

2006 Herbicide Guide for Iowa Corn and Soybean Production

New Products and Significant Label Changes

New products

Impact 2.8SC (AMVAC) Impact contains topramezone, a carotene inhibitor with the same site of action as Callisto (mesotrione). It will be used postemergence in corn to control many broadleaf weeds and some grasses. Use rate is 0.75 oz/A.

Milestone (DowAgroscience) Milestone contains aminopyralid, a new growth regular herbicide in the same chemical family as picloram (Tordon), triclopyr (Garlon) and clopyralid (Stinger). It is labeled for use in pastures, CRP, natural and non-crop areas. Use rates range from 3 to 7 oz/A. Milestone is particularly strong on weeds in the composite family (thistles, sunflower, cocklebur, etc.). It has a significantly shorter residual than picloram or clopyralid.

Propel (Rosens) Propel is a private brand offering of dimethenamid-P, the active ingredient found in Outlook.

Radius (Bayer) This product contains flufenacet (Define) and isoxaflutole (Balance) at a different ratio than used in Epic. A 15 oz rate of Radius will provide the equivalent of 15 oz Define 4SC and 1.7 oz Balance Pro. This is a significantly higher ratio of flufenacet to isoxaflutole than found in Epic.

Resolve (DuPont) Resolve contains rimsulfuron, an ALS inhibitor and component of Steadfast (nicosulfuron + rimsulfuron). Rimsulfuron provides short-term residual control of foxtails and certain broadleaf weeds.

Currently the product is labeled for postemergence applications in corn up to 12" in height, but DuPont anticipates a preemergence label in time for the 2006 growing season. Resolve does not have sufficient longevity to provide full-season control, and thus will need to be used in combination with other strategies.

New formulations

Boundary 6.5 EC (Syngenta) The old Boundary was a 7.8 lb/gal formulation, the new product should have improved storage characteristics.

Gramoxone Inteon 2S (Syngenta) This formulation of paraquat was developed to reduce human toxicity when it is ingested. Gramoxone Max is a 3 lb/gal formulation, so rates are changed to maintain same active ingredient per acre.

Select Max (Valent) Select Max is a new formulation of clethodim reported to enhance absorption of the active ingredient into plants (Inside Technology). Select Max is a 1 lb/gal formulation, whereas Select and other clethodim products contain 2 lb clethodim/gal. Select Max does not require additional adjuvants (other than AMS) when tank-mixed with a 'loaded' glyphosate product, and provides greater flexibility in additive selection when tank-mixed with other products.

Synchrony STS 28.4 DG (DuPont) The old Synchrony STS was a 42% dispersible granule.

Significant label changes

Callisto (Syngenta) Now cleared for pre and post use in sweet corn. NIS is recommended over COC with post applications due to greater crop safety. Syngenta recommends checking with seed company before making post applications due to risk injury. Lexar and Lumax labels expected to be cleared for pre use on sweet corn before the 2006 growing season.

Corn Herbicide Effectiveness Ratings¹

Weed response to selected herbicides (E = excellent G = good F = fair P = poor)

	Grasses						Broadleaves						Perennials					
	Crop tolerance	Crabgrass	Fall panicum	Foxtail	Woolly cupgrass	Shattercane	Amaranthus spp. ²	Black nightshade	Cocklebur ²	Common ragweed ²	Giant ragweed ²	Lambquarter	Smartweed	Sunflower ²	Velvetleaf	Canada thistle	Quackgrass	Yellow nutsedge
Preplant/Preemergence																		
Atrazine	E	F	P	F	P	P	E	G	G	E	F	E	E	G	G	P	F	F
Axiom, Define, Dual II Magnum, Frontier, Outlook	E	E	E	F	F	F	F-G	G	P	P	P	P	P	P	P	P	P	G
Balance Pro	F-G	G	F-G	G	G-E	F-G	G-E	F	P-F	F-G	P	G	G-E	F	G-E	P	P	G
Callisto	E	P	P	P	P	P	G-E	G-E	F-G	F-G	F	E	F-G	G-E	E	P	P	P
Degree, Harness, Surpass or Topnotch	E	E	E	E	F-G	F-G	G	G	P	P	P-F	P-F	P	P	P	P	P	G
Hornet WDG	G	P	P	P	P	P	F-G	P	G	G	G	G	G-E	G-E	G	P	P	P
Pendimax, Prowl	F-G	G-E	G-E	G	G	G	G	P	P	P	P	G-E	F	P	P-F	P	P	P
Pursuit ³	E	F-G	F	F-G	P-F	G	F-E	G-E	F	G	F	P	G-E	F-G	G	P	P	P
Python	G	P	P	P	P	P	E	F	F	F	P	F	G-E	F-G	E	P	P	P
Postemergence																		
Accent, Steadfast	G-E	P	G	G-E	G-E	E	G	P	F	P	P	P	G	P	F	F	G	F
Aim	G	P	P	P	P	P	F-G	G	P	P	E	G	P	P	E	P	P	P
Atrazine	G	F	P	F	P	P	E	E	E	G	E	E	E	E	E	F*	F	G
Basagran	E	P	P	P	P	P	P	P	E	E	F	P	E	G	G-E	G*	P	G*
Basis	F	F	F-G	G	F	G	G	P	F	F	P	G-E	G-E	G	G	P	G	P
Basis Gold or Accent Gold	G	P	G	G-E	F-G	F-G	G	F-G	E	G-E	G	E	F-G	F-G	G	P	P	P
Banvel, Clarity, etc.	F-G	P	P	P	P	P	G-E	G	E	G-E	E	G	E	G	F-G	G*	P	P
Beacon	G	P	F-G	P-F	P	E	E	G	G	E	P	G	G	F-G	F-G	F-G*	G	F
Buctril	G	P	P	P	P	P	G	G-E	E	E	G	G-E	E	G	E	P	P	P
Callisto	G-E	P	P	P	P	P	E	E	G-E	F	G	G	E	G-E	E	P	P	P
Distinct	F-G	P	F	F	P	F	G-E	G	E	G-E	G	E	E	G	G	G*	P	P
Equip	F-G	P	G	G-E	F-G	E	G	E	E	G	G	E	E	G-E	E	G*	G	P
Glyphosate (Roundup, etc.) ³	E	E	E	G-E	E	E	G-E	F-G	E	E	G-E	G	E	E	G	G	G-E	F
Hornet WDG	G	P	P	P	P	P	E	F	E	E	G	F	G-E	E	G-E	G	P	P
Liberty ²	E	E	G	G-E	E	E	G	E	E	E	G	E	E	E	E	F-G	G	F
Lightning ²	G-E	G	G	E	G	E	F-G	E	E	G	F-G	G-E	E	E	E	G	F	F
NorthStar	G	P	F-G	F	P	E	F-G	G	E	E	E	E	E	E	G	F-G	G	F
Option	G	P	G	G-E	F-G	E	G	E	F	F	P	P	P	G	G	P	G	P
Permit	G	P	P	P	P	P	E	P	G-E	G-E	G	P	G-E	E	E	P	P	G
Pursuit ³	G-E	G	G	F-G	F	E	F-G	E	G-E	G	F	P-F	E	G	G-E	F	P	P
Resource	G-E	P	P	P	P	P	G	P	F	F-G	P	F	P	P	E	P	P	P
Yukon	F-G	P	P	P	P	P	G	P	G	G-E	G	G	G-E	E	E	P	P	G
2,4-D	F	P	P	P	P	P	G	F	E	G	G-E	G	F	G	E	F*	P	P

¹Ratings in this table are based on full label rates. Premix products containing ingredients marketed as single a.i. products may not be listed in this table.

²ALS-resistant biotypes of these weeds have been identified in Iowa. These biotypes may not be controlled by all ALS herbicides.

³Use only on designated resistant hybrids.

⁴Degree of perennial weed control is often a result of repeated application.

⁵This chart should be used only as a guide. Ratings of herbicides may be higher or lower than indicated depending on soil characteristics, management factors, environmental variables, and rates applied. The evaluations for herbicides applied to the soil reflect appropriate mechanical weed control practices.

Soybean Herbicide Effectiveness Ratings¹

Weed response to selected herbicides (E = excellent G = good F = fair P = poor)

	Grasses										Broadleaves					Perennials		
	Crop tolerance	Crabgrass	Fall panicum	Foxtail	Woolly cupgrass	Shattercane	Amaranthus spp. ²	Black nightshade	Cocklebur ²	Common ragweed	Giant ragweed ²	Lambquarter	Smartweed	Sunflower ²	Velvetleaf	Canada thistle	Quackgrass	Yellow nutsedge
Preplant/Preemergence																		
Authority/Spartan	G	P	P	P	P	P	E	E	F	F	F	G-E	F	P	F-G	P	P	F-G
Command	E	G-E	G-E	E	F	F	P	F	F	G	P	G-E	G	F	E	P	P	P
Dual II Magnum, Intro, Frontier	E	E	E	E	F	F	F-G	G	P	P	P	P	P	P	P	P	P	P
FirstRate/Amplify	G-E	P	P	P	P	P	F-G	P	G	G-E	G	G-E	G	G	F-G	P	P	F-G
Sencor	F-G	P	P	P-F	P	P	E	F	F	E	P	E	E	F-G	G-E	P	P	P-F
Pendimax/Prowl/Sonalant/Treflan	G-E	E	E	E	E	G-E	G	P	P	P	P	G	F	P	P	P	P	P
Pursuit	G	F-G	F	F-G	P-F	G	F-E	G-E	F	G	F	P	G-E	F-G	G	P	P	P
Pythron	E	P	P	P	P	P	E	F	F	F	P	F-G	G-E	F	E	P	P	P
Valor SX	F-G	P	P	P	P	P	G-E	E	F	G	F	E	F	P	F	P	P	P
Postemergence																		
Assure II, Fusilade DX, Fusion, Poast Plus, Select, etc.	E	E	E	E	E	E	P	P	P	P	P	P	P	P	P	P	G-E*	P
Basagran	E	P	P	P	P	P	P-F	P-F	E	E	F	P	E	G	G-E	G*	P	G*
Blazer	F-G	P	P	F	P	F	E	G	F	G	F	F	E	F	F	F	P	P
Classic	G	P	P	P	P	P	E	P	E	G-E	F	P	G-E	E	G-E	F	P	G-E
Cobra/Phoenix	F-G	F	P	P	P	P	E	G	G-E	E	F-G	F	G	G	F	F	P	P
FirstRate/Amplify	G	P	P	P	P	P	P	P	G-E	E	E	P	G	E	G	P	P	P
Glyphosate (Roundup, etc.) ³	E	E	G-E	E	E	E	G-E	F-G	E	E	G-E	G	E	E	G	G	G-E	F
Harmony GT	F	P	P	P	P	P	E	P	F	F	P	G-E	G-E	G	G	P	P	P
Pursuit	G	G	G	F-G	F	E	F-G	E	G-E	G	F	P-F	E	G	G-E	F	P	P
Raptor	G	G-E	G-E	G-E	G	E	F-G	E	G-E	G	G	E	E	E	G-E	F	F	F
Reflex/Flexstar	F-G	P	P	P	P	P	E	F-G	F	G	G	F	G-E	F	F	P-F	P	P
Resource	G-E	P	P	P	P	P	G	P	F	F-G	P	F	P	E	P	P	P	P

¹Ratings in this table are based on full label rates. Premix products containing ingredients marketed as single a.i. products may not be included in this table.

²ALS-resistant biotypes have been identified in Iowa. These biotypes may not be controlled by all ALS products.

³Use only on appropriate resistant varieties.

* Degree of perennial weed control is often a result of repeated application.

This chart should be used only as a guide. Ratings of herbicides may be higher or lower than indicated depending on soil characteristics, managerial factors, environmental factors, and rates applied. The evaluations for herbicides applied to the soil reflect appropriate mechanical weed control practices.

Herbicide Package Mixes

The following table provides information concerning the active ingredients found in prepackage mixes, the amount of active ingredients applied with a typical use rate, and the equivalent rates of the individual products.

Corn Herbicide Premixes or Co-packs and Equivalents

Herbicide	Components (a.i./gal or % a.i.)	If you apply (per acre)	You have applied (a.i.)	An equivalent tank mix of (product)
Accent Gold	6.5% nicosulfuron	2.9 oz	0.1885 oz nicosulfuron	0.25 oz Accent
	6.5% rimsulfuron		0.1885 oz rimsulfuron	0.1885 oz rimsulfuron
	19.1% flumetsulam		0.5539 oz flumetsulam	0.69 oz Python*
	51.7% clopyralid		1.5 oz clopyralid	3.66 oz Stinger*
				*= 3.0 oz of Hornet
Accent Gold WDG	5.4% nicosulfuron	3.5 oz	0.1885 oz nicosulfuron	0.25 oz Accent
	5.4% rimsulfuron		0.1885 oz rimsulfuron	0.1885 oz rimsulfuron
	15.9% flumetsulam		0.5539 oz flumetsulam	0.69 oz Python*
	51.4% clopyralid		1.5 oz clopyralid	3.66 oz Stinger*
				*= 3.0 oz of Hornet
Axiom 68DF	54.4% flufenacet	16 oz	8.64 oz flufenacet	14.4 oz Define
	13.6% metribuzin		2.17 oz metribuzin	2.9 oz Sencor DF
Axiom AT	19.6% flufenacet	3 lb	9.41 oz flufenacet	15.7 oz Define
	4.9% metribuzin		2.35 oz metribuzin	3.1 oz metribuzin
	50.5% atrazine		1.52 lb atrazine	1.5 lb atrazine
Basis 75DF	50% rimsulfuron	0.33 oz	0.167 oz rimsulfuron	0.167 oz rimsulfuron
	25% thifensulfuron		0.083 oz thifensulfuron	0.33 oz Pinnacle 25DF
Basis Gold 89.5DF	1.34% rimsulfuron	14 oz	0.188 oz rimsulfuron	0.188 oz rimsulfuron
	1.34% nicosulfuron		0.188 oz nicosulfuron	0.25 oz Accent 75DF
	86.8% atrazine		12.15 oz atrazine	13.5 oz atrazine 90DF
Bicep II MAG. 5.5L, Cinch ATZ	2.4 lb S-metolachlor	2.1 qt	1.26 lb S-metolachlor	21 oz Dual II MAGNUM
	3.1 lb atrazine		1.63 lb atrazine	52 oz atrazine 4L
Bicep Lite II MAG, Cinch ATZ Lite	3.33 lb S-metolachlor	1.5 qt	1.24 lb S-metolachlor	21 oz Dual II MAGNUM
	2.67 lb atrazine		1.00 lb atrazine	32 oz atrazine 4L
Buctril + Atrazine	1.0 lb bromoxynil	2 pt	0.25 lb bromoxynil	1 pt bromoxynil 2E
	2.0 lb atrazine		0.50 lb atrazine	1 pt atrazine 4L
Bullet 4ME	2.5 lb alachlor	4 qt	2.5 lb alachlor	2.5 qt Micro-Tech 4ME
	1.5 lb atrazine		1.5 lb atrazine	1.5 qt atrazine 4L
Celebrity Plus	46.6 % dicamba	4.7 oz	2 oz dicamba	4 oz Banvel
	10.6% nicosulfuron		0.031 lb nicosulfuron	0.67 oz Accent
	18.1% diflufenzopyr		0.8 oz diflufenzopyr	

Corn Herbicide Package Mixes (continued)

Herbicide	Components (a.i./gal or % a.i.)	If you apply (per acre)	You have applied (a.i.)	An equivalent tank mix of (product)
Degree Xtra	2.7 lb acetochlor 1.34 lb atrazine	3 qt	2 lb acetochlor 1 lb atrazine	36.6 oz Harness 7E 1 qt atrazine 4L
Distinct 70WDG	21.4 % diflufenzopyr 55.0% dicamba	6 oz	1.3 oz diflufenzopyr 3.3 oz dicamba	1.3 oz diflufenzopyr 6 oz Banvel
Epic 58DF	48% flufenacet 10% isoxaflutole	12 oz	0.36 lb flufenacet 0.075 lb isoxaflutole	9.6 oz Define 1.6 oz Balance
Equip	30% foramsulfuron 2% iodossulfuron	1.5 oz	0.45 oz foramsulfuron 0.03 oz iodossulfuron	1.29 oz Option -
Exceed 57WG	28.5% prosulfuron 28.5% primisulfuron	1 oz	0.018 lb prosulfuron 0.018 lb primisulfuron	0.5 oz Peak 57WG 0.38 oz Beacon 75SG
Expert 4.9SC	1.74 lb S-metolachlor 2.14 lb atrazine 0.74 lb ae glyphosate	3 qt	1.3 lb S-metolachlor 1.61 lb atrazine 0.55 lb ae glyphosate	1.4 lb Dual II Mag. 1.6 qt Aatrex 4L 1.5 pt Glyphosate 3L
FieldMaster	2.0 lb acetochlor 0.75 lb glyphosate 1.5 lb atrazine	4.0 qt	2.0 lb acetochlor 0.75 lb glyphosate 1.5 lb atrazine	2.3 pt Harness 24 oz Roundup Ultra 1.5 qt atrazine 4L
FulTime 4CS	2.4 lb acetochlor 1.6 lb atrazine	4 qt	2.4 lb acetochlor 1.6 lb atrazine	3 pt Surpass 6.4EC 3.2 pt atrazine 4L
Guardsman 5L	2.33 lb dimethenamid 2.67 lb atrazine	4 pt	1.17 lb dimethenamid 1.34 lb atrazine	1.6 pt Frontier 6E 2.7 pt atrazine 4L
G-Max Lite 5L	2.25 lb dimethenamid 2.75 lb atrazine	3.0 pt	0.84 lb dimethenamid-P 1.0 lb atrazine	18 oz Outlook 2 pt Aatrex 4L
Guardsman Max 5L	1.7 lb dimethenamid-P 3.3 lb atrazine	3.4 pt	0.7 lb dimethamid-P 1.4 lb atrazine	15 oz Outlook 1.4 lb atrazine 4L
Harness Xtra	4.3 lb acetochlor 1.7 lb atrazine	2.3 qt	2.5 lb acetochlor 0.98 lb atrazine	46 oz Harness 7E 1 qt atrazine 4L
Harness Xtra 5.6L	3.1 lb acetochlor 2.5 lb atrazine	3 qt	2.325 lb acetochlor 1.875 lb atrazine	42.5 oz Harness 7E 1.9 qt atrazine 4L
Hornet WDG	18.5% flumetsulam 60% clopyralid	5 oz	0.924 oz flumetsulam 0.195 lb clopyralid	1.15 oz Python WDG 6.68 oz Stinger 3S
Keystone 5.25L	3.0 lb acetochlor 2.25 lb atrazine	2.7 qt	2.0 lb acetochlor 1.5 lb atrazine	2.5 pt Surpass 6.4E 3.0 pt Aatrex 4L

Corn Herbicide Package Mixes (continued)

Herbicide	Components (a.i./gal or % a.i.)	If you apply (per acre)	You have applied (a.i.)	An equivalent tank mix of (product)
Keystone LA 5.5L	4.0 lb acetochlor 1.5 lb atrazine	2.0 qt	2.0 lb acetochlor 0.75 lb atrazine	2.5 pt Surpass 6.4E 1.5 pt Aatrex 4L
Laddok S-12 5L	2.5 lb bentazon 2.5 lb atrazine	1.67 pt	0.52 lb bentazon 0.52 lb atrazine	1.0 pt Basagran 4S 1.0 pt atrazine 4L
Lariat 4L	2.5 lb alachlor 1.5 lb atrazine	4 qt	2.5 lb alachlor 1.5 lb atrazine	2.5 qt Lasso 4E 1.5 qt atrazine 4L
Lexar 3.7L	1.74 lb S-metolachlor 1.74 lb atrazine 0.224 lb mesotrione	3.5 qt	1.52 lb S-metolachlor 1.52 lb atrazine 0.196 lb mesotrione	1.6 pt Dual II Mag. 3 pt Aatrex 4L 6.27 oz Callisto
Liberty ATZ	1.0 lb glufosinate 3.3 lb atrazine	32 oz	0.25 lb glufosinate 0.825 lb atrazine	20 oz Liberty 0.825 qt atrazine 4L
Lightning 70DF	52.5% imazethapyr 17.5% imazapyr	1.28 oz	0.672 oz imazethapyr 0.224 oz imazapyr	0.96 oz Pursuit 70DG 0.78 oz Arsenal 28.7DF
Lumax	0.268 lb mesotrione 2.68 lb S-metolachlor 1.0 lb atrazine	3 qts	0.2 lb mesotrione 2.0 lb S-metolachlor 0.75 lb atrazine	6.4 oz Callisto 2 pt Dual II MAGNUM 0.75 qt Aatrex 4L
Marksman 3.2L	1.1 lb dicamba 2.1 lb atrazine	3.5 pt	0.48 lb dicamba 0.92 lb atrazine	0.96 pt Banvel 4S 1.84 pt atrazine 4L
NorthStar	7.5% primisulfuron 43.9% dicamba	5.0 oz	0.375 oz primisulfuron 2.20 oz dicamba	0.5 oz Beacon 75SG 4.0 oz Banvel 4L
Radius	3.57 lbs flufenacet 0.43 lbs isoxaflutole	16 oz	0.47 lb flufenacet 0.05 lb isoxaflutole	15 oz Defince 4SC 1.7 oz Balance Pro
ReadyMaster ATZ	2 lb glyphosate 2 lb atrazine	2 qt	1 lb glyphosate 1 lb atrazine	1 qt Roundup Ultra 1 qt atrazine 4L
Shotgun 3.25L	2.25 lb atrazine 1 lb 2,4-D	2 pt	0.56 lb atrazine 0.25 lb a.e. 2,4-D	1.12 pt atrazine 4L 0.53 pt Esteron 99 3.8E
Spirit 57WG	14.25% prosulfuron 42.75% primisulfuron	1 oz	0.1425 oz prosulfuron 0.4275 oz primisulfuron	0.25 oz Peak 57WG 0.57 oz Beacon 75SG
Steadfast 75DF	50% nicosulfuron 25% rimsulfuron	0.75 oz	0.37 oz nicosulfuron 0.19 oz rimsulfuron	0.5 oz Accent -

Corn Herbicide Package Mixes (continued)

Herbicide	Components (a.i./gal or % a.i.)	If you apply (per acre)	You have applied (a.i.)	An equivalent tank mix of (product)
Steadfast ATZ	2.7% nicosulfuron	14 oz	0.38 oz nicosulfuron	0.5 oz Accent
	1.3% rimsulfuron		0.18 oz rimsulfuron	-
	85.3% atrazine		0.75 lb atrazine	1.5 pt Atrazine 4L
Surpass 100 5L	3 lb acetochlor	2.5 qt	1.88 lb acetochlor	1.18 qt Surpass 6.4E
	2 lb atrazine		1.25 lb atrazine	1.25 qt atrazine 4L
WideMatch 1.5EC	0.75 lb fluroxypyr	1.3 pt	0.125 lb fluroxypyr	10.6 oz Starane 1.5E
	0.75 lb clopyralid		0.125 lb clopyralid	5.3 oz Stinger 3S
Yukon	12.5% halosulfuron	4 oz	0.031 lb halosulfuron	0.66 oz Permit
	55% dicamba		0.125 lb dicamba	4.0 oz Banvel

Soybean Herbicide Premixes or Co-packs and Equivalents

Herbicide	Components (a.i./gal or % a.i.)	If you apply (per acre)	You have applied (a.i.)	An equivalent tank mix of (product)
Axiom 68DF	54.4% flufenacet	13 oz	0.44 lb flufenacet	11.7 oz Define (Define is not labeled for use on soybean)
	13.6% metribuzin		1.77 oz metribuzin	2.36 oz Sencor 75DF
Boundary 7.8EC	5.2 lbs s-metolachlor	2.1 pt	1.4 lb s-metolachlor ¹	1.5 pt Dual II MAG.
	1.25 lbs metribuzin		0.3 lb metribuzin	6.4 oz Sencor 75DF
Canopy 75DF	10.7% chlorimuron ethyl,	6 oz	0.64 lb chlorimuron metribuzin	2.57 oz Classic 25DF
	64.3% metribuzin			
Commence 5.25E	2.25 lb clomazone	2.5 pt	0.70 lb clomazone	1.4 pt Command 4E
	3.00 lb trifluralin		0.94 lb trifluralin	1.9 pt Treflan 4E
Detail 4.1E	0.5 lb imazaquin	1 qt	0.125 lb imazaquin	0.67 pt Scepter 1.5S
	3.6 lb dimethenamid		0.90 lb dimethenamid	1.20 pt Frontier 6.0E
Domain 60DF	24.0% flufenacet	16 oz	0.24 lb flufenacet	6.4 oz Define (Define is not labeled for use on soybean)
	36.0% metribuzin		0.36 lb metribuzin	0.48 lb Sencor 75DF
Extreme	1.8% imazethapyr	3 pt	0.064 lb imazethapyr	1.44 oz Pursuit DG
	22% glyphosate		0.75 lb glyphosate	24 oz Roundup
FrontRow	flumetsulam	5 acres/pkg	0.15 oz flumetsulam	0.12 oz Python 80WDG
	chloransulam		0.25 oz chloransulam	0.3 oz FirstRate 84WDG

Soybean Herbicide Package Mixes (continued)

Herbicide	Components (a.i./gal or % a.i.)	If you apply (per acre)	You have applied (a.i.)	An equivalent tank mix of (product)
Fusion 2.67E	2 lb fluazifop 0.67 lb fenoxaprop	8 fl oz	0.125 lb fluazifop 0.042 lb fenoxaprop	8 fl oz Fusilade DX 2E 8 fl oz Option II 0.67E
Galaxy 3.67S	3 lb bentazon 0.67 lb acifluorfen	2 pt	0.75 lb bentazon 0.17 lb actfluorfen	1.5 pt Basagran 4S 0.67 pt Blazer 2S
Pursuit Plus 2.9E	0.2 lb imazethapyr 2.7 lb pendimethalin	2.5 pt	0.063 lb imazethapyr 0.84 lb pendimethalin	4.0 oz Pursuit 2S 2.00 pt Prowl 3.3E
Sequence 5.25L	3.0 lb S-metolachlor 2.25 lb glyphosate	3 pt	1.13 lb S-metolachlor 0.84 lb ae glyphosate	1.2 pt Dual Magnum 26 oz Touchdown Total
Stellar 3.1E	2.4 lb lactofen 0.7 lb flumiclorac	5 fl oz	0.094 lb lactofen 0.027 lb flumiclorac	6 fl oz Cobra 2E 4 fl oz Resource 0.86E
Storm 4S	2.67 lb bentazon 1.33 lb acifluorfen	1.5 pt	0.50 lb bentazon 0.25 lb acifluorfen	1 pt Basagran 4S 1 pt Blazer 2S
Synchrony STS DF	31.8% chlorimuron 10.2% thifensulfuron	0.5 oz	0.159 oz chlorimuron 0.051 oz thifensulfuron	0.64 oz Classic 25DF 0.068 oz Harmony GT

Herbicide Site of Action and Injury Symptoms

Herbicides kill plants by disrupting an essential physiological process. This normally is accomplished by the herbicide specifically binding to a single protein. The target protein is referred to as the herbicide “site of action.” Herbicides in the same family generally have the same site of action. The mechanism by which a herbicide kills a plant is known as its “mode of action.” For example, triazine herbicides interfere with photosynthesis by binding to the D1 protein involved in photosynthetic electron transfer. Thus, the site of action for triazines is the D1 protein, whereas the mode of action is the disruption of photosynthesis. An understanding of herbicide mode of action is essential for diagnosing crop injury or off-target injury problems and for designing weed management programs with a low risk of selecting for herbicide-resistant weed populations.

ACCase Inhibitors

The ACCase enzyme is involved in the synthesis of fatty acids. Two herbicide families attack this enzyme. Aryloxyphenoxypropanoate (commonly referred to as “fops”) and cyclohexanedione (referred to as “dims”) herbicides are used postemergence, although some have limited soil activity (e.g., fluazifop). ACCase inhibitors are active only on grasses, and selectivity is due to differences in sensitivity at the site of action, rather than differences in absorption or metabolism of the herbicide. Most herbicides in this class are translocated within the phloem of grasses. The growing points of grasses are killed and rot within the stem. At sublethal rates, irregular bleaching of leaves or bands of chlorotic tissue may appear on affected leaves. Resistant weed biotypes have evolved following repeated applications of these herbicides. An altered target site of action is responsible for the resistance. **Mode of action: ACCase.**

Product	Active ingredients
<i>Aryloxyphenoxypropanoate</i>	
Assure II _____	quizalofop-p-ethyl
Fusilade DX _____	fluazifop-p-butyl
Fusion _____	fluazifop-p butyl + fenoxaprop
Hoelon _____	diclofop
<i>Cyclohexanedione</i>	
Poast/Poast Plus _____	sethoxydim
Select/Arrow _____	clethodim

ALS Inhibitors

Several chemical families interfere with acetolactate synthase (ALS), an enzyme involved in the synthesis of branched-chain amino acids, specifically valine, leucine, and isoleucine. These amino acids are necessary for protein synthesis and plant growth. Generally, these herbicides are absorbed in plant roots and foliage and are readily translocated in the xylem and phloem. The herbicides accumulate in meristematic regions of the plant and the herbicidal effects are first noted there. Symptoms include plant stunting, chlorosis (yellowing), and tissue necrosis (death), and are evident 1 to 4 weeks after herbicide application, depending upon the plant species and environmental conditions. Soybeans and other affected broad-leaves often develop reddish veins on undersides of leaves. Symptoms in corn include reduced secondary root formation, stunted roots, shortened internodes, leaf malformations (chlorosis, window-paning) and nutrient deficiency. However, symptoms typically are not distinct or consistent. Factors such as soil moisture, temperature, and soil compaction can enhance the occurrence of injury or may mimic the herbicide injury. Some ALS inhibiting herbicides have long soil residual properties and may carry over and injure sensitive rotational crops. Herbicide resistant weed biotypes possessing an altered site of action have evolved after repeated applications of these herbicides. **Mode of action: ALS.**

Product	Active ingredients
<i>Imidazolinone herbicides</i>	
Lightning _____	imazethapyr + imazapyr
Pursuit _____	imazethapyr
Pursuit Plus _____	imazethapyr + endimethalin
Raptor _____	imazamox
Scepter _____	imazaquin
Squadron _____	imazaquin + pendimethalin

Sulfonanilides

FirstRate/Amplify _____	chloransulam
Hornet WDG _____	flumetsulam + clopyralid
Python _____	flumetsulam

Sulfonylureas

Accent _____	nicosulfuron
Accent Gold _____	nicosulfuron + rimsulfuron + clopyralid + flumetsulam
Ally/Cimarron _____	metsulfuron
Basis _____	rimsulfuron + thifensulfuron
Basis Gold _____	rimsulfuron + nicosulfuron + atrazine
Beacon _____	primisulfuron
Canopy _____	chlorimuron + metribuzin
Celebrity Plus _____	nicosulfuron + dicamba + diflufenzopyr
Classic _____	chlorimuron
Equip _____	foramsulfuron + iodoflufenzopyr + safener
Exceed, Spirit _____	prosulfuron + primisulfuron
Express _____	tribenuron
Harmony GT _____	thifensulfuron
NorthStar _____	primisulfuron + dicamba
Option _____	foramsulfuron + safener
Permit _____	halosulfuron
Resolve _____	rimsulfuron
Steadfast _____	nicosulfuron + rimsulfuron
Steadfast ATZ _____	nicosulfuron + rimsulfuron + atrazine
Synchrony STS _____	chlorimuron + thifensulfuron
Yukon _____	halosulfuron + dicamba

Microtubule Inhibitors

Dinitroaniline (DNA) herbicides inhibit cell division by interfering with the formation of microtubules. Dinitroaniline herbicides are soil-applied and absorbed mainly by roots. Very little herbicide translocation into plants occurs, thus the primary herbicidal effect is on root development. Soybean injury from DNA herbicides is characterized by root pruning. Roots that do develop are thick and short. Hypocotyl swelling also occurs. The inhibited root growth causes tops of plants to be stunted and often to demonstrate a dark green color. Corn injured by DNA carryover demonstrates root pruning and short, thick roots. Leaf margins may have a reddish color. Since DNAs are subject to little movement in the soil, such injury is often spotty due to localized concentrations of the herbicide. Early season stunting from DNA herbicides typically does not result in significant yield reductions. **Mode of action: microtubule.**

<u>Product</u>	<u>Active ingredients</u>
Balan _____	benefin
Commence _____	trifluralin + clomazone
Prowl, Pentagon,	
Pendimax _____	pendimethalin
Sonalan _____	ethallfluralin
Surflan _____	oryzalin
Treflan, Trifluralin _____	trifluralin

Synthetic Auxins

Several chemical families cause abnormal root and shoot growth by upsetting the plant hormone (auxin) balance. These herbicides are primarily effective on broadleaf species. Uptake can occur through seeds or roots with soil-applied treatments or leaves when applied postemergence. Synthetic auxins translocate throughout plants and accumulate in areas of high growth activity. Corn injury may occur in the form of onion leafing, proliferation of roots, or abnormal brace root formation. Corn stalks may become brittle following application; this response usually lasts for 7 to 10 days following application. The potential for injury increases when applications are made to corn taller

than 10 to 12 inches in height. Soybean injury from synthetic auxin herbicides is characterized by cupping and crinkling of leaves. Soybeans are extremely sensitive to dicamba; however, early season injury resulting only in leaf malformation usually does not affect yield potential. Soybeans occasionally develop symptoms characteristic of dicamba in the absence of this herbicide. This response is poorly understood, but usually develops during periods of rapid growth or following stress from other postemergence herbicide applications. Dicamba has a high vapor pressure and may move off target due to volatilization. **Mode of action: auxin.**

Product _____ Active ingredients

<i>Benzoic</i>	
Banvel, Clarity _____	dicamba
Celebrity Plus _____	dicamba + nicosulfuron + diflufenzopyr
Distinct _____	dicamba + diflufenzopyr
Marksman _____	dicamba + atrazine
NorthStar _____	dicamba + primisulfuron
Yukon _____	dicamba + halosulfuron

<i>Phenoxy</i>	
(many) _____	MCPA
(many) _____	2,4-D
Butoxone, Butyrac _____	2,4-DB

<i>Pyridines</i>	
Crossbow _____	triclopyr + 2,4-D
Grazon P&D _____	picloram + 2,4-D
Hornet WDG _____	clopyralid + flumetsulam
Redeem _____	triclopyr +clopyralid
Milestone _____	aminopyralid
Stinger, Transline _____	clopyralid
Tordon _____	picloram*

Photosystem II Inhibitors

Several families of herbicide bind to a protein involved in electron transfer in Photosystem II (PSII). These herbicides inhibit photosynthesis, which may result in chlorosis of plant leaves followed by necrosis of leaf tissue. A secondary substance formed as a result of photosynthesis inhibition may be responsible for plant death. When PSII inhibitors are applied to the leaves,

uptake occurs into the leaf but very little movement out of the leaf occurs. Injury to corn occurs as yellowing of leaf margins and tips followed by browning, whereas injury to soybean occurs as yellowing or burning of outer leaf margins. The entire leaf may turn yellow, but veins usually remain somewhat green (interveinal chlorosis). Lower leaves are most affected, and new leaves may be unaffected. Triazine and urea herbicides generally are absorbed both by roots and foliage, whereas benzothiadiazole and nitrile herbicides are absorbed primarily by plant foliage. Triazine-resistant biotypes of several weed species have been confirmed in Iowa following repeated use of triazine herbicides. Although the other PSII herbicides attack the same target site, they bind on a different part of the protein and remain effective against triazine resistant weeds. **Mode of action: PSII.**

Product _____ Active ingredients

<i>Benzothiadiazole</i>	
Basagran _____	bentazon
Galaxy, Storm _____	bentazon + acifluorfen
Laddok _____	bentazon + atrazine

<i>Nitriles</i>	
Buctril _____	bromoxynil
Buctril+Atrazine _____	bromoxynil + atrazine

<i>Triazines</i>	
AAtrex, Atrazine _____	atrazine
Evik _____	ametryne
Princep _____	simazine
Sencor _____	metribuzin

<i>Ureas</i>	
Karmex _____	diuron
Lorox _____	linuron

Photosystem I Inhibitors

Herbicides in the bipyridilium family rapidly disrupt cell membranes, resulting in wilting and tissue death. They capture electrons moving through Photosystem I (PSI) and produce highly destructive compounds. Very little translocation of bipyridilium herbicides occurs due to loss of plant membrane structure. Injury occurs only where the herbicide spray contacts the plant. Complete spray coverage is essential for weed control.

The herbicide molecules carry strong positive charges that cause them to be very tightly adsorbed by soil colloids. Consequently, bipyridilium herbicides have no significant soil activity. Injury to crop plants from paraquat drift occurs in the form of spots of dead leaf tissue wherever spray droplets contact the leaves. Typically, slight drift injury to corn, soybeans, or ornamentals from a bipyridilium herbicide does not result in significant growth inhibition. **Mode of action: PSI.**

Product	Active ingredients
Diquat, Reward	diquat
Gramoxone Max	paraquat

ProtoporphyrinogenOxidase (PPO) Inhibitors

The specific site of action is an enzyme involved in synthesis of a precursor of chlorophyll; the enzyme is referred to as PPO. Postemergence applied diphenyl ether herbicides (e.g., acifluorfen) kill weed seedlings through contact action, membrane destruction, and photosynthesis inhibition. Thorough plant coverage by the herbicide spray is required. Applying the herbicide prior to prolonged cool periods or during hot, humid conditions will result in crop injury. Injury symptoms range from speckling of foliage to necrosis of whole leaves. Under extreme situations, herbicide injury has resulted in the death of the terminal growing point, which produces short, bushy soybean plants. Most injury attributable to diphenyl ether herbicides is cosmetic and does not affect yields. The aryl triazolines herbicides are absorbed both by roots and foliage. Susceptible plants emerging from soils treated with these herbicides turn necrotic and die shortly after exposure to light. Soybeans are most susceptible to injury if heavy rains occur when beans are cracking the soil surface. **Mode of action: PPO.**

Product	Active ingredients
<i>Aryl triazolines</i>	
Aim	carfentrazone
Authority, Spartan	sulfentrazone
Gauntlet	sulfentrazone+ cloransulam

Canopy XL	sulfentrazone+ chlorimuron
Command Xtra	sulfentrazone + clomazone

Diphenyl Ethers

Blazer, UltraBlazer	acifluorfen
Cobra, Phoenix	lactofen
Flexstar, Reflex	fomesafen
Goal	oxyfluorfen

Phenylphthalimides

Gangster	flumioxazin + cloransulam
Resource	flumiclorac
Valor	flumioxazin

Enolpyruvyl Shikimate Phosphate Synthase (EPSPS) Inhibitors

Glyphosate is a substituted amino acid that interferes with amino acid synthesis by inhibiting the EPSPS enzyme. This enzyme is involved in the synthesis of several essential amino acids. Glyphosate is nonselective and is very tightly bound in soil, so no root uptake occurs. Applications must be made to plant foliage. Translocation occurs out of leaves to all plant parts including underground storage organs of perennial weeds. Translocation is greatest when plants are actively growing. Injury symptoms are fairly slow in appearing. Leaves slowly wilt, turn brown, and die. Sublethal rates of glyphosate sometimes produce phenoxy-type symptoms with feathering of leaves (parallel veins) or proliferation of vegetative buds. **Mode of action: EPSPS.**

Product	Active ingredients
Roundup,	
Glyphomax,	
Rodeo, Touchdown,	
others	glyphosate
ReadyMaster ATZ	glyphosate + atrazine
Extreme	glyphosate + imazethapyr
Sequence	glyphosate + s- metolachlor

Glutamine Synthetase Inhibitors

Glufosinate (Liberty) inhibits the enzyme glutamine synthetase, causing a buildup of ammonia in the plant which becomes phytotoxic. Glufosinate

is relatively fast acting and provides effective weed control in three to seven days. Symptoms appear as chlorotic lesions on the foliage followed by necrosis. There is limited translocation of glufosinate within plants. The herbicide has no soil activity. Liberty is nonselective except to crops that carry the Liberty Link gene. **Mode of action: GS.**

Product	Active ingredients
Liberty	glufosinate
Liberty ATZ	glufosinate + atrazine

Hydroxyphenyl Pyruvate Dioxygenase (HPPD) Inhibitors

Isoxaflutole (Balance Pro) and mesotrione (Callisto) bind to HPPD, an enzyme involved in the synthesis of carotene pigments. Injury symptoms include bleaching or chlorosis. Although the chemicals have the same site of action, they are not chemically related. The herbicides are absorbed both by roots and foliage. **Mode of action: bleacher.**

Product	Active ingredients
Balance Pro	isoxaflutole
Epic, Radius	isoxaflutole + flufenacet
Callisto	mesotrione
Lexar, Lumax	mesotrione + atrazine + S-metolachlor

Diterpene Inhibitors

Clomazone interferes with the synthesis of the same pigments as the HPPD inhibitors, but acts at a different enzyme within the metabolic pathway. Sensitive plants exposed to the herbicide turn white. Clomazone is xylem mobile and taken up in roots and shoots. Differential metabolism of clomazone confers tolerance to plants. Clomazone has a relatively high vapor pressure and may volatilize off the soil surface resulting in off-target injury. **Mode of action: bleacher.**

Product	Active ingredients
Command	clomazone
Command Xtra	clomazone + sulfentrazone

Auxin Transport Inhibitors

Diflufenzopyr (Distinct) has a unique mode of action in that it inhibits the transport of auxin, a naturally occurring growth regulator. Diflufenzopyr is primarily active on broadleaf species, but it may suppress certain grasses under favorable conditions. Diflufenzopyr is primarily active through foliar uptake, but it can be absorbed through the soil for some residual activity. Injury symptoms are similar to growth regulator herbicides. **Mode of action: auxin transport.**

<u>Product</u>	<u>Active ingredients</u>
Distinct _____	diflufenzopyr + dicamba

Lipid Synthesis Inhibitors

Although the specific target site for the thiocarbamate herbicides has not been identified, it is believed the primary site of action is lipid synthesis. In grasses, thiocarbamate herbicides inhibit meristem activity and cause abnormal emergence of leaves from the coleoptile. The growth of susceptible broadleaf weeds is inhibited, and plants exhibit cupped or crinkled leaves. Uptake may occur through seeds, shoots, and roots; shoots are more affected than roots. These herbicides are soil-applied and most must be physically incorporated into the soil due to volatility characteristics. Corn injury from thiocarbamate herbicides is demonstrated by leaves not properly unrolling from the coleoptile. Leaves are stunted and twisted, often appearing knotted. In recent years, antidotes or safeners have been developed that help to prevent thiocarbamate injury to corn. These are formulated directly with the

herbicide. The protective mechanism of these antidotes is not known, but they may enable corn to more rapidly degrade the herbicides. The antidotes are formulated directly with the herbicides; Sutan+ contains R-25788, and Eradicane contains R-29148. Soybean injury from thiocarbamate herbicides occurs as slowed emergence and crinkling of leaves on seedling plants. The antidotes or safeners do not protect soybeans from thiocarbamate herbicides. **Mode of action: lipid.**

<u>Product</u>	<u>Active ingredients</u>
Eradicane _____	EPTC + R-29148
Sutan+ _____	butylate + R-29148
Sutazine _____	butylate + R-29148 + atrazine

Unknown Site of Action

Herbicides in the amide family (also referred to as acetanilides or acetamides) inhibit root and shoot growth causing stunted, malformed seedlings. The specific site of action and mode of action of this herbicide family is unknown. Normal cell division, cell elongation, and protein synthesis are potentially inhibited. The herbicides must be present in early stages of germination and growth of weeds for effective control. These herbicides are most effective on annual grass weeds, although some small-seeded annual broadleaf weeds are also sensitive. Injury symptoms to corn from these herbicides include leafing out underground and failure of leaves to properly unfurl. Soybean injury from these herbicides occurs in the form of a shortened mid-vein in the leaflets resulting in crinkling and a heart-shaped appearance. Dimethenamid (Frontier) and flufenacet (Axiom) have

slightly different chemical structures than the amide herbicides, but it is believed they kill plants in the same manner as the amides. **Mode of action: unknown.**

<u>Product</u>	<u>Active ingredients</u>
Axiom, Domain _____	flufenacet + metribuzin
Axiom AT _____	flufenacet + metribuzin + atrazine
Bicep II MAGNUM, Cinch ATZ _____	s-metolachlor + atrazine + safener
Bicep Lite II MAGNUM	s-metolachlor + atrazine + safener
Boundary _____	metolachlor + metribuzin
Bullet _____	alachlor + atrazine
Define _____	flufenacet
Degree, Harness, Surpass _____	acetochlor + safener
Degree Xtra, Harness Xtra	acetochlor + atrazine + safener
Dual II MAGNUM/Cinch	s-metolachlor + safener
Domain _____	flufenacet + metribuzin
Epic, Radius _____	flufenacet + isoxaflutole
FieldMaster _____	acetochlor + atrazine + glyphosate + safener
Frontier, Outlook _____	dimethenamid
FulTime _____	acetochlor + atrazine + safener
Guardman Max _____	dimethenamid + atrazine
Lariat _____	alachlor + atrazine
Lasso, Intrro, MicroTech _____	alachlor
Outlook _____	dimethenamid-P
Surpass 100 _____	acetochlor + atrazine + safener
TopNotch _____	acetochlor + safener

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