Unknown Note: While the site of action of herbicides in Group Z is unknown it is likely that they differ in site of action between themselves and from other groups.	Arylamino propionic acid	Flamprop-M-methyl /-isopropyl	25

		Pyrazolium	difenzoquat	26
		Organoarsenical	DSMA MSMA	17
		Other	<i>bromobutide</i> <i>(chloro)-flurenol</i>	
			cinmethylin	
			<i>cumyluron</i>	
			dazomet	
			<i>dymron = daimuron</i> <i>methyl-dimuron =</i> <i>methyl-dymron</i> <i>etobenzanid</i> <i>fosamine</i> <i>indanofan</i> <i>metam</i> <i>oxaziclomefone</i> <i>oleic acid</i>	
			pelargonic acid pyributicarb	

**Remarks:**

According to information and comments following herbicides are classified in the January 2005 version in HRAC (WSSA) groups:

B (2): cancelled: #9; #9; procarbazon  
Approved ISO name: propoxycarbazon

E (14): cancelled: pyrazogyl  
Approved name: pyraclonil

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