# HERBICIDE RESISTANT WEEDS

**X1.** Herbicide resistance occurs with repeated use of a specific herbicide or a combination of herbicides for control of weed species that contain some plants in the population with a resistant genes. The resistant type will increase with each use of the herbicide(s) because the gene pool in the field will shift from susceptible to resistant. This shift may be permanent, assuming that the resistant type plants are equally "fit" in the cropping environment. Use of one herbicide from a group with one mode of action may give resistance to other herbicides with the same mode of action. However, weed specificity for resistance is known for different herbicides within a mode of action group. For example, if a wild oat population is resistant to one ACCase inhibitor herbicide, other ACCase inhibitor herbicides may or may not provide control.

Weed populations with wide genetic diversity may develop resistance rapidly, especially for herbicides with a single mode of action. Large plant numbers, prolific seed production, high rates of weed migration/spread, and diverse environmental conditions may contribute to high genetic diversity. For example, kochia developed resistance rapidly in North Dakota to SU herbicides because of genetic diversity and the single mode of action (ALS inhibition). Weeds may vary in resistance to herbicides of the same mode of action group, especially if the herbicides are from different chemical classes. For example, weeds resistant to SU herbicides may or may not be cross-resistant to the Imi class of ALS inhibitors. Weeds may also vary in resistance to herbicides of the same chemical class, depending on their specific resistance mutation(s). Table X1 lists herbicides within various mode of action groups as a guide for possible cross resistance.

#### Types of Resistance

Altered target site - Genetic mutations within a herbicide site of action can prevent complete herbicide interaction with binding sites, allowing the target-site protein to remain functional. The incomplete inhibition of the altered site of action may result in little to no observed plant injury. Where the herbicide has such little inhibitory effect on the site of action, plants may survive greater than 10 times the normal herbicide rate (considered high-level resistance). Modes of action where high-level resistance is most often seen include ACCase, ALS, and photosystem II inhibitors. However, target- site alterations may only partially reduce a herbicide's inhibitory effect. Such are considered low-level resistance because plants are unlikely to survive greater than 10 times the normal use rate. Plants with low-level target-site resistance may sometimes be controlled when the herbicide is applied to small plants at high-end label rates. Examples of low-level resistance due to target-site alterations include common ragweed resistant to PPO inhibitors, and goosegrass and some ryegrass resistant to glyphosate.

Altered herbicide metabolic processes - Plants prevent herbicide toxicity by rapid degradation. Corn degrades atrazine by this mechanism. This type of resistance is more complex than altered site-of-action type resistance because it involves several plant processes. Plants with altered metabolism resistance can degrade several unrelated herbicides of different modes of action through multiple genes controlling metabolic processes.

Plant injury may occur because plants can not rapidly degrade absorbed herbicide, causing this mechanism to be considered low-level resistance. Therefore increasing the herbicide rate to smaller plants may control more plants. Examples of altered herbicide metabolism include some ryegrass resistant to ACCase, ALS, and photosystem II inhibitors, and velvetleaf resistant to atrazine. Metabolic resistance is believed to be present in many other weed species.

#### Herbicide sequestration / Altered herbicide localization -

Movement of herbicide is impeded, moved away from its target site, or moved to a location where it is ineffective. This may be at the whole-plant or cellular level. Nearly all plants with this type of resistance are injured shortly after the herbicide application because the herbicide can not be moved away from the site of action fast enough and for a long enough time. Herbicide sequestration is considered low-level resistance because increasing rates applied to smaller plants increases mortality. Examples of herbicide sequestration include glyphosate-resistant horseweed and some ryegrass, likely glyphosate-resistant common and giant ragweed, and weed biotypes resistant to paraquat.

**Target-site amplification** - Some glyphosate-resistant Palmer amaranth has been shown to express increased levels of herbicide-susceptible EPSPS target-site protein. Many of these plants have up to 100 copies or more of the EPSPS gene, and likely produce more target-site enzyme than glyphosate can fully inhibit. This case is the only known example of this type of mechanism.

#### Cross and Multiple Resistance

A plant with a single resistance mechanism that survives treatment with chemicals within the same mode of action is cross resistant to those chemicals. Resistance that develops to one ALS herbicide chemistry often confers cross resistance to other ALS herbicide chemistries. The same is generally true with imidazolinones. In some cases, resistance that develops to a SU confers cross resistance to imidazolinones.

A plant with two or more resistance mechanisms that survives treatment with different chemicals within different modes of action has multiple resistance. Different resistance mechanisms are involved; therefore, a kochia plant that survives SU and atrazine has multiple resistance.

#### Herbicide resistant weed species in ND:

(#) = Herbicide mode of action, see pages 104-105. ACCase inhibitor herbicides (1): Wild oat, green foxtail, and yellow foxtail - All ACCase herbicides except Select\*.

#### ALS inhibitor herbicides (2):

Wild oat - Assert, Everest, Olympus, Rimfire, and Silverado. Kochia, waterhemp, c. ragweed, and wild mustard - All ALS herb. E. black nightshade and redroot pigweed - Imi herbicides. Marshelder - Imi herbicides and Express\* (SU).

#### Mitotic inhibitor (3):

Green foxtail - Treflan\*, Sonalan, Prowl.

Growth regulator (4): Kochia - 2,4-D and Banvel\*.

Photosystem II inhibitor (5): Kochia - atrazine.

**EPSP synthase inhibitor (9) (glyphosate):** C. ragweed. Kochia, waterhemp, and lambsquarters = unconfirmed.

#### Multiple Resistance:

Wild oat - ACCase (1) + ALS (2), Lipid synthesis (8) + Unknown (26). Kochia - Growth Regulator (4) + ALS (2).

#### Herbicide resistant weed species in other U.S. states:

**ALS inhibitor (2):** Yellow foxtail, giant foxtail, lambsquarters, sunflower, common cocklebur, giant ragweed, and Russian thistle.

Growth regulator (4): Wild mustard and field bindweed.

**Photosystem II Inhibitor (5):** Yellow foxtail, redroot pigweed, Powell amaranth, lambsquarters, and common ragweed. \*Or generic equivalent. **EPSP Synthase Inhibitor (9) (glyphosate):** Kochia, horseweed (marestail), common and giant ragweed, waterhemp, lambsquarters (unconfirmed).

PPO inhibitor (14): Common and giant ragweed and waterhemp.

# Multiple Resistance:

Powell amaranth - ALS (2) + triazine\* (5) - Canada Horseweed/Marestail - ALS (2) + Roundup\* (9) Multiple resistance (shown below) has been documented in biotypes of waterhemp, common ragweed, and giant ragweed: ALS (2) + PPO (14)

ALS (2) + Roundup\* (9) ALS (2) + Roundup\* (9) + PPO (14)

#### Weeds expressing some natural tolerance to Roundup\*:

Cinquefoil, clover, lambsquarters, common mallow, dandelion, horseweed (marestail), kochia, nightshade, nutsedge, prickly lettuce, smartweed, velvetleaf, waterhemp, wild buckwheat.

Weeds expressing some natural tolerance to glufosinate (lgnite/Liberty): grasses, lambsquarters, yellow nutsedge.

Genetically engineered crops resistant to glyphosate and glufosinate may be used to control weeds resistant to other herbicides. However, heavy selection pressure from these herbicides may cause selection of multiple resistant biotypes.

For a comprehensive list of resistant weeds in North Dakota, U.S., and world see web site: **www.weedscience.com** 

# STRATEGIES TO MINIMIZE HERBICIDE RESISTANT WEEDS

The following strategies should be effective in reducing problems with herbicide tolerant and resistant weed biotypes, but no single strategy is likely to be totally effective.

Weed resistance to herbicides <u>cannot</u> be prevented, but can be delayed. Herbicide rotations and tillage will only delay resistance by the length of time the selection pressure for a given herbicide is removed by an alternative control method. Resistance should occur in no-till fields before conventional-till fields. The gene pool does not revert back in absence of the original selection, except when the resistant plants are poorly fit. Fitness has not been greatly different for resistance management.

#### General Guidelines:

**1. Scout fields regularly** and identify weeds that escape herbicide treatment. Monitor changes in weed populations early (single plants or small patches) and restrict spread of escaped weeds that match the herbicide use pattern. If there are dead plants, unaffected plants, and plants showing intermediate responses then resistance should be strongly considered.

2. Apply herbicides in tank-mix, prepackage, or sequential mixtures that include multiple modes of action. Two or more herbicides in the tank-mix must have substantial activity against potentially resistant weeds to be most effective. Many commercial premixes do not contain herbicides that target the same weed species. Effective tank-mixtures likely reduce the selection of herbicide-resistant biotypes more successfully than rotating herbicide modes of action. Antagonism should be reduced as much as possible.

**3. Rotate herbicides with different modes of action in consecutive years**. Few novel modes of action are likely to be released in the foreseeable future, therefore proper management of all currently available modes of action is necessary.

**4. Rotate crops**, particularly those with different life cycles, e.g. winter annual crops (winter wheat), perennial crops (alfalfa), and summer annual crops (spring wheat, corn or beans). Do not use herbicides with the same mode of action in the different crops unless other effective control practices are also included.

**5. Use high rates of herbicides.** Use full herbicide rates and use the most effective adjuvants with herbicides applied alone and in tank-mixtures. Reduced rates will allow plants with low-level resistance to hybridization and produce plants with high-level resistance.

### Methods for Resistance Management

**Method 1. Continued Herbicide Use -** This approach allows for the use of the preferred herbicide until resistance occurs and then change to an alternative herbicide. This method requires more intense monitoring for resistance. The best resistance management strategy is early identification of resistant plants and then complete control (eradication) of the resistant plants while the infestation is small. Hand weeding, non-selective herbicides, cultivation, or combinations of methods can be used for eradication. Identification can be best accomplished with highly effective herbicide rates so that resistant plants are obvious for early eradication. Elimination of all resistant plants prior to reproduction on an annual basis should allow for continuous use of the herbicide.

#### Advantages:

1. Allow use of preferred herbicide.

Allow use of the herbicide best suited for weeds in a given field.
 The above may save costs as a herbicide with a second mode of action may not be needed for the weeds present before resistance develops.

#### Disadvantages:

1. Resistance will occur sooner and require earlier monitoring for resistance.

Does not save the herbicide for use in crops without alternatives.
 Requires hand-labor for greatest effect.

**Method 2. Rotate Herbicides -** This system will delay resistance, but may use unnecessary or less desirable herbicides in rotation or in mixture. Delaying resistance by alternative herbicides in the crop rotation is a means of keeping a herbicide for use in a crop that does not have an effective alternative.

#### Advantages:

 Monitoring for resistance is less essential but still very important.
 Herbicide mixtures may control more weed species and reduce the need for scouting to choose the appropriate herbicide for the field. <u>Disadvantages:</u>

1. Will use herbicides other than the most desired.

- 2. Will select for multiple resistance.
- 3. Fewer herbicide options saved for future use.

#### Testing weeds for herbicide resistance:

Plant samples can be sent to Ag-Quest to test for weed resistance. Contact before sending to determine cost and packaging instructions. Ag-Quest, Inc.

Haisheng Xie (Dr. Z), Ph.D #210 South Railway Street, Box 144 Minto, Manitoba, Canada, R0K 1M0 Office 204 776-5565 haisheng.xie@agquest.com, www.agquest.com ACCase or ALS (Group 1) herbicides = \$80 CAN/sample Dinitroaniline (Group 3) herbicides = \$45 CAN/sample

On-line study course on herbicide mode of action can be found at: http://www.wsweedscience.org/Lessons/lessons.asp

\*Or generic equivalent.

#### Herbicide Common Mode of Action Name Tradename Premix or Co-pack Tradenames clodinafop-P Discover NG. ACC-ase fenoxaprop-P Inhibitor (1) Puma = Tacoma. Fusion, Wolverine. fluazifop-P Fusilade DX. Aryloxyphenoxy Fusion. propionic acid "Fop" quizalofop Assure II = Targa clethodim Select = Trigger = Volunteer = Intensity. Cyclohexanedione Arrow, Clethodim, Envoy, Section, Select "Dim" Max, Shadow, Tap Out. sethoxydim Poast. Rezult. tralkoxydim Achieve. Axial XL Axial TBC Phenylpyrazolin "Den" pinoxaden ALS Enzyme imazamethabenz Assert. Inhibitor (2) imazamox Beyond = Clearcast = Raptor. ClearMax. imazapic Cadre = Impose = Plateau. Journey. Arsenal = Habitat. Lightning, OneStep, Sahara. Imidazolinone imazapyr imazethapyr Pursuit = Thunder. Authority Assist, Extreme=Thunder Master, Lightning, "Imi" Matador, Pursuit Plus. Sulfonylurea chlorimuron Classic. Enlite, Freestyle, Instigate, Traverse, Valor XLT. Chism, Cimarron Max/X-tra, Finesse/G&B, Report Extra. Glean = Report = Telar. "SU" chlorsulfuron foramsulfuron Option. Equip. Priority. halosulfuron Permit = Sandea. metsulfuron Accurate=Ally=Cimarron=Escort=Metgard = Accurate Extra, Agility, Ally Extra, Chisum, Cimarron Max, Metsulfuron=Patriot=Plotter=Romet=Valuron. Cimarron X-tra, Finesse, Report Extra. nicosulfuron Accent/Q, Adapt, Nic-It, Nico. Celebrity Plus, Clarion, Ironclad, Steadfast/Q, Stout. prosulfuron Exceed, Spirit. Peak. . rimsulfuron Matrix = Resolve DF=Rule. Resolve SG. Diligent, Instigate, Ironclad, Prequel, Require Q, Resolve Q, Steadfast/Q, Traverse, Trigate. sulfometuron Oust. sulfosulfuron Certainty (turf), Maverick. thifensulfuron Harass = Harmony DF = Treaty = Unity = Accurate Extra, Agility, Affinity BS/TM, Ally Extra, Basis, Enlite, Freestyle, Harmony Extra, Nimble, Rapport BS/TM, Volta. Resolve Q, TNT, Treaty Extra. triasulfuron Fuego, Rave. Amber. Accurate Extra, Agility, Affinity/Edition/Rapport Broadspec tribenuron Express = Nuance = Victory. /Tankmix, Ally Extra, Freestyle, Harmony Extra, Nimble, Supremacy, Trigate, TNT. triflusulfuron UpBeet. Authority First=Sonic, FrontRow, Gangster. cloransulam FirstRate. Triazolopyrimidine "TPS" florasulam Axial TBC, FirstStep, GoldSky, Orion, Starane Flex. FrontRow, Hornet, SureStart, TripleFlex. flumetsulam Pvthon. pyroxulam PowerFlex. GoldSky. flucarbazone Everest 2.0 = Pre-Pare. Raze. Sulfonylaminocarbonyltriazolinone Olympus Flex, Rimfire Max. propoxycarbazone Olympus. "SACT thiencarbazone Corvus. Mitotic Inhibitor (3) ethalfluralin Sonalan. Prowl/H20 = Acumen = Pendimax=Pendant. pendimethalin Pursuit Plus, Spartan Guard. Dinitroaniline (DNA) . trifluralin Trifluralin = Treflan = Triflurex = Trust/others. Buckle, Freedom. **Growth Regulators** 2.4-D 2.4-D. others. See bromoxynil. Crossbow, Curtail = Commando, (4) ForeFront, Grazone P+D = Gun Slinger, Landmaster BW = Phenoxy Campaign = Credit Master, Rage D-Tech, Shotgun, Starane+Salvo, Weedmaster = see dicamba. MCPA amine MCPA Amine. Rhomene. others. MCPA ester Daggar, MCPA E, Rhonox, Sword, Wildcard. See bromoxynil. ClearMax, Curtail M, Hat Trick, Orion, Starane+Sword. Benzoic acids dicamba-dma salt Banvel = Dicamba = Oracle = Rifle. Pulsar dicamba-dga salt Clarity = Sterling Blue. Banvel SGF. dicamba-Na salt Agility, Distinct=Overdrive, Require Q, Status, Yukon. dicamba acid Vision. Latigo. dicamba-ipa salt Fallow Master = Fallow Star. Weedmaster = Banvel + 2,4-D = Brash = Outlaw = Range dicamba-dea salt Star = Rifle D. Pyridine aminopyralid Milestone. CleanWave, ForeFront, Curtail/M, = Redeem, clopyralid Clean Slate, Clopyr Ag = Garrison = Spur = WideMatch = Colt, Hat Trick, Hornet, SureStart, TripleFlex. Stinger = Reclaim = Transline. fluroxypyr Starane = Comet = Trump Card = Vista. CleanWave, Colt+Salvo/Sword, GoldSky, Hat Starane Ultra = Obtain = Vista XRT. Trick, Pulsar, Raze, Supremacy, Starane Flex/NXT, Trooper Pro, WideMatch = Colt. Tordon 22K = Triumph 22K. Grazone P+D = Gun Slinger, Surmount, Trooper Extra/Pro. picloram Garlon = Remedy. Pathfinder II. PastureGard, Redeem, Vengence Plus. triclopyr - (DPX-KJM44 / DPX-MAT44) Plainview, Perspective, Steamline, Viewpoint. Pyrimidine aminocyclopyrachlor quinclorac (dicots) Quinoline Drive=Quinstar=Quinclorac. Paramount

# X1. Herbicide Classification and Mode of Action for Resistant Weed Management

Mode of Action      Name      Tradename      Premix or Co-pack Tradenames        Protocystem II Inhibitor (9) - Site A Intradename      Attraine, ethers.      See 2.4-0, demmk parture, Enversion, Bornoor, Mittylyphotete, actional (19) - Site A Intradename      Intradename      See 2.4-0, demmk parture, Enversion,		Common	Herbicide		
Photosystem II Inhibitor (5) * 16A      atrazine Inazine      Atrazine, others.      See 2.4.0, dicamba, pentacon, bornsynil, dyshoaate, activatione        Trazine Trazine      Amarine / Inazine      Princep.      Amarine / Princep.      Amarine / Princep.        Princep.      Membazine - Sectors Th-Cor.      Aminony MIZ, Boundary, Cancey, Domain, Matador.        Photosystem II Inhibitor (6) - Site B      Deface.      Basagram.      Setums - Byten, Diss Byten Processem II        Photosystem II Inhibitor (7) - Site A      Deface.      Basagram.      Setums - Byten, Diss Byten Processem II        Photosystem II Inhibitor (7) - Site A      duron      Diaron - Direx - Karman.      Bronze - Basagram.        Photosystem II Inhibitor (7) - Site A      duron      Diaron - Direx - Karman.      -        Photosystem II Inhibitor (7) - Site A      duron      Direx - Karman.      -        Photosystem II Inhibitor (7) - Site A      duron      Direx - Karman.      -        Protosystem II Inhibitor (7) - Site A      duron      Epster - Eradicane = Razencane.      -        Photosystem II Inhibitor (7) - Site A      Basagram.      -      -        Basagram II      Byten Site A      -      -        Inhibitor (7) - Site A      Basag	Mode of Action	Name	Tradename	Premix or Co-pack Tradenames	
Triazino      Imatibio      Procesp.      Derby.        Triazino      mattibuzin      Mettibuzin      Second Triazino      Bedamix = Phon-Des 2Hs, BNS Puis = Progress.        Photosystem II      Inhibitor (6) - Site B      Breazon      Bedamix = Phon-Des 2Hs, BNS Puis = Progress.        Photosystem II      Inhibitor (6) - Site B      Brocken = Bion	Photosystem II Inhibitor (5) - Site A	atrazine	Atrazine, others.	See 2,4-D, dicamba, bentazon, bromoxynil, glyphosate, acetochlor, dimethenamid-P, s-metolachlor + or - safener.	
Triazinone methozin Methozin Senoor 17:Cor. Authority MTZ, Boundary, Canopy, Domain, Marador. Preny-Crataman Aphanex Betanax. Betamize Fiberbace Set BNB Plus = Progress. Betamize Phen-Des 54, BNB Plus = Progress. Betamize Phene	Triazine	simazine	Princep.	Derby.	
Phenyl-carbamate desmedipham Alphanex - Betamex. Betamix - Phon-Des 8-8, BNB us - Progress. Photosystem II Inhibitor (9) - Site B Photosystem II Inhibitor (9) - Site A Innoise - Bioro - Brown -	Triazinone	metribuzin	Metribuzin = Sencor = Tri-Cor.	Authority MTZ, Boundary, Canopy, Domain, Matador.	
Photosystem II Inhibitor (6) - Site B      Bentazon Bentazon Bentazon II      Bentazon Bentazon Bentazon II      Bentazon Be	Phenyl-carbamate	desmedipham phenmedipham	Alphanex = Betanex. -	Betamix = Phen-Des 8+8, BNB Plus = Progress. Betamix = Phen-Des 8+8, BNB Plus = Progress.	
Inhibitor (6) - Site B      bromoxynal      BroClean = Bronx = Buchi = Moxy.      Bronate = Bison = Bronx = Muscle, Volverine. Bronate Advanced = B G = Bronx = Muscle, Volverine. Bronate Advanced = B G = Bronx = Muscle, Volverine. Bronate Advanced = B G = Bronx = Muscle, Volverine. Bronate Advanced = B G = Bronx = Muscle, Volverine. Bronate Volverine.        Photosystem II Inhibitor (7) - Site A - Initiation C - Jose A - Bronate Muscle, Volverine. Bronate Statem Distret Construct Prope	Photosystem II	bentazon	Basagran.	Galaxy, Laddok S-12, Rezult, Storm.	
Photosystem II Inhibitor (7) - Site A. different than 5      Idiuron Explose      Diuron = Dirax + Rarmax. Lorax = Linxitorion.      Krovar, Sahara, WeedBlast.	Inhibitor (6) - Site B	bromoxynil	BroClean = Bromox = Brox = Buctril = Moxy.	Bronate = Bison = Bromac = Bromox MCPA = Maestro MA = Wild Card Xtra, Brox M, Huskie, Wolverine. Bronate Advanced = B-5 = Bison Advanced = Bromac Advanced = Brox M Ultra = Wolfpack Advanced. Bromoxynil + 2,4-D(2 lb+2 lb), B-4, Double Up, Maestro D. Bromoxynil + 2,4-D (2 lb+2.5 lb) = WECO Max.	
Lipid Synthesis      cycloate      Ro-Neet.      Powerplay, Imperium.        Thiocathamate      trinilate      Far-Go.      Buckle.        PSPS Pythase      diytholeschipak.      Roundup, several generics - see page 71.      Extreme, Failow Master, Landmaster BW, others.        Calutamic Synthesis      diytholeschipak.      Roundup, several generics - see page 71.      Extreme, Failow Master, Landmaster BW, others.        Blaeching: Pythone      bellubutamid      UBH-520.      -        Desaturase Inhibitor (10)      Unrocholdone      Racer.      -        Blaeching: Pythone      bellubutamid      UBH-520.      -        Synthase Inhibitor (10)      Unrocholdone      Command      Command Xra, Commence.        Synthase Inhibitor (14)      formesare      Command      Command Xra, Commence.        Synthase Inhibitor (14)      formesare      Command      Stallar.        Diphonylether      factofon      Coda.      -        Itraining      fluthiacct      Cadet      -        Nephonylethalimide      fluthiacct      Cadet      -        Oxadiazole      pyradiume      Farty Acid      -        Phonylypizzole <td>Photosystem II Inhibitor (7) - Site A - different than 5</td> <td>diuron linuron tebuthiuron</td> <td>Diuron = Direx = Karmex. Lorox = Linex = Linuron. Spike.</td> <td>Krovar, Sahara, WeedBlast. - -</td>	Photosystem II Inhibitor (7) - Site A - different than 5	diuron linuron tebuthiuron	Diuron = Direx = Karmex. Lorox = Linex = Linuron. Spike.	Krovar, Sahara, WeedBlast. - -	
EPSP Synthase      glyphosate-ipa, K,      Roundup, several generics - see page 71.      Extreme, Fallow Master, Landmaster BW, others.        Glutamine Synthet- ase Inhibitor (10)      Liberty = Finale. Ignite 280. Rely 200.      -        Breaching: Phytoene Desturase Inhibitor (10)      Deflobutamid      UBH-320.      -        Breaching: DOVP (PDS) (12)      Ibutamone      -      -        Breaching: DOVP Synthase Inhibitor      Glutamone      -      -        PPO (Protox) Inhibitor (PDS) (12)      Glutamone      -      -        PPO (Protox) Inhibitor (14)      Iomesaten      Flexstar. Reflex = Top Gun.      Flexstar. GT, Prefix.        Diphenylethet      Goal.      -      -      -        Imine      Fluitiacot      Caol.      -      -        Ininiacot      Caola.      -      -      -        Nyhenylphthalimide      Fluitiacot      Caola.      -      -        Nyhenylphthalimide      Sharpen.      -      -      -        Pyrimidinedinone      Sharpen.      -      -      -      -        Trazolinone      Carbitarzone      Am opulacitarzone      -	Lipid Synthesis Inhibition (8) Thiocarbamate	cycloate EPTC triallate	Ro-Neet. Eptam = Eptek = Eradicane = Razencane. Far-Go.	- Powerplay, Imperium. Buckle.	
Glutamine Synthet- age Inhibitor (10)      Liberty = Finale. Ignite 280. Rely 200.      -        Bleaching: Phytoene Desturase Inhibitor (PDS) (12)      beflubutamid      UBH-820.      -        Bleaching: DXP      domazone      -      Nikyl.        Bleaching: DXP      domazone      -      Nikyl.        PPO (Protox) Inhibitor (14)      command Xtra, Commence.      -        Synthase Inhib. (13)      -      Galaxy, Storm.        PPO (Protox) Inhibitor oxyfluorfen      Cotar, Pheenix.      Galaxy, Storm.        Dphenylether      oxdicrofin      Cotar, Pheenix.      Stellar.        Dyhenylether      oxdicrofin      Cotar, Pheenix.      Stellar.        Nyherylethhalimide      fluminoszain      Resource.      -        Horinozazin      Protograd.      Stellar.      -        Prenylpyrazole      pyralifuen      ET. Vida.      -        Primiliondinone      saflufenazol      Sharpen.      Varidit      Suresstar.        Trazolinone      saflutenazol      Sharpen.      Varidit      Suresstar.        Trazolinone      saflutenazol      Sharpen.      Varidit      Suresstar.	EPSP Synthase Inhibitor (9)	glyphosate-ipa, K, dma, (NH <sub>4</sub> ) <sub>2</sub>	Roundup, several generics - see page 71.	Extreme, Fallow Master, Landmaster BW, others.	
Bleaching: Phytoene Desaturase Inhibitor    beflubutamid    UBH-820.    -      (PDS) (12)    Iluttamone    -    Nikyl.      Bleaching: DOXP    domazore    Command Xtra, Commence.      Synthase Inhib. (13)    Omazore    Command Xtra, Commence.      PPO (Protox) Inhibitor    acifluorifen    Ultra Blazer.    Galaxy. Storm.      (14)    tomesafen    Flexstar, Reflex = Top Gun.    Flexstar, Car, Prefix.      Diphenylether    lactolen    Cobra, Phoenix.    Stellar.      Imine    Iluthiacet    Cadet.    -      Nyhenviphthalimide    flumitoraz    Resource.    -      Panylogical Surgard.    -    -    -      Oxadiazole    oxadiargyl    Raft, Topstar.    -      Pyrimidinedione    safuferacil    Sharpen.    Verdict      Triazolinone    carfentrazone    Spartan = Blanket = Crossing = Portfolio.    Authority Assist/First-Sonic/MTZ, Spartan Advance/Charge      Very Long Chain    acetochlor    Harress = Confidence.    Imperium, Breakfree ATZ Lite=Keystn LA=Volley ATZ Lite, Keystn LA=Volley ATZ Lite, Charge Max      Strating and Blanket = Crossing = Portfolio.    Authority Assist/First-Sonic/MTZ, Spartan Advance/Char	Glutamine Synthet- ase Inhibitor (10)	glufosinate	Liberty = Finale. Ignite 280. Rely 200.	-	
Desstursse inhibitor      Načef.      -        Pilos (12)      flutamone      -        Bleaching: DOXP      clomazone      Command        Synthase Inhibitor      command      Command Xtra, Commence.        PPO (Protox) Inhibitor      actifuorfen      Ultra Blazer.        Ophenylether      covificurian      Cobra, Phoenix.        Imine      fluthiacet      Cadet.        N-phenylphthalimide      fluthiacet      Cadet.        Proving and the actifue acti	Bleaching: Phytoene	beflubutamid	UBH-820.	-	
(Hzb) (12)      Initiation      Initiation      Initiation        Synthase Inhib. (13)      Command      Command Xtra, Commence.        Synthase Inhib. (13)      Initiation      Command      Command Xtra, Commence.        PCP (Protox) Inhibitor Check Inhibitor      Initiation      Flexstar, Reflex = Top Gun.      Flexstar, Galaxy, Storm.        Diphenylether      Initiation      Goal.      -      -        Innine      Huthitacet      Cadet.      -      -        N-phenylphthalimide      Flexitar, Reflex = Top Gun.      Flexitar, Commence.      -        Oxadiazole      Example      Cadet.      -      -        Pyrimidinedione      Exating Mulein      Extremation      -      -        Triazolinone      Sature and Sharpen.      Verdict      -      -        Very Long Chain satifuenzone      Spattan = Blanket = Crossing = Portfolio.      Authority Assist/First-Sonio/MTZ, Spattan Advance/Charge        Very Long Chain satifuenzone      Action Intro Lasso, others.      -      -        Actamide      dimethenamid-Poulto Advance/Charge      -      -        Multical biolor      alachlor      -      -	Desaturase Inhibitor	flurochloridone	Racer.	- Nikvl	
Description      Dominance      Dominance        PPO (Protox) Inhibitor      actionen      Uitra Blazer.      Galaxy, Storm.        PPO (Protox) Inhibitor      actoren      Cobra, Phoenix.      Stellar.        Diphenylether      lactoren      Cobra, Phoenix.      Stellar.        Inine      flumicozari      Cobra, Phoenix.      Stellar.        N-phenylphthalimide      flumicorac      Resource.      -        Itimioxazin      Valor = Broadstar = Chateau = Encompass = Payload = Suregard.      -        Oxadiazole      oxadiargyl      Raft, Topstar.      -        Phenylpyrazole      pyraflufen      ET, Vida.      -        Primidinedione      cafrentrazone      Spartan = Blanket = Crossing = Portfolio.      Priority, Rage, Rage D-Tech, Spartan Advance/Charge        Very Long Chain      actochor      Harness = Confidence.      Imperium, Breakfree AT2 Lite-Keystn LA=Volley AT2 Lite, Surpass = Breakfree Volley.      Surgass = Breakfree Volley.      Surgass = Breakfree Volley.        Acetamide      dimethernamid-P      Dual B.g. Parallel PCS, Stalwart.      -        Dual B.g. Parallel PCS, Stalwart.      Dual B.g. Parallel PCS, Stalwart.      -        Scetamide      para	Reaching: DOXP	clomazone	Command	Command Xtra, Commence	
PPO (Protox) Inhibitor    acfiluorfen    Utra Blazer.    Galazer.    Galazer.      (14)    Diphenylether    Goal.    Flexstar. Reliex = Top Gun.    Flexstar. GT, Prefix.      Diphenylether    Goal.    -    -      Imine    fluthiacet    Cadet.    -      N-phenylphthalimide    fluthiacet    Cadet.    -      Oxadiazole    oxadiazgyl    Reft, Topstar.    -      Pyrimidinedione    Traizolinone    Safufenacii    Sharpen.    Verdict      Traizolinone    Cadetherazone    Spartan Advance/Charge    Priority, Rage, Rage D-Tech, Spartan Advance/Charge      Very Long Chain    catcholin    Barress = Confidence.    Imperium, Breakfree AT2 Lite=Keystn LA=Volley At2 Lite, Surpass = Breakfree > Volley.      Degree, TopNotch, Warrant.    alachlor    Alachlor, Intrro, Lasso, others.    -      Acetamide    fludencacif    Deline.    Doal al BE, Parallel PCS, Stalwart.    -      Oxyacetamide    Dual BE, Parallel PCS, Stalwart.    -    Prefix, Sequence.    Biondary. Prefix, Sequence.      Oxyacetamide    fludenacet    Deline.    Doal all Magnum, Brawl II, Cinch.    Biondary. Prefix, Sequence.    Biondary. Prefix, Sequence	Synthase Inhib. (13)	olomazone	Command	Command Adra, Commonoc.	
(14)    fomesafen    Flexstar, Reflex = Top Gun.    Flexstar GT, Prefix.      Diphenylether    actofen    Cobra, Phoenix.    Stellar.      Imine    fluthiacet    Cadet.    -      N-phenylphthalimide    flumioxar.    Resource.    -      Humioxar.    Valor = Broadstar = Chateau = Encompass =    Firece, Gangster, Diligent, Enlite.      Payload = Suregard.    -      Oxadiargyl    Raft, Topstar.    -      Phenylpyrazole    pyraflufen    ET, Vida.    -      Pyrimidinedione    saflufenacil    Sharpen.    Verdict      Triazolinone    carfentrazone    Aim = Quicksilver.    Profinity, Rage, Rage D-Tech, Spartan Advance/Charge      Yery Long Chain    acetochlor    Hamess = Contidence.    Imperium, Breakfree ATZ Lite=Keystn LA=Volley ATZ Lite, Surgars B. Terokito, Intro, Lasso, others.    -      Acetamide    dimethernamid-F    Outook = Cournit = Establish = Propele Sortie.    Verdict, Commit/Propel ATZ Lite=Establish/G-Max Lite.      Magnum, Brawi II, Cinch.    Dual II, Me-Tou-Lachior, Parallel, Stalwart.    Parallel Plus, Stalwart.      Netioachlor    Smetolachlor    Dual II, Me-Tou-Lachior, Parallel, Stalwart.    Parallel Plus, Stalwart.      Sm	PPO (Protox) Inhibitor	acifluorfen	Ultra Blazer.	Galaxy, Storm.	
Diphenylether      Iactofen      Cobra, PhoEnx.      Stellar.        Imine      fluthiacet      Cadat.      -        N-phenylphthalimide      fluthiacet      Cadet.      -        N-phenylphthalimide      fluthiacet      Cadet.      -        Oxadiazole      oxadiargyl      Resource.      -        Phenylpyrazole      pyraflufen      ET, Vida.      -        Pyrimidinedione      caffurfanzone      Sharpen.      Verdict        Triazolinone      caffurfanzone      Spartan = Blanket = Crossing = Portfolio.      Authority AssistPrirst=Sonic/MTZ, Spartan Advance/Charge        Very Long Chain      acetochlor      Harness = Confidence.      Imperium, Breakfree ATZ Lite=Keystn LA=Volley ATZ Lite, SureStart=TripleFlax.        (15)      alachlor      Halenker, Extovite Stawart.      Proverplay.        Aclatini, Intro, Lasso, others.      -      Vergetix, Stalwart.      Newpriay.        Aclatini, Intro, Lasso, others.      -      Natador.      Stalwart.        Metolachlor      Dual 8E, Parallel PCS, Stalwart.      Boundary, Prix, Sequence.      Boundary, Prix, Stalwart Xtra.        Dual 8E, Parallel PCS      Define.      Domain. Epic, Radius.	(14)	fomesafen	Flexstar, Reflex = Top Gun.	Flexstar GT, Prefix.	
Imine      Intinie      Intinie      Intinie      Intinie      Intinie        N-phenylphthalimide      flumicorac      Resource.      -      -        Oxadiazole      oxadiargyl      Raft, Topstar.      -      -        Phenylpyrazole      pyraflufen      ET, Vida.      -      -        Pyrimidinedione      saffurenacil      Sharpen.      Verdict      -        Triazolinone      carfentrazone      Alm = Quicksilver.      Priority, Rage, Rage D-Tech, Spartan Charge.        Suffentrazone      Spartan = Blanket = Crossing = Portfolio.      Authority Assist/First=Sonic/MTZ, Spartan Advance/Charge        Yery Long Chain      acetochlor      Harness = Confidence.      Timperium, Breaktree ATZ Lite-Keysth LA=Volley ATZ Lite, Surgass = Breaktree = Volley.        Degree, TopNotch. Warrant.      Alachlor, Intro, Lasso, others.      -      -        Acetamide      dimethenamid-P      Outook = Commit = Establish = Propel Sortio.      -      -        Dual II. Me-Too-Laschlor, Parallel PCS, Stalwart.      Buondary, Prefix, Sequence.      -      -        Streater      Dual II. Megnum, Brawl II, Cinch.      ATZ Lite, Camix, Camix, Charger Max.      Buondary. Prefix, Sequence.      -	Diphenylether	lactoten	Cobra, Phoenix.	Stellar.	
Minimize      District      District        Ni-phenylphthalimide      filumicolorac filumicolorac filumication      Resource.      -        Oxadiazole      oxadiargyl      Raft, Topstar.      -        Phenylpyrazole      pyraflufen      ET, Vida.      -        Primidinedines      safufenacii      Sharpen.      Verdict        Triazolinone      carfentrazone sulfentrazone sulfentrazone      Spartan = Blanket = Crossing = Portfolio.      Authority Assist/First=Sonic/MTZ, Spartan Charge.        Yery Long Chain Fatty Acid Inhibitor (15)      Resource.      Imperium, Breakfree ATZ Lite=Keystn LA=Volley ATZ Lite, SureStart=TripleFiex.        Acetamide      alachlor      Harness = Confidence.      Imperium, Breakfree ATZ Lite=Keystn LA=Volley ATZ Lite, SureStart=TripleFiex.        Outlook = Commit = Establish = Propel=Sortei. S-metolachlor      Outlook = Commit = Establish = Propel=Sortei.      Parallel PUs, Stalwart Xtra.        Dual Magnum, Brawl II, Me-Too-Lachtor, Parallel, Stalwart C. S-metol + safener      Dual Magnum, Brawl II, Cinch.      Boundary, Prefix, Sequence.        Isoxaline      pyroxasulfone      Zidu (KIH-485).      Elect.      Domain, Epic, Radius.        Unknown (16)      difuleracopyr      -      Celebrity Plus, Distinct, Status.      -	Imine	fluthiacet	Cadet	-	
ftumioxazin    Valor = Broadstar = Chateau = Encompass = Payload = Suregard.    Fierce, Gangster, Diligent, Enlite. -      Oxadiazole    oxadiargyl    Raft, Topstar.    -      Phenylpyrazole    pyrafluten    ET, Vida.    -      Pyrimidinedione    saflufenacil    Sharpen.    Verdict      Triazolinone    carlentrazone    Aim = Quicksilver.    Priority, Rage, Rage D-Tech, Spartan Charge.      Very Long Chain Fatty Acid Inhibitor (15)    acetochlor    Harness = Confidence.    Imperium, Breakfree ATZ Lite=Keystn LA=Volley ATZ Lite, Degree, TopNotch, Warrant.      Acetamide    alachlor    Alachlor, Intro, Lasso, others.    -      Acetamide    Outlook = Commit = Establish = Propel= Sortie.    Verdict, Commit/Propel ATZ Lite=Establish/G-Max Lite.      Dual II, Me-Too-Lachtor, Parallel, Stalwart C.    Dual II Magnum, Brawl, Charger Max.    Boundary, Prefix, Sequence.      S-meto + safener    Dual II Magnum, Brawl II, Cinch.    Bio Cadr? (2011), Prox + Sharpen? (2011)      Unknown (16)    ethofumesate    Nortron = Ethofumesate = Ethotron.    BNB Plus = Progress.      Auxin Inhibitor (22)    paraquat    Fierce Ader? (2011), Prox + Sharpen? (2011)      Unknown (26)    diffenzoquat quinclorac (grass)    Primestore.    - <t< td=""><td>N-phenylphthalimide</td><td>flumiclorac</td><td>Besource.</td><td>-</td></t<>	N-phenylphthalimide	flumiclorac	Besource.	-	
Oxadiazole    oxadiazole    oxadiazole    -      Phenylpyrazole    pyraflufen    ET, Vida.    -      Pyrimidinedione    Saflufenacii    Sharpen.    Verdict      Triazolinone    carfentrazone    Spartan = Blanket = Crossing = Portfolio.    Authority Assist/First=Sonid/MTZ, Spartan Advance/Charge      Very Long Chain    Fatty Acid Inhibitor    Harness = Confidence.    Imperium, Breakfree ATZ Lite=Keystn LA=Volley ATZ Lite, Surgass = Breakfree = Volley.      Jogree, TopNotch, Warrant.    Degree, TopNotch, Warrant.    -    Powerplay.      Acetamide    dimethenamid-P    Dual IK, Parallel PCS, Stalwart.    Verdict, Commit/Propel ATZ Lite=Establish/G-Max Lite.      Matador.    Joual II, Me-Too-Lachor, Parallel, Stalwart C.    Parallel Plus, Stalwart Xtra.    Bourdary, Prefix, Sequence.      Streetolachlor    S-metol-safener    Dual II, Me-Too-Lachor, Parallel, Stalwart C.    Parallel Plus, Stalwart Xtra.    Bourdary, Prefix, Sequence.      Stozaline    pyroxasulfone    Zidua (KIH-485).    Fierce. Pyrox + Cadet? (2011), Pyrox + Sharpen? (2011)      Unknown (16)    ethofuresate    Nortron = Ethofumesate = Ethotron.    BNB Plus = Progress.      Auxin Inhibitor (19)    difutenzopyr    -    Celebrity Plus, Distinct, Status.   <		flumioxazin	Valor = Broadstar = Chateau = Encompass = Payload = Suregard.	Fierce, Gangster, Diligent, Enlite. -	
Phenylpyrazole      pyraflufen      ET, Vida.      -        Pyrimidinedione      saflufenacil      Sharpen.      Verdict        Triazolinone      carfentrazone      Spartan = Blanket = Crossing = Portfolio.      Authority Assist/First=Sonic/MTZ, Spartan Advance/Charge        Very Long Chain      acetochlor      Harness = Confidence.      Firestity Acid Inhibitor        (15)      acetochlor      Harness = Breaktree = Volley.      Buestinger, TopPolatoh. Warrant.        Acetamide      dimethenamid-P      Outlook = Commit = Establish = Propele Sorte.      -        Matdolr, Intro, Lasso, others.      -      -      -        Oxyacetamide      flufenacet      Dual 8E, Parallel PCS, Stalwart.      -        S-metolachlor      Dual II Megnum, Brawl [I, Cinch.      Boundary, Prefix, Sequence.      Boundary, Prefix, Sequence.        S-metolachlor      Dual II Magnum, Brawl II, Cinch.      Eicer. Prox Ac Cade? (2011), Pyrox + Sharper? (2011)        Unknown (16)      ethofumesate      Nortron = Ethofumesate = Ethotron.      BNB Plus = Progress.        Auxin Inhibitor (19)      difuer.coguat      Avenge.      -        quinclorac (grass)      Drive = Facet = Paramount.      -        Inhibitor (22) </td <td>Oxadiazole</td> <td>oxadiargyl</td> <td>Raft, Topstar.</td> <td>-</td>	Oxadiazole	oxadiargyl	Raft, Topstar.	-	
Pyrimidinedione      saffufenacil      Sharpen.      Verdict        Triazolinone      carfentrazone      Sharpen.      Priority, Rage, Rage D-Tech, Spartan Charge.        Very Long Chain      acetochlor      Harness = Confidence.      Priority, Rage, Rage D-Tech, Spartan Charge.        Fatty Acid Inhibitor      acetochlor      Harness = Confidence.      Imperium, Breakfree ATZ Lite-Keystn LA=Volley ATZ Lite, Surgass = Breakfree = Volley.        Inethenamid-P      Degree, TopNotch. Warrant.      Alachlor      Alachlor, Intro, Lasso, others.        Acetamide      dimethenamid-P      Outlook = Commit = Establish = Propel= Sortie.      Verdict, Commit/Propel ATZ Lite=Establish/G-Max Lite.        Matchor      Alachlor      Ne=Too-Lachlor, Parallel, Stalwart.      Parallel Plus, Stalwart Xtra.        S-metolachlor      Dual II, Me-Too-Lachlor, Parallel, Stalwart C.      Bicep Lite II Magnum, Brawl II ATZ, Camix, Charger Max.        S-metol + safener      Dual II Magnum, Brawl II, Cinch.      ATZ Lite, Cinch ATZ Lite, Halex GT, Lumax.        Oxyacetamide      flufenacet      Define.      Domain, Epic, Radius.        Isoxaline      pyroxasulfone      Zidua (KIH-485).      Fierce. Pyrox + Cadel? (2011), Pyrox + Sharpen? (2011)        Unknown (16)      ethofumesate      Nortron = Ethofumesate = Et	Phenylpyrazole	pyraflufen	ET, Vida.	-	
Triazolinone    carfentrazone    Aim = Quicksilver.    Priority, Rage, Rage D-Tech, Spartan Charge.      Very Long Chain    acetochlor    Harness = Confidence.    Imperium, Breakfree ATZ Lite=Keystn LA=Volley ATZ Lite,      Fatty Acid Inhibitor    Surpass = Breakfree = Volley.    Buset = Consing = Portfolio.    Imperium, Breakfree ATZ Lite=Keystn LA=Volley ATZ Lite,      Acetamide    dimethenamid-P    Alachlor, Intrro, Lasso, others.    -      Acetamide    dimethenamid-P    Dual BE, Parallel PCS, Statwart.    Priority, Rage, Rage D-Tech, Spartan Charge.      S-metolachlor    Alachlor, Intrro, Lasso, others.    -    -      S-metolachlor    Bual II, Me-Too-Lachlor, Parallel, Stalwart.    Matador.      S-metolachlor    Dual II Magnum, Brawl II, Cinch.    Bicep Lite II Magnum, Brawl II ATZ, Camix, Charger Max.      S-metolachlor    S-metolachlor    Dual II Magnum, Brawl II, Cinch.    Bicep Lite II Magnum, Brawl II ATZ, Camix, Charger Max.      Isoxaline    pyroxasulfone    Zidua (KIH-485).    Fierce. Pyrox + Cadet? (2011), Pyrox + Sharpen? (2011)      Unknown (16)    ethofumesate    Nortron = Ethofumesate = Ethotron.    BNB Plus = Progress.    -      Auxin Inhibitor (19)    difuenzopyr    -    Celebrity Plus, Distinct, Status.    -	Pyrimidinedione	saflufenacil	Sharpen.	Verdict	
Very Long Chain Fatty Acid InhibitoracetochlorHarness = Confidence. Surpass = Breakfree = Volley. Degree, TopNotch. Warrant. Alachlor, Intrro, Lasso, others.Imperium, Breakfree ATZ Lite=Keystn LA=Volley ATZ Lite, SureStart=TripleFlex. Powerplay.Acetamidealachlor alachlor metolachlorAlachlor, Intrro, Lasso, others. Outlook = Commit = Establish = Propel= Sortie Dual 8E, Parallel PCS, Stalwart. Dual II, Me-Too-Lachlor, Parallel, Stalwart C. Dual Magnum, Braw, Charger Max. Dual II Magnum, Braw II, Cinch.Domain, Epic, Radius. Domain, Epic, Radius. Domain, Epic, Radius.Oxyacetamide IsoxalinepyroxasulfoneZidua (KIH-485).Fierce. Pyrox + Cadet? (2011), Pyrox + Sharpen? (2011)Unknown (16)ethofumesateNortron = Ethofumesate = Ethotron.BNB Plus = Progress.Auxin Inhibitor (19)diflufenzopyr-Celebrity Plus, Distinct, Status.Photosystem I Inhibitor (22)paraquat paraquatAvenge. Pirestorm, Gramoxone Inteon, Parazone, RelyInhibitor (27) Unknown (26)difenzoquat quinclorac (grass)AvengeInhibitor (27) Unknown (26)difustor e Facet = ParamountBleaching: HPPD Inhibitior (27) triketnenCallisto = Tenacity. LemobrioneCallisto = Tenac	Triazolinone	carfentrazone sulfentrazone	Aim = Quicksilver. Spartan = Blanket = Crossing = Portfolio.	Priority, Rage, Rage D-Tech, Spartan Charge. Authority Assist/First=Sonic/MTZ, Spartan Advance/Charge	
AcetamideAlachorAlachor, Intro, Lasso, onerseAcetamidedimethenamid-P metolachlor meto + safenerOutlook = Commit = Establish = Propel= Sortie. Dual 8E, Parallel PCS, Stalwart. Dual 11, Me-Too-Lachlor, Parallel, Stalwart C. Dual Magnum, Brawl, Charger Max. Dual II, Me-Too-Lachlor, Parallel, Stalwart C. Buendary, Prefix, Sequence. Bicep Lite II Magnum, Brawl II ATZ, Camix, Charger Max. Domain, Epic, Radius.Parallel PUs, Stalwart Xtra. Boundary, Prefix, Sequence. Bicep Lite II Magnum, Brawl II ATZ, Camix, Charger Max. ATZ Lite, Cinch ATZ Lite, Halex GT, Lumax.OxyacetamideflufenacetDefine.Domain, Epic, Radius.IsoxalinepyroxasulfoneZidua (KIH-485).Fierce. Pyrox + Cadet? (2011), Pyrox + Sharpen? (2011)Unknown (16)ethofumesateNortron = Ethofumesate = Ethotron.BNB Plus = Progress.Auxin Inhibitor (19)diflufenzopyr-Celebrity Plus, Distinct, Status.Photosystem I Inhibitor (22)diquat quinclorac (grass)Reglone = Diquat E-Ag. Firescorm, Gramoxone Inteon, Parazone, RelyInhibitor (27) triketonecallisto = Tenacity.Callisto Xtra, Camix, Halex GT, Instigate, Lumax, Trigate. LaudisIsoxazole Pyrasulfatole topramezoneimpactProde, Street (30):Por, cutivator, rotary-hoe, etcAdapted from WSSA Herbicide Classification System For Resistant Weed Management, Weed Technol. 17:606-608	Very Long Chain Fatty Acid Inhibitor (15)	acetochlor	Harness = Confidence. Surpass = Breakfree = Volley. Degree, TopNotch. Warrant.	Imperium, Breakfree ATZ Lite=Keystn LA=Volley ATZ Lite, SureStart=TripleFlex. Powerplay.	
S-meto + safenerDual II Magnum, Brawl II, Cinch.Bicep Lite II Magnum, Brawl II ATZ, Camix, Charger Max ATZ Lite, Cinch ATZ Lite, Halex GT, Lumax.OxyacetamideflufenacetDefine.Domain, Epic, Radius.IsoxalinepyroxasulfoneZidua (KIH-485).Fierce. Pyrox + Cadet? (2011), Pyrox + Sharpen? (2011)Unknown (16)ethofumesateNortron = Ethofumesate = Ethotron.BNB Plus = Progress.Auxin Inhibitor (19)diflufenzopyr-Celebrity Plus, Distinct, Status.Photosystem IdiquatReglone = Diquat E-Ag. Firestorm, Gramoxone Inteon, Parazone, RelyUnknown (26)difenzoquat quinclorac (grass)Avenge. Drive = Facet = ParamountBleaching: HPPD Inhibition(27) triketonemesotrioneCallisto = Tenacity. LaudisIsoxazoleisoxaflutoleBalance Flexx.Corvus, Epic, Prequel, Radius.Pyrazolonepyrasulfatole topramezoneCold, Hard STEEL (30): Plow, cultivator, rotary-hoe, etcAdapted from WSSA Herbicide Classification System For Resistant Weed Management. Weed Technol. 17:606-608	Acetamide	dimethenamid-P metolachlor meto + safener S-metolachlor	Outlook = Commit = Establish = Propel= Sortie. Dual 8E, Parallel PCS, Stalwart. Dual II, Me-Too-Lachlor, Parallel, Stalwart C. Dual Magnum, Brawl, Charger Max.	Verdict, Commit/Propel ATZ Lite=Establish/G-Max Lite. Matador. Parallel Plus, Stalwart Xtra. Boundary, Prefix, Sequence.	
OxyacetamideflufenacetDefine.Domain, Epic, Radius.IsoxalinepyroxasulfoneZidua (KIH-485).Fierce. Pyrox + Cadet? (2011), Pyrox + Sharpen? (2011)Unknown (16)ethofumesateNortron = Ethofumesate = Ethotron.BNB Plus = Progress.Auxin Inhibitor (19)diflufenzopyr-Celebrity Plus, Distinct, Status.Photosystem IdiquatReglone = Diquat E-AgInhibitor (22)paraquatFirestorm, Gramoxone Inteon, Parazone, RelyUnknown (26)difenzoquat quinclorac (grass)AvengeInhibition(27) triketonemesotrioneCallisto = TenacityInhibition(27) triketoneIsoxaflutoleBalance Flexx.Corvus, Epic, Prequel, Radius.PyrazolonepyrasulfatoleTopramezoneImpactCold, Hard STEEL (30): Plow, cultivator, rotary-hoe, etcAdapted from WSSA Herbicide Classification System For Resistant Weed Management. Weed Technol. 17:606-608		S-meto + safener	Dual II Magnum, Brawl II, Cinch.	Bicep Lite II Magnum, Brawl II ATZ, Camix, Charger Max ATZ Lite, Cinch ATZ Lite, Halex GT, Lumax.	
IsoxalinepyroxasulfoneZidua (KIH-485).Fierce. Pyrox + Cadet? (2011), Pyrox + Sharpen? (2011)Unknown (16)ethofumesateNortron = Ethofumesate = Ethotron.BNB Plus = Progress.Auxin Inhibitor (19)diflufenzopyr-Celebrity Plus, Distinct, Status.Photosystem I Inhibitor (22)diquat paraquatReglone = Diquat E-Ag. Firestorm, Gramoxone Inteon, Parazone, RelyUnknown (26)difenzoquat quinclorac (grass)Avenge. Drive = Facet = ParamountBleaching: HPPD Inhibition(27) triketonemesotrioneCallisto = Tenacity. Laudis.Callisto Xtra, Camix, Halex GT, Instigate, Lumax, Trigate. -IsoxazoleisoxaflutoleBalance Flexx.Corvus, Epic, Prequel, Radius.Pyrazolonepyrasulfatole topramezone-Cold, Hard STEEL (30): Plow, cultivator, rotary-hoe, etcAdapted from WSSA Herbicide Classification System For Resistant Weed Management. Weed Technol. 17:606-608	Oxyacetamide	flufenacet	Define.	Domain, Epic, Radius.	
Unknown (16)ethofumesateNortron = Ethofumesate = Ethotron.BNB Plus = Progress.Auxin Inhibitor (19)diflufenzopyr-Celebrity Plus, Distinct, Status.Photosystem I Inhibitor (22)diquat paraquatReglone = Diquat E-Ag. Firestorm, Gramoxone Inteon, Parazone, RelyUnknown (26)difenzoquat quinclorac (grass)Avenge. Drive = Facet = ParamountBleaching: HPPD Inhibition(27) triketom Isoxazolemesotrione isoxaflutoleCallisto = Tenacity. Laudis.Callisto Xtra, Camix, Halex GT, Instigate, Lumax, Trigate. -IsoxazoleisoxaflutoleBalance Flexx.Corvus, Epic, Prequel, Radius.Pyrazolonepyrasulfatole topramezone-Cold, Hard STEEL (30): Plow, cultivator, rotary-hoe, etc.Hord Steat Weed Management. Weed Technol. 17:606-608.	Isoxaline	pyroxasulfone	Zidua (KIH-485).	Fierce. Pyrox + Cadet? (2011), Pyrox + Sharpen? (2011)	
Auxin Inhibitor (19)    difufenzopyr    -    Celebrity Plus, Distinct, Status.      Photosystem I    diquat    Reglone = Diquat E-Ag.    -      Inhibitor (22)    paraquat    Firestorm, Gramoxone Inteon, Parazone, Rely.    -      Unknown (26)    difenzoquat    Avenge.    -      quinclorac (grass)    Drive = Facet = Paramount.    -      Bleaching: HPPD    mesotrione    Callisto = Tenacity.    Callisto Xtra, Camix, Halex GT, Instigate, Lumax, Trigate.      Inhibition(27) triketone    isoxaflutole    Balance Flexx.    -      Isoxazole    pyrasulfatole    -    -      pyrazolone    pyrasulfatole    -    Huskie, Wolverine.      topramezone    Impact.    -    -      Cold, Hard STEEL (30): Plow, cultivator, rotary-hoe, etc.    -    -      Adapted from WSSA Herbicide Classification System For Resistant Weed Management. Weed Technol. 17:606-608.    -	Unknown (16)	ethofumesate	Nortron = Ethofumesate = Ethotron.	BNB Plus = Progress.	
Photosystem I    diquat paraquat    Reglone = Diquat E-Ag. Firestorm, Gramoxone Inteon, Parazone, Rely.    -      Unknown (26)    difenzoquat quinclorac (grass)    Avenge. Drive = Facet = Paramount.    -      Bleaching: HPPD Inhibition(27) triketone    mesotrione    Callisto = Tenacity.    Callisto = Tenacity.    Callisto = Tenacity.      Inhibition(27) triketone    isoxaflutole    Balance Flexx.    Corvus, Epic, Prequel, Radius.      Pyrazolone    pyrasulfatole    -    Huskie, Wolverine.      topramezone    Impact.    -      Cold, Hard STEEL (30):    Plow, cultivator, rotary-hoe, etc.    Husked Technol. 17:606-608.	Auxin Inhibitor (19)	diflufenzopyr	-	Celebrity Plus, Distinct, Status.	
Innibitor (22)    paraduat    Filestorm, Gramoxone Inteon, Parazone, Reiz.    -      Unknown (26)    difenzoquat    Avenge.    -      quinclorac (grass)    Drive = Facet = Paramount.    -      Bleaching: HPPD    mesotrione    Callisto = Tenacity.    Callisto Xtra, Camix, Halex GT, Instigate, Lumax, Trigate.      Inhibition(27) triketone    tembotrione    Laudis.    -      Isoxazole    isoxaflutole    Balance Flexx.    Corvus, Epic, Prequel, Radius.      Pyrazolone    pyrasulfatole    -    Huskie, Wolverine.      topramezone    Impact.    -    -      Cold, Hard STEEL (30): Plow, cultivator, rotary-hoe, etc.    -    -      Adapted from WSSA Herbicide Classification System For Resistant Weed Management. Weed Technol. 17:606-608.    -	Photosystem I	diquat	Regione = Diquat E-Ag.	-	
Onknown (20)    Unerizedual quinclorac (grass)    Average. Drive = Facet = Paramount.    -      Bleaching: HPPD    mesotrione    Callisto = Tenacity.    Callisto Xtra, Camix, Halex GT, Instigate, Lumax, Trigate.      Inhibition(27) triketone    tembotrione    Laudis.    -      Isoxazole    isoxaflutole    Balance Flexx.    Corvus, Epic, Prequel, Radius.      Pyrazolone    pyrasulfatole topramezone    -    Huskie, Wolverine.      Cold, Hard STEEL (30): Plow, cultivator, rotury-hoe, etc.    -      Adapted from WSSA Herbicide Classification System For Resistant Weed Management. Weed Technol. 17:606-608.		paraquat	Avenge		
Bleaching: HPPD    Intestition (27) triketone    Laudis.    -      Inhibition(27) triketone    Laudis.    -      Isoxazole    isoxaflutole    Balance Flexx.    Corvus, Epic, Prequel, Radius.      Pyrazolone    pyrasulfatole    -    Huskie, Wolverine.      Cold, Hard STEEL (30):    Plow, cultivator, rotary-hoe, etc.    -      Adapted from WSSA Herbicide Classification System For Resistant Weed Management. Weed Technol. 17:606-608.	Unknown (26)	quinclorac (grass)	Drive = Facet = Paramount.	- - Colliste Vtra, Comiry Halay CT, Instigate Lumay Triggte	
Isoxazole    isoxaflutole    Balance Flexx.    Corvus, Epic, Prequel, Radius.      Pyrazolone    pyrasulfatole    -    Huskie, Wolverine.      topramezone    Impact.    -      Cold, Hard STEEL (30):    Plow, cultivator, rotary-hoe, etc.      Adapted from WSSA Herbicide Classification System For Resistant Weed Management. Weed Technol. 17:606-608.	Inhibition(27) triketone	tembotrione	Camsio = renacity. Laudis	Lamsto Atra, Carriix, Halex GT, Instigate, Lumax, Trigate.	
Pyrazolone  pyrasulfatole topramezone  -  Huskie, Wolverine.    Cold, Hard STEEL (30):  Plow, cultivator, rotary-hoe, etc.  -    Adapted from WSSA Herbicide Classification System For Resistant Weed Management. Weed Technol. 17:606-608.	Isoxazole	isoxaflutole	Balance Elexx	Corvus Epic Prequel Radius	
Cold, Hard STEEL (30): Plow, cultivator, rotary-hoe, etc.	Pvrazolone	pyrasulfatole	-	Huskie, Wolverine.	
Cold, Hard STEEL (30): Plow, cultivator, rotary-hoe, etc. Adapted from WSSA Herbicide Classification System For Resistant Weed Management. Weed Technol. 17:606-608.		topramezone	Impact.	-	
Adapted from WSSA Herbicide Classification System For Resistant Weed Management. Weed Technol. 17:606-608.	Cold. Hard STEEL (30): Plow. cultivator. rotary-hoe. etc.				
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