

2012 Weed Control Recommendations

for Kentucky Grain Crops



NOTICE

Kentucky Agriculture Water Quality Act

In 1994, the Kentucky General Assembly passed The Kentucky Agriculture Water Quality Act (AWQA). The AWQA (KRS 224.71-100 through 224.71-140) states that landowners of 10 acres or more that conduct or allow agriculture or silviculture (forestry) production on their land were required to develop and implement a water quality plan by October 23, 2001.

These individual water quality plans will be based upon the guidance found in the Kentucky Agriculture Water Quality Plan. One of the six sections that make up the Kentucky Agriculture Water Quality Plan is Pesticides and Fertilizer (Section 2). Therefore, if your agriculture operation, of 10 acres or more, involves the use and storage of agriculture chemicals, then your water quality plan must include information about those pesticide and fertilizer activities.

In an effort to help landowners/producers more effectively develop and implement the Pesticides and Fertilizer section of their water quality plan, the Extension publication ***Agricultural Chemical Storage and Handling*** (IP-41) is available at your local County Extension Offices. This publication is one of several that make up the Kentucky Assessment System or KY·A·Syst.

For further information about the Kentucky Agriculture Water Quality Act, the sections of the Plan and the KY·A·Syst publications that apply to your situation, contact your local:

- University of Kentucky Cooperative Extension Service County Office
- Division of Conservation
- Division of Water Regional Office
- USDA Natural Resource Conservation Service
- USDA Farm Service Agency
- Division of Forestry District Office
- Local Conservation District Office
- County Health Department
- Kentucky Farm Bureau Federation

Conversion Factors

Liquid Measure

3 teaspoons = 1 tablespoon = 14.8 ml
1 fluid ounce = 2 tablespoons = 29.6 ml
1 pint = 2 cups = 16 fluid ounces = 473.2 ml
1 quart = 2 pints = 4 cups = 32 fl. oz. = 946.4 ml
1 gallon = 4 quarts = 8 pints = 16 cups = 128 fl. oz. = 3786 ml
1 gallon = 3.79 liters = 8.355 pounds
1 cubic foot of water = 62.43 pounds = 7.48 gallons

Area Measure

1 acre = 43,560 sq ft = 160 sq rods = 4840 sq yd = 0.4ha

Dry Measure

1 pound=16 ounces=454 grams
1 short ton = 2000 pounds = 908 kg
1 long ton = 2240 pounds = 1017 kg

Linear Measure

12 inches = 1 foot = 30.5 cm
36 inches = 3 feet = 1 yard = 0.9 meters
1 rod = 16.5 feet
1 mile = 5280 feet = 1760 yards = 1.6 km

Listing of pesticide products implies no endorsement by the University of Kentucky or its representatives. Criticism of products not listed is neither implied nor intended.

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2012 Weed Control Recommendations for Kentucky Farm Crops

James R. Martin and J. D. Green

Introduction

The use of herbicides suggested in this publication is based on research at the Kentucky Agricultural Experiment Station and elsewhere. We have given what we believe to be the most effective herbicides, with the most suitable rates and times of application. Use of trade or brand names in this publication does not imply approval of the product to the exclusion of others which may be of similar or suitable composition.

Herbicide registrations and labels are constantly being revised and changed; therefore, herbicides recommended in this publication were registered for the prescribed uses when the publication was printed. If the registration of a herbicide product listed has been canceled, it would no longer be recommended by the University of Kentucky.

Read and follow label directions carefully before you buy, store, mix, apply, or dispose of a pesticide. Follow carefully the precautions stated on the label of the bag or container. It is hazardous to use herbicides for purposes other than those specified on the approved label. Use herbicides only on crops for which they are approved and recommended. Use only recommended amounts. Besides wasting money, using too much material may damage the crop and make it unsafe for food or feed. The seizure of any raw agricultural commodity, moving in interstate commerce, which carries a pesticide residue in excess of the established tolerance, is authorized by the Environmental Protection Agency.

Apply herbicides only at time specified on the label, and observe the recommended intervals between the time of treatment and time of planting, pasturing or harvesting the crop. Guard against possible injury to nearby susceptible crops or plants.

In general, the use of herbicides should supplement good agricultural practices which include:

- 1) the use of high quality crop seed free of weed seed;
- 2) proper planting methods with good seed to soil contact;
- 3) high soil fertility and good crop rotation; and
- 4) practices that prevent weeds from producing mature seeds.

Method and Time of Herbicide Treatment

Herbicides are generally considered to be either soil active or foliar active. Soil active herbicides are generally applied to the soil surface since they are most effective when weeds are germinating. Foliar active herbicides control weeds after they have emerged from the soil.

Herbicides can also be applied at different times for weed control. They are applied either before or after crop planting. The timing of the application is dependent on: a) the herbicide characteristics; b) weed(s) to be controlled; and c) crop being grown. The following terms are often used that refer to the time of herbicide application:

1) Before Planting-- **preplant soil incorporated, preplant surface applied, preplant foliar** as a "burndown" of existing vegetation, or **early preplant** (usually 7 to 30 days before planting);

2) After Planting (before crop and weed emergence) -- **preemergence** onto the soil surface;

3) After Crop and Weed Emergence -- **cracking stage** (at crop emergence), **postemergence, directed** or **semi-directed** between the rows of taller crops on small weeds, or **layby** before crop canopy.

Herbicides used in no-tillage crop production generally consist of a foliar "burndown" herbicide plus a soil residual. A non-selective foliar herbicide is applied before or at planting, but before crop emerges to kill all existing vegetation. Soil residual herbicides provide additional weed control throughout the growing season.

Incorporation

Proper application of any preplant and incorporated herbicide is extremely important. A well-prepared seedbed prior to application of the herbicide is necessary to obtain thorough mixing (incorporation) of the chemical into the soil. It is advisable to incorporate thoroughly immediately after spraying, preferably in the same operation. Delayed incorporation could result in poor weed control.

Incorporation into the top 2 to 3 inches of soil following seedbed preparation is necessary to ensure effective weed control regardless of weather conditions. Incorporation should be made using power-driven cultivation equipment set to cut to a depth of 2 to 3 inches, or a tandem disc set to cut to a depth of 4 to 6 inches, operated at 4 to 6 mph. This should be followed by a spike-tooth harrow or some other leveling tillage equipment which extends beyond the ends of the disc. Incorporation to a depth below 3 inches will reduce effectiveness of the herbicide by one-third or more.

For thorough mixing, disc in two different directions (cross disc). Thorough incorporation to a depth of not more than 2 to 3 inches of a preplant-incorporated herbicide may be the most important part of a management program.

Cultivation

Timely, shallow cultivation may be necessary following herbicide treatment. When cultivating, the cultivator should be set as shallow as possible. This will prevent bringing new weed seeds from below the herbicide layer to the soil surface.

If rainfall does not occur within 7 to 10 days following application of a preemergence herbicide, a shallow incorporation such as with a rotary hoe may be necessary for maximum weed control.

Cultivation following a preplant-incorporated herbicide application should also be shallow, or less than one half the depth that the herbicide was incorporated.

Types of Herbicide Formulations

Herbicides are formulated as water solutions (S), liquids (L), emulsifiable concentrates (EC), dry flowables (DF), soluble granules (SG), water dispersible granules (WDG), wettable powders (WP), flowables (F), or micro-encapsulated (MT, ME),. They are usually added to water and applied as a spray solution. Most spray mixtures require constant agitation to prevent the herbicides from settling to the bottom of the tank. Granular (G) herbicides are applied dry. *Do not mix granular herbicides with different granular pesticides or fertilizers.*

Restricted Use Herbicides

Some herbicide products are classified as Restricted Use Pesticides because they have a higher potential for affecting the environment, human health, or animals. Herbicides currently classified as Restricted Use appear below. Pesticide certification is required to purchase and use these products.

AAtrex	Corvus	Lexar
Atrazine	Degree Xtra	Lumax
Balance	Expert	Marksman
Authority MTZ	FieldMaster	Metal II AT
Brawl II ATZ	Firestorm	Micro-Tech
Breakfree	FulTime	Milo-Pro
Breakfree ATZ	Gramoxone	Parazone
Buctril/Atrazine	Guardsman Max	Prequel
Bullet	Harness	Radius
Callisto Xtra	Harness Xtra	Simazat
Charger Max ATZ	Intrro	Stalwart XTRA
Cinch ATZ	Keystone	Volley
Confidence Xtra		Volley ATZ

Current regulations require that accurate records be kept for all pesticides which include Restricted Use Pesticides as well as those classified as General Use Pesticides. An applicator must make a written record within 30 days after the application. Records to keep include product name and EPA registration number, total amount applied, location, crop or site of application, size of treated area, name and certification number of applicator or supervisor, and date of application.

Environmental & Safety Precautions (WPS)

Proper use of herbicides and other pesticides is important to the safety of humans and the environment. Pesticide labels contain precautionary statements to inform people of the potential hazards and safeguards associated with pesticides. The types of precautionary statements may vary depending on particular product and its use. Examples of issues that may require precautionary statements are: 1) use of protective clothing, 2) exposure to domestic animals, 3) storage, 4) disposal of excess pesticides, rinsates and containers, 5) toxicity to fish and wildlife, 6) groundwater, and 7) endangered species. To assure the pesticide is used in a safe manner, it is important to read and follow the label directions.

Worker Protection Standards (WPS) were established to protect pesticide handlers and agricultural workers. This federal EPA regulation requires that employees are informed about pesticide use and protection practices. WPS requires pesticide safety training for workers and handlers, display of safety posters, and access to labeling and other specific information at a central location. Further protection is ensured by excluding workers from areas being treated with a pesticide, REI (Restricted-Entry Intervals) following a pesticide application, and proper use of PPE (Personal Protective Equipment). REI's and protective clothing requirements are listed on the pesticide label.

Water Quality Statements

The potential for contamination of surface and/or ground water has become an important consideration when choosing herbicides. Several products have groundwater advisory statements on their label. Such statements advise not to apply these herbicides where the water table (groundwater) is close to the surface and where the soils are very permeable (i.e. well drained soils such as sands, sandy loams, or loamy sands). Refer to these statements and observe all precautions on the label when using these products. Listed below are herbicide products with active ingredients which have been identified as seeping or leaching through soil and can enter groundwater.

*AAtrex	Degree	OpTill
*Atrazine	Degree Xtra	Outlook
Authority	Distinct	Parallel
Authority Assist	Dual II Magnum	Phoenix
Authority MTZ	*Expert	Prequel
Authority XL	Extreme	*Princep
Balance	*FieldMaster	Pursuit
*Bicep II Magnum	FirstRate	Python
Boundary	Flexstar	Radius
*Brawl II ATZ	*FulTime	Realm Q
Breakfree	Gangster	Require Q
*Breakfree ATZ	*Guardsman Max	Scepter
*Buctril/Atrazine	Halex GT	Sencor
*Bullet	Harness	Sequence
Callisto	*Harness Xtra	Sharpen
*Callisto Xtra	Hornet WDG	*Simazat
Camix	Integrity	Status
Charger Max	*Keystone	Storm
*Charger Max ATZ	Laudis	SureStart
Cinch	*Lexar	TopNotch
*Cinch ATZ	Lightning	TripleFLEX
Confidence	*Lumax	UltraBlazer
Cobra	*Marksman	Valor
*Confidence Xtra	*Medal II AT	Verdict
Corvus	Micro-Tech	Volley
Define	Milo-Pro	*Volley ATZ
		Warrant

**Manufacturers of atrazine and simazine containing products have developed strategies for limiting their movement to both ground and surface water. The maximum rate of these products for early preplant, preplant incorporated, or preemergence applications depends on soil erodibility, as defined by the Natural Resources Conservation Service, and percent of ground covered with plant residue. A summary of the label precautions and restrictions can be found at the beginning of the corn section in this publication.*

Herbicide Classification

Herbicide mode of action can be defined as the mechanism whereby a herbicide interferes with plant metabolism or function that inhibits plant growth or leads to plant death. Herbicides are often classified according to their mode of action, since herbicides within the same mode of action class will typically produce similar symptoms on susceptible plants. The major mode of action categories include: ACCase inhibitors, ALS inhibitors of amino acids, synthetic auxins (growth regulators), photosynthesis inhibitors (photosystem II), EPSP synthetase enzyme inhibitors, glutamine synthetase inhibitors, pigment inhibitors (carotenoid biosynthesis and 4-HPPDs), cell membrane disruptors (photosystem I and PPO inhibitors), microtubule assembly inhibitors (root growth inhibition), and cell division (seedling shoot growth inhibitors). The following tables list these herbicide groups with representative examples of herbicide products within each classification and general information on how they function to interfere with plant growth.

Herbicide Resistance

In recent years herbicide resistance has become an important issue to consider when making weed management decisions. Crops traditionally susceptible to some herbicides are being developed which are tolerant (i.e. resistant) to specific herbicides. For example, soybean varieties and corn hybrids resistant to glyphosate products are now available to producers.

On the other hand, herbicide resistance can occur and develop from natural weed populations. For example, resistance of smooth pigweed to triazine type herbicides (i.e. Atrazine and Princep) has been found and documented in some localized areas of Kentucky where corn is grown in consecutive years. Other states have also reported weed resistance in field crops following the continuous use of certain herbicides. The potential for weed resistance to develop increases with continuous use of herbicides that have the same mode of action (i.e. similar chemistry). Therefore, herbicide use should be monitored and production practices implemented to prevent and reduce the potential for weed resistance to occur.

A key to avoiding development of herbicide resistant weed populations is prevention. Listed below are management strategies to consider in preventing and dealing with herbicide resistant weeds.

***Scout fields** regularly and identify weeds present. Respond quickly to shifts in weed populations to restrict spread of weeds.

***Select a herbicide based on weeds present** and use a herbicide only when necessary.

***Rotate crops.** Crop rotation helps disrupt weed cycles and some weed problems are more easily managed in some crops than others.

***Rotate herbicides.** Avoid using the same herbicide or another herbicide with the same mode of action (i.e. herbicides that inhibit the same process in target weeds) for two consecutive years in a field. It is possible for a herbicide used in one crop to have the same mode of action as a different herbicide used in another crop. For example: Accent, Classic, Harmony Extra, Harmony SG, Lightning, Scepter, Option, Osprey, Permit, Pursuit, Spirit, Python, Resolve, Steadfast, Stout, and Synchrony "STS" contain active ingredients with the same mode of activity in plants (i.e. these herbicides are ALS/AHAS inhibitors).

***Apply herbicides with different modes of action** as a tank mixture or sequential application during the same season.

***Combine other weed control practices** such as cultivation with herbicide treatments where soil erosion potential is minimized.

***Clean tillage and harvest equipment** to avoid moving weed problems from one field to the next.

Tank Mixtures & Sequential Applications

For broad spectrum weed control, more than one herbicide may be necessary. In this publication we have included only formulations or tank mixtures registered with the EPA by the manufacturer.

When tank mixing two or more herbicide products it is important to consult the product(s) label to determine if potential problems may occur. Often a jar test may be required to determine if the products are compatible in the spray tank. Some tank mixtures or herbicide combinations can reduce weed control activity (i.e. they are **antagonistic**); whereas, other tank mixes will increase the weed control activity (i.e. **synergistic**). The potential for crop injury is sometimes increased by applying two or more herbicides to the same crop.

In addition to combining herbicides, sequential herbicide applications are used to provide season-long weed control. These applications may consist of an early pre-plant herbicide treatment followed by an application of a soil-applied herbicide at planting or a herbicide treatment before or at planting followed by a postemergence herbicide application later in the season after the crop has emerged. When using herbicides in sequential treatments, extreme care should be taken to keep within the recommended rates for each herbicide. In addition, rotational crop options may be reduced when herbicides with similar modes of action are applied the same crop season.

Herbicide Classification By Mode of Action Groups

Group CODE	Herbicide Classification	Herbicide Examples	Site of Uptake	Plant Selectivity	Translocation	Symptomology
1	ACCase Inhibitors (lipid synthesis) *Aryloxyphenoxy propionates *Cyclohexanediones	Axial XL, Assure II, Fusion, Select, Poast	foliage	grasses	phloem mobile (with sugars)	Growing point rots at the nodes, new leaves pull out easily
2	ALS Inhibitors (amino acid synthesis) * Imidazolinones * Sulfonylureas * Sulfonamides	Scepter, Pursuit, Lightning Accent, Classic, Harmony FirstRate, Python	soil or foliage	selected broadleaves or grasses	phloem mobile (with sugars); xylem mobile in soil uptake	Chlorotic new growth, shortened internodes, reddened veins on soybeans, yellow flash in corn, bottle brush roots
3	Microtubule Assembly Inhibitors (root growth inhibitor) * Dinitroanilines	Prowl, Treflan	soil	grasses more than broadleaves	minimal transport	Stunting and clubbed root tips
4	Synthetic Auxins (Growth Regulator) • Phenoxy acids • Benzoic acids • Pyridine carboxylic acids	2,4-D dicamba [Clarity, Banvel] Starane, Vista	foliage primarily	broadleaves	phloem mobile (with sugars)	Distorted growth of new leaves, callus growth on stems
5	Photosynthesis Inhibitors [PS II] * Triazines * Triazinones	Binding Site A Atrazine, Princep Sencor	soil or foliage	broadleaves more than grasses	xylem mobile (moves with water)	Contact burn of existing leaves, chlorosis of oldest leaf margins of seedlings if soil uptake
6	* Benzothiadiazinones * Nitriles	Binding Site B Basagran Buctril				
7	* Phenylureas	Binding Site C Lorox				
9	EPSP Synthetase Inhibitor (amino acid synthesis) * Glycines	glyphosate [Durango, Roundup, Touchdown, etc.]	foliage	generally non-selective	phloem mobile (with sugars)	Chlorotic new growth to death depending on rate, occasionally white flash
10	Glutamine Synthetase Inhibitor (nitrogen metabolism)	Ignite, Liberty	foliage	non-selective	primarily contact	Chlorosis of entire plant in 4 - 5 days
13	Carotenoid Biosynthesis (pigment inhibitor)	Command	soil or foliage	grasses and selected broadleaves	xylem mobile (moves with water)	Bleaching (whitening) of leaves
14	PPO Inhibitors (cell membrane disruptors) * Diphenylethers * Triazolinones * N-phenylphthalamides * Pyrimidinedione	Blazer, Cobra, Flexstar Aim, Authority, Spartan Resource, Valor Sharpen	foliage or soil	broadleaves more than grasses	xylem mobile (moves with water), acts as a contact when applied POST	Contact burn of existing leaves, chlorosis of veins if soil uptake
15	Cell Division Inhibitors (seedling shoot growth inhibitors) * Chloroacetamides * Oxyacetamides	Degree, Harness, Surpass, Warrant, Dual, Lasso, Intro, Outlook, Define	soil	grasses more than broadleaves	xylem mobile (minimal transport)	Leafing out under-ground, wrapped leaves of grasses, bugging whipping
19	Auxin Transport Inhibitor	diflufenzopyr[Distinct, Status]	foliage	broadleaves	phloem mobile	-----
22	Cell Membrane Disruptors [PS I] * Bipyridyliums	paraquat [Gramoxone]	foliage	non-selective	contact activity	Rapid water soaking of existing leaves
27 (28)	4-HPPDs (pigment inhibitors)	Balance, Callisto, Impact, Laudis	soil or foliage	selected broadleaves or grasses	xylem mobile (moves with water)	Bleaching (whitening) of existing leaves

Relative Risk of Developing Resistance to Herbicides Based on their Mode of Action

HIGH RISK

ACCase Inhibitors [Group 1] (Lipid Synthesis)

Achieve (tralkoxydim)
Arrow (clethodim)
Assure II (quizalofop)
Axial (pinoxaden)
Fusilade DX (fluazifop)
Fusion (fluazifop + fenoxaprop)
Poast, Poast Plus (sethoxydim)
Section, Volunteer (clethodim)
Select, Select MAX (clethodim)

ALS Inhibitors [Group 2] (Amino Acid Synthesis)

Accent, Nic-It (nicosulfuron)
Audit (thifensulfuron + tribenuron)
Basis (rimsulfuron + thifensulfuron)
Beacon (primisulfuron)
Canopy EX (chlorimuron + tribenuron)
Classic (chlorimuron)
Cloak EX (chlorimuron+tribenuron)
Everest (flucarbozone)
Exceed (primisulfuron + prosulfuron)
Express (tribenuron-methyl)
Finesse (chlorsulfuron + metsulfuron)
FirstRate (cloransulam)
FirstShot SG (thifensulfuron+tribenuron)
HarmonyExtra(thifensulfuron+tribenuron)
Harmony GT, Unity (thifensulfuron)
LeadOff (rimsulfuron + thifensulfuron)
Lightning (imazapyr + imazethapyr)
Osprey (mesosulfuron)
Permit (halosulfuron)
PowerFlex (pyroxsulam)
Pursuit (imazethapyr)
Python (flumetsulam)
Raptor (imazamox)
Resolve SG (rimsulfuron)
Resolve Q (rimsulfuron + thifensulfuron)
Scepter (imazaquin)
Solida (rimsulfuron)
Spirit (prosulfuron + primisulfuron)
Steadfast (rimsulfuron + nicosulfuron)
Synchrony (chlorimuron+ thifensulfuron)
Volta Extra (thifensulfuron + tribenuron)

MEDIUM RISK

Photosynthesis Inhibitors – PS II (Binding Site A) [Group 5]

AAtrex (atrazine)
Princep (simazine)
Milo-Pro (propazine)
Metri (metribuzin)
Sencor (metribuzin)
Simazat (atrazine + simazine)

(Binding Site B) [Group 6]

Basagran (bentazon)
Buctril (bromoxynil)

(Binding Site C) [Group 7]

Lorox (linuron)

Cell Membrane Disruptors

(PPO Inhibitors) [Group 14]

Aim (carfentrazone)
Authority, Spartan (sulfentrazone)
Cadet (fluthiacet-methyl)
Cobra, Phoenix (lactofen)
Flexstar, Reflex (fomesafen)
Resource (flumicloric)
Sharpen (salfufenacil)
Spartan Charge
(sulfentrazone+carfentrazone)

Stellar (lactofen + flumicloric)

Ultra Blazer (acifluorfen)

Valor, Emcompass (flumioxazin)

Vida (pyraflufen)

(Photosystem I) [Group 22]

Firestorm (paraquat)
Gramoxone (paraquat)

Carotenoid Biosynthesis

(Pigment Inhibitor) [Group 13]

Command (clomazone)

4-HPPDs

(Pigment Inhibitor) [Group 27 (28)]

Balance (isoxaflutole)
Callisto (meostrione)
Impact (topramezone)
Laudis (tembotrione)

LOW RISK

Microtubule Assembly Inhibitors (Root Growth Inhibitors) [Group 3]

Prowl (pendimethalin)
Treflan (trifluralin)

Synthetic Auxins [Group 4] (Growth Regulators)

Banvel, Clarity (dicamba)
Butoxone 175 (2,4-DB)
Butyrac 200 (2,4-DB)
2,4-D [various products]
Oracle, Sterling (dicamba)
Vista (fluroxypyr)
Weedmaster (dicamba + 2,4-D)

EPSP Synthetase Inhibitors

(Amino Acid Synthesis) [Group 9]

Glyphosate [various products]
Roundup, Touchdown (glyphosate)

LOWEST RISK

Glutamine Synthetase Inhibitors

(Nitrogen Metabolism) [Group 10]

Ignite (glufosinate)
Liberty (glufosinate)

Cell Division Inhibitors [Group 15] (Seedling Shoot Growth)

Breakfree (acetochlor)
Degree, Harness (acetochlor)
Surpass, Topnotch (acetochlor)
Warrant (acetochlor)
Dual, Parallel (metolachlor)
Dual II Magnum (S-metolachlor)
Medal II (S-metolachlor)
Intro, Micro-Tech (alachlor)
Outlook, Establish (dimethenamid-P)
Define (flufenacet)
Devrinol (napropamide)

Agricultural Herbicides that Contain Two or More Different Modes of Action

ALS Inhibitors [Group 2] *and*

Synthetic Auxins (Growth Regulators) [Group 4]

Hornet WDG (flumetsulam + clopyralid)
NorthStar (primisulfuron + dicamba)
Require Q (rimisulfuron + dicamba)
Yukon (halosulfuron + dicamba)

ALS Inhibitors [Group 2] *and*

Synthetic Auxins (Growth Regulators) [Group 4] *and*

Cell Division (shoot growth inhibitors) [Group 15]

SureStart (flumetsulam + clopyralid + acetochlor)
TripleFLEX (flumetsulam + clopyralid + acetochlor)

ALS Inhibitors [Group 2] *and*

Photosynthesis Inhibitors (PS II) [Group 5]

Canopy (chlorimuron + metribuzin)
Cloak (chlorimuron + metribuzin)

ALS Inhibitors [Group 2] *and*

EPSP Synthetase Inhibitor [Group 9]

Extreme (imazethapyr + glyphosate)
Tackle (imazethapyr + glyphosate)
ThunderMaster (imazethapyr + glyphosate)

ALS Inhibitors [Group 2] *and*

PPO Inhibitors [Group 14]

Authority Assist (imazethapyr + sulfentrazone)
Authority First (chloransulam + sulfentrazone)
Authority XL (chlorimuron + sulfentrazone)
Envive (chlorimuron + thifensulfuron + flumioxazin)
Gangster (chloransulam + flumioxazin)
Guantlet (chloransulam + sulfentrazone)
OpTill (imazethapyr + saflufenacil)
Priority (halosulfuron + carfentrazone)
Sonic (chloransulam + sulfentrazone)
Valor XLT (chlorimuron + flumioxazin)

ALS Inhibitors [Group 2] *and*

4-HPPDs (pigment inhibitors) [Group 27 (28)]

Capreno (thiencarbozone-methyl + tembotrione)
Corvus (thiencarbozone-methyl + isoxaflutole)
Prequel (rimsulfuron + isoxaflutole)
Realm Q (rimsulfuron + mesotrione)

Synthetic Auxins (Growth Regulators) [Group 4] *and*

Photosynthesis Inhibitors (PS II) [Group 5]

Marksman (dicamba + atrazine)

Synthetic Auxins (Growth Regulators) [Group 4] *and*

Auxin Transport Inhibitors [Group 19]

Distinct (dicamba + diflufenzopyr)
Status (dicamba + diflufenzopyr)

Photosynthesis Inhibitors (PS II) [Group 5] *and*

PPO Inhibitors [Group 14]

Authority MTZ (metribuzin + sulfentrazone)

Photosynthesis Inhibitors (PS II) [Group 5] *and*

PPO Inhibitors [Group 14]

Authority MTZ (metribuzin + sulfentrazone)

Photosynthesis Inhibitors (PS II) [Group 5] *and*

Cell Division (shoot growth inhibitors) [Group 15]

Axiom (metribuzin + flufenacet)
Bicep II Magnum (atrazine + S-metolachlor)
Breakfree ATZ (atrazine + acetochlor)
Boundary (metribuzin + S-metolachlor)
Bullet (atrazine + alachlor)
Cinch ATZ (atrazine + S-metolachlor)
Degree Xtra (atrazine + acetochlor)
Domain (metribuzin + flufenacet)
Fultime (atrazine + acetochlor)
Guardsman Max (atrazine + dimethenamid-P)
Harness Xtra (atrazine + acetochlor)
Medal II AT (atrazine + S-metolachlor)
Volley ATZ (atrazine + acetochlor)

Photosynthesis Inhibitors (PS II) [Group 5] *and*

Cell Division (shoot growth inhibitors) [Group 15]] *and*

EPSP Synthetase Inhibitor [Group 9]

Expert (atrazine + S-metolachlor + glyphosate)
FieldMaster (atrazine + acetochlor + glyphosate)

Photosynthesis Inhibitors (PS II) [Group 5] *and*

4-HPPDs (pigment inhibitor) [Group 27 (28)]

Callisto XTRA (atrazine + mesotrione)

Photosynthesis Inhibitors (PS II) [Group 5] *and*

Cell Division (shoot growth inhibitors) [Group 15] *and*

4-HPPDs (pigment inhibitor) [Group 27 (28)]

Lexar, Lumax (atrazine + S-metolachlor + mesotrione)

Photosynthesis Inhibitors (PS II) [Group 6] *and*

PPO Inhibitors [Group 14]

Storm (bentazon + aciflurofen)

EPSP Synthetase Inhibitor [Group 9] *and*

PPO Inhibitors [Group 14]

Spartan Advance (glyphosate + sulfentrazone)
Flexstar GT (glyphosate + fomesafen)

EPSP Synthetase Inhibitor [Group 9] *and*

Cell Division (shoot growth inhibitors) [Group 15]

Sequence (glyphosate + S-metolachlor)

EPSP Synthetase Inhibitor [Group 9] *and*

Cell Division (shoot growth inhibitors) [Group 15]] *and*

4-HPPDs (pigment inhibitor) [Group 27 (28)]

Halex GT (glyphosate + S-metolachlor + mesotrione)

PPO Inhibitors [Group 14] *and*

Cell Division (shoot growth inhibitors) [Group 15]

Verdict (saflufenacil + dimethenamid-P)
Prefix (S-metolachlor + fomesafen)

Cell Division (shoot growth inhibitors) [Group 15] *and*

4-HPPDs (pigment inhibitors) [Group 27 (28)]

Camix (S-metolachlor + mesotrione)
Radius (flufenacet + isoxaflutole)

Adjuvants and Additives

An adjuvant is any substance included in the herbicide formulation which enhances the effectiveness of the herbicide. Additives include adjuvants or other substances added to the spray mixture which may result in increased or decreased effectiveness of the spray mixture or for improving application. Products typically recommended for use with herbicides contain 80 to 90% of the active agent. Additives include such substances as:

- 1) **Emulsifier**—a substance which promotes the suspension of one liquid or another
- 2) **Surfactant**—a material which favors or improves the emulsifying, dispersing, spreading, wetting or other surface modifying properties of liquids
- 3) **Oil Concentrate**—a blend of non-phytotoxic crop oils, surfactants and emulsifiers
- 4) **Wetting Agent**—a substance that reduces interfacial tensions and causes spray solutions or suspensions to make better contact with treated surfaces.
- 5) **Nitrogen Fertilizers**—an ammonium containing fertilizer that enhances the uptake of certain post-emergence herbicides inside the cell wall (eg. 28% or 32% Urea Ammonium Nitrate or Ammonium Sulfate)
- 6) **Drift Control Agent**—a substance added to the spray solution to reduce the potential for off-site movement of spray particles.

Weed Sprayers

Even distribution of herbicides at the proper rate is essential for good weed control. A small variation in the rate of application of some herbicides may result in failure to kill weeds or may cause injury to the crop. For spray applications of herbicides in farm crops, the low pressure sprayer (15 to 50 pounds per square inch pressure) is most suitable either for broadcast or band spraying. Hand sprayers of 3 or 4-gallon capacity are suitable for small areas and for spot spraying.

A good field sprayer should have:

- 1) a pump that is easily replaced, resistant to wear and chemicals, and that has a capacity of 8 to 15 gallons per minute;
- 2) a boom equipped with nozzles with replaceable tips, the nozzles being evenly spaced on the bottom for broadcast spraying;
- 3) 50-mesh screens for suction line and nozzles, and a gauge that measures pressure accurately from 10 to 100 pounds per square inch; and
- 4) a mechanical or jet agitator to keep the spray well mixed and prevent the herbicide from settling to the bottom of the tank.

For row-band spraying, use an even, flat fan nozzle such as a Tee Jet[®] 8003-E or similar nozzle type for mounting back of each planter press-wheel.

Sprayer Calibration

To be sure of applying the right amount of material per acre, it is necessary to know how much liquid the sprayer is delivering per acre at a given speed and pressure. The following is a fast, simple method of calibrating a sprayer for broadcast application.

Ounce Calibration Method:

- 1) Measure the correct distance in the field shown in the following table. Select the appropriate distance for your nozzle or row spacing.
- 2) In the field to be sprayed, note the time in seconds spent to drive the measured distance at the desired throttle setting (speed).
- 3) Catch the nozzle discharge for the noted time (#2 above) in a measuring cup or other container graduated in ounces.
- 4) The total discharge per row or nozzle spacing in ounces is equal to the gallons per acre applied.
- 5) Repeat for each nozzle or nozzle group to ensure equal distribution.

SPRAYER CALIBRATION (Distance)

Nozzle Spacing (inches)	Distance to Catch Discharge (feet)
40	102
38	107
36	113
34	120
32	127
30	136
28	146
26	157
24	170
22	185
20	204
18	227
16	255
14	291

Sprayer Cleanup

Ideally spray equipment should be cleaned in the field after the spray job has been completed. Do not clean spray equipment in areas where rinse water will contaminate water supplies, streams, or injure susceptible crops.

Flushing of spray equipment with water will be sufficient for removing potentially harmful amounts of many pesticides. However, there are certain groups of pesticides such as a plant growth-regulator, sulfonylurea herbicides and organophosphate insecticides that may require special attention in cleaning equipment. *Special attention to clean out procedures can be critically important when switching applications between crops to help avoid significant crop injury.* As a rule, a sprayer that has been used to apply 2,4-D or other growth regulator type herbicides should not be used in treating tobacco or other susceptible crops.

Some pesticide labels provide specific information on cleaning spray equipment; therefore, consult the label for guidelines. If specific guidelines are not indicated on the label the following procedure is generally recommended:

1. Fill the tank at least one-half full with fresh water. Flush tanks, lines, booms, and nozzles for at least 5 minutes using a combination of agitation and spraying. Rinsate from this procedure is best sprayed onto cropland to avoid accumulation of pesticide-contaminated rinsate at one site. Thoroughly rinse the inside surfaces of the tank. Pay particular attention to the surfaces around the tank fill access and tank plumbing fixtures. The use of a 360-degree nozzle or other special rinsing nozzles installed permanently to the spray system can help automate this procedure.
2. Fill the tank again with fresh water and add one of the following cleaning solutions or a commercially available tank cleaner. Agitate the solution for 15 minutes and operate the spray booms long enough to ensure that all nozzles and boom lines are filled with the cleaning solution. Let the solution stay in the system for several hours, preferably overnight. When emptying the tank, spray the cleaning solution onto an area suitable for the rinsate solution.

To make a cleaning solution add one of following to each 50 gallons of water:

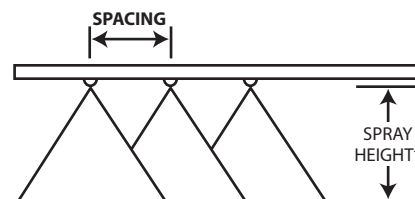
- a) 2 quarts of household ammonia, or
- b) 4 pounds of trisodium phosphate cleaner.

3. Add more water and rinse the system again by using a combination of agitation and spraying. Remove and clean nozzles, screens, and strainers in a bucket of cleaning agent and water. Use safety precautions for the agrichemicals and cleaning products used.
4. Make a final rinse and flush the system again with clean water.

Nozzles

Many types of nozzles are available for use. Each type provides different patterns, flow rates, spray angles, and droplet sizes. The following chart is meant as an aid in sprayer calibration and are presented courtesy of Spraying Systems Co. of Wheaton, Illinois. Though the TeeJet® brand is popular in Kentucky, similar nozzles from other manufacturers are perfectly acceptable.

TIP NO. (Strainer Screen Size)		Liquid Pressure in PSI	Capacity 1 Nozzle in GPM	Capacity 1 Nozzle in oz./min.	GALLONS PER ACRE 20" SPACING				GALLONS PER ACRE 30" SPACING			
80° SERIES	110° SERIES				5 MPH	6 MPH	7 MPH	8 MPH	5 MPH	6 MPH	7 MPH	8 MPH
8001VS (100 Mesh)	11001VS (100 Mesh)	30	.09	11	5.1	4.3	3.7	3.2	3.4	2.9	2.5	2.1
		35	.09	12	5.6	4.6	4.0	3.5	3.7	3.1	2.6	2.3
		40	.10	13	5.9	5.0	4.2	3.7	4.0	3.3	2.8	2.5
		45	.11	14	6.3	5.3	4.5	3.9	4.2	3.5	3.0	2.6
		60	.12	15	7.3	6.1	5.2	4.6	4.9	4.0	3.5	3.0
80015VS (100 Mesh)	110015VS (100 Mesh)	30	.13	17	7.7	6.4	5.5	4.8	5.1	4.3	3.7	3.2
		35	.14	18	8.3	6.9	6.0	5.2	5.6	4.6	4.0	3.5
		40	.15	19	8.9	7.4	6.4	5.6	5.9	5.0	4.2	3.7
		45	.16	20	9.5	7.9	6.8	5.9	6.3	5.3	4.5	3.9
		60	.18	23	10.9	9.1	7.8	6.8	7.3	6.1	5.2	4.6
8002VS (50 Mesh)	11002VS (50 Mesh)	30	.17	22	10.3	8.6	7.4	6.4	6.9	5.7	4.9	4.3
		35	.19	24	11.1	9.3	7.9	6.9	7.4	6.2	5.3	4.6
		40	.20	26	11.9	9.9	8.5	7.4	7.9	6.6	5.7	5.0
		45	.21	27	12.6	10.5	9.0	7.9	8.4	7.0	6.0	5.3
8003VS (50 Mesh)	11003VS (50 Mesh)	30	.26	33	15.4	12.9	11.0	9.7	10.3	8.6	7.4	6.4
		35	.28	36	16.7	13.9	11.9	10.4	11.1	9.3	7.9	6.9
		40	.30	38	17.8	14.9	12.7	11.1	11.9	9.9	8.5	7.4
		45	.32	41	18.9	15.8	13.5	11.8	12.6	10.5	9.0	7.9
8004VS (50 Mesh)	11004VS (50 Mesh)	30	.35	45	21	17.2	14.7	12.9	13.7	11.4	9.8	8.6
		35	.37	47	22	18.5	15.9	13.9	14.8	12.3	10.6	9.3
		40	.40	51	24	19.8	17.0	14.9	15.8	13.2	11.3	9.9
		45	.42	54	25	21	18.0	15.8	16.8	14.0	12.0	10.5
8005VS (50 Mesh)	11005VS (50 Mesh)	30	.43	55	26	21	18.4	16.1	17.2	14.3	12.3	10.7
		35	.47	60	28	23	19.8	17.4	18.5	15.4	13.2	11.6
		40	.50	64	30	25	21	18.6	19.8	16.5	14.1	12.4
		45	.53	68	32	26	23	19.7	21	17.5	15.0	13.1
8006VS (50 Mesh)	11006VS (50 Mesh)	30	.52	67	31	26	22	19.3	21	17.2	14.7	12.9
		35	.56	72	33	28	24	21	22	18.5	15.9	13.9
		40	.60	77	36	30	25	22	24	19.8	17.0	14.9
		45	.64	82	38	32	27	24	25	21	18.0	15.8
8008VS (50 Mesh)	11008VS (50 Mesh)	30	.69	88	41	34	29	26	27	23	19.6	17.2
		35	.75	96	44	37	32	28	30	25	21	18.5
		40	.80	102	48	40	34	30	32	26	23	19.8
		45	.85	109	50	42	36	32	34	28	24	21
60	.98	125	58	49	42	36	39	32	28	24	21	



*Adjust spray height in the field to overlap approximately 30% of each edge of pattern.

SUGGESTED MINIMUM SPRAY HEIGHT	
SPRAY ANGLE	SPRAY HEIGHT 20" SPACING
80°	17-19"
110°	10-12"

Flat Fan Spray Tips

- 8002VS Stainless Steel with VisiFlo color coding
- 8002-HSS Hardened Stainless Steel
- 8002-SS Stainless Steel
- 8002 Brass

Herbicides, Formulations, Manufacturers, and Crops

Trade Name*	MOA Group	Active Ingredient	Manufacturer	Crops
AAtrex 4WDL 90 WDG	Group 5	atrazine	Syngenta	corn (field, popcorn), grain sorghum
Accent (SP) 75DF	Group 2	nicosulfuron	DuPont	corn (field, popcorn, sweet)
Accent Q	Group 2	nicosulfuron (54.5%)+ isoxadifen (safener)	DuPont	corn (field, popcorn, sweet)
Acumen 3.3EC	Group 3	pendimethalin	Tenkoz	corn (field, popcorn), soybean, tobacco
Aim 1.9EW or Aim 2EC	Group 14	carfentrazone	FMC	corn (field, popcorn), grain sorghum, soybean, wheat, barley
Alecto 41 HL [3 lb ae/gal]	Group 9	glyphosate (isopropylamine salt)	Ritter Chemical	corn (field, popcorn), grain sorghum, soybean, wheat, barley
Arrow 2EC	Group 1	clethodim	Makhteshim-Agan	soybean
Assure II 0.88E	Group 1	quizalofop P-ethyl	DuPont	soybean
Atrazine 4 WDL 90 WDG	Group 5	atrazine	(various)	corn (field, popcorn), grain sorghum
Audit 75 WDG	Group 2	thifensulfuron (56.25%) + tribenuron (18.75%)	Arysta Life Science	wheat, barley, corn(field), grain sorghum, soybean, fallow
Authority Assist 4L	Group 14 Group 2	sulfentrazone (3.33 lb) + imazethapyr (0.67 lb)	FMC	soybean
Authority First DF 70DF	Group 14 Group 2	sulfentrazone (62.1%) + cloransulam (7.9%)	FMC	soybean
Authority MTZ 45DF	Group 14 Group 5	sulfentrazone (18%) + metribuzin (27%)	FMC	soybean
Authority XL 70DF	Group 14 Group 5	sulfentrazone (62.22%) + chlorimuron (7.78%)	FMC	soybean
Axial 0.83 EC or Axial XL 0.42EC	Group 1	pinoxaden	Syngenta	wheat, barley
Axiom 68DF	Group 15 Group 5	flufenacet (54.4%) + metribuzin (13.6%)	Bayer CropScience	corn (field), soybean, wheat
Balance Flexx	Group 27(28)	isoxaflutole (2 lb) + cyprosulfamide (safener)	Bayer CropScience	corn (field)
Banvel 4S	Group 4	dicamba (dimethylamine salt)	Arysta Life Science	corn, grain sorghum, wheat, barley, oats
Basagran 4S	Group 6	bentazon	Arysta Life Science	corn (field, popcorn), grain sorghum, soybean
Basis 75 WDG	Group 2 Group 2	rimsulfuron (50%) + thifensulfuron (25%)	DuPont	corn (field)
Beacon 75DF	Group 2	primisulfuron	Syngenta	corn (field, popcorn)
Bicep II Magnum 5.5L	Group 15 Group 5	S-metolachlor (2.4 lb) + atrazine (3.1 lb) + benoxacor (safener)	Syngenta	corn (all types), grain sorghum
Boundary 6.5EC	Group 15 Group 5	S-metolachlor (5.25 lb) + metribuzin (1.25 lb)	Syngenta	Soybean
Brawl II 7.64EC	Group 15	S-metolachlor (2.4 lb) + benoxacor (safener)	Tenkoz	corn (all types), soybean, grain & forage sorghum
Brawl II ATZ 5.5L	Group 15 Group 5	S-metolachlor (2.4 lb) + atrazine (3.1 lb) + benoxacor (safener)	Tenkoz	corn (all types), grain sorghum
Breakfree 6.4EC	Group 15	acetochlor + dichlormid (safener)	DuPont	corn (field, popcorn)
Breakfree ATZ 5.25L	Group 15 Group 5	acetochlor (3.0 lb) + atrazine (2.25 lb) + dichlormid (safener)	DuPont	corn (field, popcorn)

Herbicides, Formulations, Manufacturers, and Crops

Trade Name*	MOA Group	Active Ingredient	Manufacturer	Crops
Buccaneer 4S or Buccaneer Plus [3 lb ae/gal]	Group 9	glyphosate (isopropylamine salt)	Tenkoz	corn (field, popcorn), grain sorghum, soybean, wheat, barley
Buccaneer 5 [3.75 lb ae/gal]	Group 9	glyphosate (isopropylamine salt)	Tenkoz	corn (field, popcorn), grain sorghum, soybean, wheat, barley
Buctril 2EC	Group 6	bromoxynil (2 lb)	Bayer CropScience	corn (field, popcorn), grain sorghum, wheat, barley, oats
Bullet 4WDL	Group 15 Group 5	alachlor (2.5 lb) + atrazine (1.5 lb)	Monsanto	corn (field, popcorn), grain sorghum
Butyrac 200 2EC	Group 4	2,4-DB	Albaugh	Soybean
Cadet 0.91EC	Group 14	fluthiacet-methyl (0.91 lb)	FMC	corn (field, popcorn), soybean
Callisto 4SC	Group 27	Mesotrione (4 lb)	Syngenta	corn (field, popcorn, sweet corn), sorghum (grain, sweet)
Callisto Xtra 3.7L	Group 5 Group 27(28)	atrazine (3.2 lb) + mesotrione (0.5 lb)	Syngenta	corn (field, yellow popcorn, silage, sweet corn)
Camix 3.67L	Group 15 Group 27(28)	S-metolachlor (3.34 lb) + mesotrione (0.33 lb) + benoxacor (safener)	Syngenta	corn (field, yellow popcorn)
Canopy 75WDG	Group 2 Group 5	chlorimuron (10.7 %) + metriburin (64.3%)	DuPont	Soybean
Canopy EX 29.5 WDG	Group 2 Group 2	chlorimuron (22.7 %) + tribenuron (6.8%)	DuPont	Soybean
Capreno 3.45SC	Group 2 Group 27(28)	thiencarbozone (0.57 lb) + tembotrione (2.88 lb) + isoxadifen (safener)	Bayer CropScience	corn (field, popcorn, sweet corn)
Celebrity Plus	Group 4 Group 19 Group 2	dicamba (42.4%) + diflufenzopyr (17%) + nicosulfuron (10.6%)	BASF	corn (field)
Charger Basic 7.62 EC	Group 15	S-metolachlor	Agrilience	corn (all types), grain sorghum, soybean
Charger Max 7.64EC	Group 15	S-metolachlor + (seed safener)	Agrilience	corn (all types), grain sorghum, soybean
Charger Max ATZ 5.5 L	Group 15 Group 5	S-metolachlor (2.4 lb) + atrazine (3.1 lb) + (seed safener)	Agrilience	corn (all types), grain sorghum
Cinch 7.64EC	Group 15	S-metolachlor + benoxacor (safener)	DuPont	corn (all types), grain sorghum, soybean
Cinch ATZ 5.5L	Group 15 Group 5	S-metolachlor (2.4 lb) + atrazine (3.1 lb) + benoxacor (safener)	DuPont	corn (all types), grain sorghum
Cinco [4 lb ae/gal]	Group 9	glyphosate (isopropylamine salt)	Loveland Products	corn (field, popcorn), grain sorghum, soybean, wheat, barley
Clarity 4S	Group 4	dicamba (diglycolamine salt)	BASF	corn (field, popcorn), grain sorghum, wheat, barley
Classic 25DF	Group 2	Chlorimuron	DuPont	Soybean
Cloak 75WDG	Group 2 Group 5	chlorimuron (10.7%0 + metribuzin (64.3%)	Nufarm	Soybean
Cloak EX 29.5WDG	Group 2 Group 2	chlorimuron (22.7% + tribenuron (6.8%)	Nufarm	Soybean
Cobra 2EC	Group 14	Lactofen	Valent	Soybean
Command 3ME	Group 13	Clomazone	FMC	Soybean, tobacco
Confidence 7E	Group 15	acetochlor + (safener)	Agrilience	corn (field, popcorn)

Herbicides, Formulations, Manufacturers, and Crops

Trade Name*	MOA Group	Active Ingredient	Manufacturer	Crops
Confidence Xtra 5.6L	Group 15 Group 5	acetochlor (3.1 lb) + atrazine (2.5 lb) + (safener)	Agrilience	corn (field, popcorn)
Cornerstone or Cornerstone Plus [3 lb ae/gal]	Group 9	glyphosate (isopropylamine salt)	Agrilience	corn (field, popcorn), grain sorghum, soybean, wheat, barley
Corvus 2.63L	Group 2 Group 27(28)	thiencarbozone (0.75 lb) + isoxaflutole (1.88 lb) + Safener	Bayer CropScience	corn (field)
Credit Xtreme [4.5 lb ae/gal]	Group 9	glyphosate [isopropylamine salt (2.5 lb)+ potassium salt (2.0 lb)]	Nufarm	corn (field, popcorn), grain sorghum, soybean, wheat, barley
2,4-D [several forms]	Group 4	2,4-D	(various)	corn, grain sorghum, soybean, wheat, barley
Dawn 2L	Group 14	Fomesafen	Chemnova	soybean
Define 4SC	Group 15	Flufenacet	Bayer CropScience	corn (field)
Degree 3.8CS	Group 15	acetochlor + MON13900 (safener)	Monsanto	corn (field, popcorn, sweet)
Degree Xtra 4.04CS	Group 15 Group 5	acetochlor (2.7 lb) + atrazine (1.34 lb) + MON13900 (safener)	Monsanto	corn (field, popcorn), grain sorghum
Diablo 4S	Group 4	dicamba (dimethylamine salt)	Nufarm	Corn, grain sorghum, wheat, barley, oats
Discover NG 0.5EC	Group 1	clodinafop-propargyl	Syngenta	wheat
Distinct 70WDG	Group 19 Group 4	diflufenzopyr (0.2 lb) + dicamba (0.5 lb)	BASF	corn (field)
Dual II Magnum 7.64EC	Group 15	S-metolachlor + benoxacor (safener)	Syngenta	corn (all types), grain sorghum, soybean
Duramax [4 lb ae/gal]	Group 9	glyphosate (dimethylamine salt)	Dow AgroSciences	corn (field, popcorn), grain sorghum, soybean, wheat, barley
Durango DMA [4 lb ae/gal]	Group 9	glyphosate (dimethylamine salt)	Dow AgroSciences	corn (field, popcorn), grain sorghum, soybean, wheat, barley
Encompass 51DG	Group 14	flumioxazin	Tenkoz	Soybean
Envive 41.3DG	Group 2 Group 2 Group 14	chlorimuron (9.2%) + thifensulfuron (2.9%) + flumioxazin (29.2%)	DuPont	Soybean
Equip 32 WDG	Group 2 Group 2	foramsulfuron (30%) + iodosulfuron-methyl (2%)	Bayer	corn (field)
Establish 6E	Group 15	dimethenamid-P	Tenkoz	corn (field, popcorn), grain sorghum, soybean
ET 0.298E	Group 14	pyraflufen-ethyl	Nichina America	corn (field, popcorn), soybean, wheat
Expert 4.88L	Group 15 Group 5 Group 9	S-metolachlor (1.74 lb) + atrazine (2.14 lb) + glyphosate [IPA salt] (1.0 lb)	Syngenta	corn (field corn, Roundup Ready hybrids, popcorn, sweet corn), grain sorghum, forage sorghum
Express (TotalSol) 50 DF	Group 2	tribenuron-methyl	DuPont	Corn (field), grain sorghum, soybean, wheat, barley, fall fallow
Extreme 2.17L	Group 2 Group 9	imazethapyr (0.17 lb) + glyphosate [IPA salt] (2 lb)	BASF	soybean
FieldMaster 4.25L	Group 15 Group 5 Group 9	acetochlor (2 lb) + atrazine (1.5 lb) + glyphosate[IPA salt](0.75 lb) + MON13900 (safener)	Monsanto	corn (field, popcorn, seed)

Herbicides, Formulations, Manufacturers, and Crops

Trade Name*	MOA Group	Active Ingredient	Manufacturer	Crops
Finesse 75DF	Group 2 Group 2	chlorsulfuron (62.5%) + metsulfuron-methyl (12.5%)	DuPont	wheat
Finesse Grass & Broadleaf 71.7DF	Group 2 Group 2	chlorsulfuron (25%) + flucarbazone (46.7%)	DuPont	wheat
Firestorm 3S	Group 22	paraquat	Chemtura	corn (field, popcorn), grain sorghum, soybean, wheat, barley
FirstRate 84WDG	Group 2	cloransulam	Dow AgroSciences	soybean
FirstShot SG (TotalSol)	Group 2 Group 2	thifensulfuron (25%) + tribenuron (25%)	DuPont	corn (field), grain sorghum, soybean, wheat, barley, fallow
Flexstar 1.88L	Group 14	fomesafen	Syngenta	soybean
Flexstar GT 3.29S	Group 14 Group 9	fomesafen (0.66 lb) + glyphosate (2.63 lb)	Syngenta	soybean
Flexstar GT 3.5 [2.82S]	Group 14 Group 9	fomesafen (0.56 lb) + glyphosate (2.26 lb)	Syngenta	soybean
Fomesafen 1.88 L	Group 14	fomesafen	Willowood	soybean
FulTime 4CS	Group 15 Group 5	acetochlor (2.4 lb) + atrazine (1.6 lb)	Dow AgroSciences	corn (field, popcorn, sweet)
Fusilade DX 2E	Group 1	fluazifop-P-butyl (2 lb)	Syngenta	soybean
Fusion 2.56EC	Group 1 Group 1	fluazifop-P-butyl (2 lb) + fenoxaprop-P-ethyl (0.56 lb)	Syngenta	soybean
Gangster V 51DG GangsterFR 84DG [co-pack]	Group 14 Group 2	flumioxazin cloransulam	Valent	soybean
Gly-4 Plus [3 lb ae/gal]	Group 9	glyphosate (isopropylamine salt)	UniversalCrop Protection	corn (field, popcorn), grain sorghum, soybean, wheat, barley
Glyfos or Glyfos X-tra [3 lb ae/gal]	Group 9	glyphosate (isopropylamine salt)	Cheminova	corn (field, popcorn), grain sorghum, soybean, wheat, barley
Glyphogan [3 lb ae/gal]	Group 9	glyphosate (isopropylamine salt)	Makhteshim Agan	corn (field, popcorn), grain sorghum, soybean, wheat, barley
Gly Star Plus [3 lb ae/gal]	Group 9	glyphosate (isopropylamine salt)	Albaugh	corn (field, popcorn), grain sorghum, soybean, wheat, barley
Gly Star Original [3 lb ae/gal]	Group 9	glyphosate (isopropylamine salt)	Albaugh	corn (field, popcorn), grain sorghum, soybean, wheat, barley
GlySupreme Plus [3 lb ae/gal]	Group 9	glyphosate (isopropylamine salt)	Mey Corp	corn (field, popcorn), grain sorghum, soybean, wheat, barley
Gramoxone SL or Gramoxone Inteon	Group 22	paraquat (2 lb)	Syngenta	corn (field, popcorn), grain sorghum, soybean, wheat, barley, tobacco
Guardsman Max 5E	Group 15 Group 5	dimethenamid-P (1.7 lb) + atrazine (3.3 lb)	BASF	corn (field, popcorn), grain sorghum
Halex GT [4.39EC]	Group 15 Group 9 Group 27(28)	S-metholachlor (2.09) + glyphosate (2.09) + mesotrione (0.209)	Syngenta	corn (Glyphosate-Tolerant hybrids)
Harass 75DF	Group 2	thifensulfuron (75%)	Cheminova	wheat, barley, oats, corn (field), grain sorghum, soybean, fallow
Harmony Extra (TotalSol) 50DF	Group 2 Group 2	thifensulfuron (33.33%) + tribenuron (16.67%)	DuPont	wheat, barley, oats, corn(field), grain sorghum, soybean, fallow
Harmony SG 50DF (TotalSol)	Group 2	thifensulfuron (50%)	DuPont	wheat, barley, oats, corn (field), grain sorghum, soybean, fallow
Harness 7E	Group 15	acetochlor + MON13900 (safener)	Monsanto	corn (field, popcorn)

Herbicides, Formulations, Manufacturers, and Crops

Trade Name*	MOA Group	Active Ingredient	Manufacturer	Crops
Harness Xtra 5.6L	Group 15 Group 5	acetochlor (3.1 lb) + atrazine (2.5 lb) + MON13900 (safener)	Monsanto	corn (field, popcorn)
Honcho or Honcho Plus [3 lb ae/gal]	Group 9	glyphosate (isopropylamine salt)	Monsanto	corn (field, popcorn), grain sorghum, soybean, wheat, barley
Hornet 68.5WDG	Group 2 Group 4	flumetsulam (18.5%) + clopyralid (50%)	Dow AgroSciences	corn (field)
Hoss Ultra [3 lb ae/gal]	Group 9	glyphosate (isopropylamine salt)	Helena	corn (field, popcorn), grain sorghum, soybean, wheat, barley
Huskie	Group 27 Group 6	pyrasulfotole (0.31 lb) + bromoxynil (1.75 lb)	Bayer CropScience	wheat, barley, grain sorghum
Ignite	Group 10	glufosinate-ammonium (2.34 lb)	Bayer CropScience	corn (field), soybean [LibertyLink]
Impact 2.8SC	Group 27(28)	topramezone	AMVAC	corn (field, popcorn, sweet)
Integrity	Group 14 Group 15	saflufenacil (0.57 lb) + dimethenamid-P (5.0 lb)	BASF	corn (field, popcorn, silage)
Intensity 2EC	Group 1	clethodim	Loveland	soybean
Intrro 4E	Group 15	alachlor	Monsanto	grain sorghum, soybean
Keystone 5.25L	Group 15 Group 5	acetochlor (3.0 lb) + atrazine (2.25 lb)	Dow AgroSciences	corn (field, popcorn, sweet)
Laudis	Group 27(28)	tembotrione (3.5 lb)	Bayer CropScience	corn (field, popcorn, sweet)
LeadOff 33.4WDG	Group 2 Group 2	rimsulfuron (16.7%) + thifensulfuron-methyl (16.7%)	DuPont	corn (field)
Lexar 3.7L	Group 15 Group 27(28) Group 5	S-metolachlor (1.74 lb) + mesotrione (0.224 lb) + atrazine (1.74 lb) + benoxacor (safener)	Syngenta	corn (field, popcorn, sweet), grain sorghum
Lightning 70DG	Group 2 Group 2	imazethapyr (52.5%) + imazapyr (17.5%)	BASF	corn (CLEARFIELD hybrids)
Linex 4L	Group 7	linuron (4 lb)	DuPont	soybean
Lumax 3.9EC	Group 15 Group 27(28) Group 5	S-metolachlor (2.68 lb) + mesotrione (0.268 lb) + atrazine (1.0 lb) + benoxacor (safener)	Syngenta	corn (field, popcorn, sweet), grain sorghum
Mad Dog or Mad Dog Plus [3 lb ae/gal]	Group 9	glyphosate (isopropylamine salt)	Loveland	corn (field, popcorn), grain sorghum, soybean, wheat, barley
Marksman 3.2S	Group 4 Group 5	dicamba (1.1 lb) + atrazine (2.1 lb)	BASF	corn (field, popcorn)
MCPA	Group 4	MCPA	(various)	small grains
Medal 7.62EC	Group 15	S-metolachlor	Syngenta	corn (all types), grain & forage sorghum, soybean
Medal II 7.64EC	Group 15	S-metolachlor + benoxacor (safener)	Syngenta	corn (all types), grain & forage sorghum, soybean
Medal II AT 5.5L	Group 15 Group 5	S-metolachlor (2.4 lb) + atrazine (3.1 lb) + benoxacor (safener)	Syngenta	corn (all types), grain & forage sorghum
Me-Too-Lachlor	Group 15	metolachlor (8 lb)	Drexel	sorghum, soybean
Me-Too-Lachlor II	Group 15	metolachlor (7.8 lb)	Drexel	corn (field), popcorn
Metribuzin 75DF	Group 5	metribuzin (75%)	Makhteshim Agan	corn(field), soybean, wheat (tolerant varieties)
Metri 75DF	Group 5	metribuzin (75%)	United Phosphorus	corn(field), soybean, wheat (tolerant varieties)

Herbicides, Formulations, Manufacturers, and Crops

Trade Name*	MOA Group	Active Ingredient	Manufacturer	Crops
Micro-Tech 4WDL	Group 15	alachlor	Monsanto	corn (field, popcorn), grain sorghum, soybean
Milo-Pro 4F	Group 5	propazine (4.0 lb)	Albaugh	grain sorghum
Mirage or Mirage Plus [3 lb ae/gal]	Group 9	glyphosate (isopropylamine salt)	Loveland	corn (field, popcorn), grain sorghum, soybean, wheat, barley
NIC-IT	Group 2	nicosulfuron (2.0 lb)	Cheminova	corn (field, popcorn, sweet)
Nimble 75DF	Group 2 Group 2	thifensulfuron (50%) + tribenuron (25%)	Cheminova	wheat, barley, oats, corn (field), grain sorghum, soybean, fallow
NorthStar 47.4DG	Group 2 Group 4	primisulfuron (7.5%) + dicamba [sodium salt] (39.9%)	Syngenta	corn (field, popcorn)
OpTill 68WDG	Group 14 Group 2	saflufenacil (17.8%) + imazethapyr (50.2%)	BASF	corn (CLEARFIELD hybrids), soybean
Olympus Flex	Group 2 Group 2	propoxycarbazone (6.75%) + mesosulfuron (4.5%)	Bayer CropScience	Wheat
Osprey 4.5WDG	Group 2	mesosulfuron-methyl	Bayer CropScience	wheat
Outlook 6E	Group 15	dimethenamid-P	BASF	corn (field, popcorn), grain sorghum, soybean
Parallel 7.8E	Group 15	metolachlor + safener	Makhteshim Agan	corn (all types), grain & forage sorghum, soybean
Parallel PCS 8E	Group 15	metolachlor	Makhteshim Agan	grain & forage sorghum, soybean
Parallel Plus 5.5L	Group 15 Group 5	metolachlor (2.7 lb) + atrazine (2.8 lb)	Makhteshim Agan	corn, grain sorghum
Paraquat Conc. 3SL	Group 22	paraquat	Solera	corn (field, popcorn), grain sorghum, soybean, wheat, barley
Parazone 3 SL	Group 22	paraquat	Makhteshim Agan	corn (field, popcorn), grain sorghum, soybean, wheat, barley
Pendant 3.3EC	Group 3	pendimethalin	Winfield Solutions	corn (field, popcorn), soybean, tobacco
Pendimax 3.3EC	Group 3	pendimethalin	Dow AgroSciences	corn (field), soybean, tobacco
Permit 75DF	Group 2	halosulfuron	Gowan	corn (field), grain sorghum
Phoenix 2EC	Group 14	lactofen	Valent	soybean
Poast 1.5E	Group 1	sethoxydim	Micro Flo /BASF	soybean, tobacco
Poast Plus 1EC	Group 1	sethoxydim	BASF	soybean
PowerFlex	Group 2	pyroxsulam (7.5%)	Dow AgroSciences	wheat
Prefix 5.29L	Group 15 Group 14	S-metolachlor (4.34 lb) + fomesafen (0.95 lb)	Syngenta	soybean
Prequel 45WDG	Group 2 Group 27(28)	rimsulfuron (15%) + isoxaflutole (30%)	DuPont	corn (field)
Primero	Group 2	nicosulfuron (75%)	Rotam	corn
Princep 4WDG 90DF	Group 5	Simazine	Syngenta	corn (all types)
Priority 62.5DF	Group 14 Group 2	carfentrazone (12.5%) + halosulfuron (50%)	TENKOZ	corn (all types), grain sorghum
Prowl 3.3EC	Group 3	pendimethalin	BASF	corn (field, popcorn), soybean, tobacco
Prowl H ₂ O 3.8L	Group 3	pendimethalin	BASF	corn (field, popcorn), soybean, tobacco, wheat
Pravin	Group 2	rimsulfuron (25%)	Makhteshim Agan	corn (field)
Pursuit 70DG 2S	Group 2	imazethapyr	BASF	corn (CLEARFIELD hybrids), soybean

Herbicides, Formulations, Manufacturers, and Crops

Trade Name*	MOA Group	Active Ingredient	Manufacturer	Crops
Python 80WDG	Group 2	flumetsulam	Dow AgroSciences	corn (field), soybean
Radius 4L	Group 15 Group 27(28)	flufenacet (3.57 lb) + isoxaflutole (0.43 lb)	Bayer CropScience	corn (field)
Rage D-Tech 6EC	Group 14 Group 4	carfentrazone (0.13 lb) + 2,4-D ester (5.92 lb)	FMC	corn (field, popcorn), sorghum, soybean, wheat, barley
Raptor 1S	Group 2	imazamox	BASF	soybean
Rattler or Rattler Plus [3 lb ae/gal]	Group 9	glyphosate (isopropylamine salt)	Helena	corn (field, popcorn), grain sorghum, soybean, wheat, barley
RealmQ 38.75WDG	Group 2 Group 27(28)	rimsulfuron (7.5%) + mesotrione (31.25%) + isoxadifen [safener]	DuPont	corn (field)
Rely 280 SL	Group 10	glufosinate-ammonium (2.34 lb)	Bayer CropScience	corn (field), soybean[<i>LibertyLink</i>]; also tree & nut crops
Report Extra 75DF	Group 2 Group 2	chlorsulfuron (62.5%) + metsulfuron-methyl (12.5%)	Chemnova	wheat, barley
Require Q (mp)	Group 2 Group 4	rimsulfuron (6.25%) + dicamba (48.12%) + isoxadifen [safener]	DuPont	corn (field)
Resolve SG Resolve DF	Group 2	rimsulfuron (25%)	DuPont	corn (field)
Resolve Q	Group 2 Group 2	rimsulfuron (18.4%) + thifensulfuron (4.0%)	DuPont	corn (field)
Resource 0.86EC	Group 14	flumiclorac pentyl	Valent	corn (field), soybean
Rifle	Group 2	dicamba (dimethylamine salt)	Loveland	corn, grain sorghum, wheat, barley, oats
Roundup Original [3 lb ae/gal]	Group 9	glyphosate (isopropylamine salt)	Monsanto	corn (field, popcorn), grain sorghum, soybean, wheat, barley
Roundup PowerMAX [4.5 lb ae/gal]	Group 9	glyphosate (potassium salt)	Monsanto	corn (field, popcorn), grain sorghum, soybean, wheat, barley
Roundup WeatherMAX [4.5 lb ae/gal]	Group 9	glyphosate (potassium salt)	Monsanto	corn (field, popcorn), grain sorghum, soybean, wheat, barley
Rythum 1.88L	Group 14	fomesafen	Chemnova	soybean
Scepter 70DG	Group 2	Imazaquin	BASF	soybean
Section 2EC	Group 1	cClethodim	AgriLiance	soybean
Select 2EC	Group 1	clethodim	Valent	soybean
SelectMAX 0.97EC	Group 1	clethodim	Valent	soybean, corn (field)
Sencor 4F or Sencor 75DF	Group 5	metribuzin	Bayer CropScience	corn (field), soybean, wheat (tolerant varieties)
Sequence 5.25L	Group 9 Group 15	glyphosate (2.25 lb ae) + S-metolachlor (3 lb)	Syngenta	corn (field, popcorn), grain & forage sorghum, soybean
Shadow	Group 1	clethodim (2 lb)	Arysta	soybean
Sharpen 2.85S	Group 14	saflufenacil (2.85 lb)	BASF	corn(field, popcorn),grain sorghum, soybean, wheat, barley, oats
Showdown [3 lb ae/gal]	Group 9	glyphosate (isopropylamine + monoammonium salt)	Helena	corn (field, popcorn), grain sorghum, soybean, wheat, barley
Simazat 4L	Group 5 Group 5	simazine (2 lb)+ atrazine (2 lb)	Drexel	corn
Solida	Group 2	rimsulfuron (25%)	Chemnova	corn (field)

Herbicides, Formulations, Manufacturers, and Crops

Trade Name*	MOA Group	Active Ingredient	Manufacturer	Crops
Sonic 70DG	Group 14 Group 2	sulfentrazone (62.1%) + cloransulam (7.9%)	Dow AgroSciences	soybean
Spartan Advance 3.56L	Group 14 Group 9	sulfentrazone (0.56 lb) + glyphosate (3 lb ae)	FMC	soybean
Spartan Charge	Group 14 Group 14	sulfentrazone (3.15 lb) + carfentrazone (0.35 lb)	FMC	soybean
Spirit 57DF	Group 2 Group 2	prosulfuron (14.2%) + primisulfuron (42.8%)	Syngenta	corn (field, popcorn)
Stalwart 8EC	Group 15	metolachlor	Sipcam Agro	Soybean
Starane 1.5EC	Group 4	fluroxypyr	Dow AgroScience	corn (field), grain sorghum, small grains
Status 56WG	Group 19 Group 4	diflufenzopyr (0.16 lb) + dicamba (0.4 lb) + isoxadifen (safener)	BASF	corn (field)
Steadfast 75DF	Group 2 Group 2	nicosulfuron (50%) + rimsulfuron (25%)	DuPont	corn (field)
Steadfast Q	Group 2 Group 2	nicosulfuron (25.2%) + rimsulfuron (12.5%) + isoxadifen (safener)	DuPont	corn (field)
Stealth 3.3EC	Group 3	pendimethalin	Loveland	corn (field, popcorn), soybean, tobacco
Sterling Blue 4S	Group 4	dicamba (4 lb) (dimethylamine salt)	Agrilience	corn, grain sorghum, wheat, barley, oats
Storm 4S	Group 6 Group 14	bentazon (2.67 lb) + acifluorfen (1.33 lb)	United Phosphorus	soybean
Stout 72.5WDG	Group 2 Group 2	nicosulfuron (67.5%) + thifensulfuron-methyl (5%)	DuPont	corn (field)
SureStart 4.25SE	Group 15 Group 2 Group 4	acetochlor (3.75 lb) + flumetsulam (0.12 lb) + clopyralid (0.38 lb) + dichlormid (safener)	Dow AgroSciences	corn (field, silage)
Surpass 6.4EC	Group 15	acetochlor + dichlormid (safener)	Dow AgroSciences	corn (field, popcorn, sweet)
Synchrony XP 28.4DF	Group 2 Group 2	chlorimuron (21.5%) + thifensulfuron (6.9%)	DuPont	soybean (STS varieties)
Tackle 4.1L	Group 2 Group 9	imazethapyr (0.128 lb) + glyphosate [IPA salt] (4 lb)	Chemnova	soybean
Targa 0.88E	Group 1	quizalofop P-ethyl	Gowan	soybean
Thief	Group 2	thifensulfuron	Loveland	wheat, barley, oats, corn (field), grain sorghum, soybean, fallow
ThunderMaster 2.17L	Group 2 Group 9	imazethapyr (0.17 lb) + glyphosate [IPA salt] (2 lb)	Albaugh	soybean
TNT Broadleaf 75DF	Group 2 Group 2	thifensulfuron (50%) + tribenuron (25%)	Gowan	wheat, barley, oats, corn (field), grain sorghum, soybean, fallow
TopNotch 3.2CS	Group 15	acetochlor + dichlormid (safener)	Dow AgroSciences	corn (field, popcorn, sweet)
Touchdown HiTech [5 lb ae/gal]	Group 9	glyphosate (potassium salt)	Syngenta	corn (field, popcorn), grain sorghum, soybean, wheat, barley
Touchdown Total [4.17 ae/gal]	Group 9	glyphosate (potassium salt)	Syngenta	corn (field, popcorn), grain sorghum, soybean, wheat, barley
Traxion [4.17 lb ae/gal]	Group 9	glyphosate	Syngenta	corn (field, popcorn), grain sorghum, soybean, wheat, barley
TriCor 75DF	Group 5	metribuzin	United Phosphorus	corn (field), soybean, wheat (tolerant varieties)

Herbicides, Formulations, Manufacturers, and Crops

Trade Name*	MOA Group	Active Ingredient	Manufacturer	Crops
TripleFLEX	Group 15 Group 2 Group 4	acetochlor (3.75 lb) + flumetsulam (0.12 lb) + clopypalid (0.38 lb)	Monsanto	corn (field, silage)
Treflan 4HFP	Group 3	trifluralin	UAP Loveland	corn (field), soybean
Ultra Blazer 2L	Group 14	acifluorfen	United Phosphorus	soybean
Unity 75WDG	Group 2	thifensulfuron	Gowan	wheat, barley, oats, corn (field), grain sorghum, soybean, fallow
Valor SX 51WDG	Group 14	flumioxazin	Valent	corn (field), soybean
Valor XLT 40.3DG	Group 14 Group 2	flumioxazin (30%) + chlorimuron (10.3%)	Valent	soybean
Verdict	Group 14 Group 15	saflufenacil (0.57 lb) + dimethenamid-P (5.0 lb)	BASF	corn (field, popcorn, silage), soybean
Vida 0.208E	Group 14	pyraflufen-ethyl	Gowan	corn (field, popcorn) soybean, wheat
Vision	Group 4	dicamba (3.8 lb ae)	Helena	corn, grain sorghum, wheat, barley, oats
Volley ATZ 5.25L	Group 15 Group 5	acetochlor (3.0 lb) + atrazine (2.25 lb)	TENKOZ	corn (field, popcorn)
Volta 75 DF	Group 2	thifensulfuron	ROTAM	wheat, barley, oats, corn (field), grain sorghum, soybean, fallow
Volta Extra 75DF	Group 2 Group 2	thifensulfuron (50%) + tribenuron (25%)	ROTAM	wheat, barley, oats, corn (field), grain sorghum, soybean, fallow
Volunteer 2EC	Group 1	clethodim	TENKOZ	soybean
Warrant	Group 15	acetochlor	Monsanto	soybean
Weedmaster	Group 4 Group 4	dicamba (2.87 lb) + 2,4-D (1.0 lb)	Nufarm	sorghum
Weedone 638	Group 4	2,4-D (2.8 lb ae) [2,4-D acid+butoxyethyl ester]	Nufarm	corn, sorghum, soybean, small grains
Weedone 650	Group 4	2,4-D (5.64 lb ae) [ethylhexyl ester]	Nufarm	corn, sorghum, soybean, small grains
Weedone LV4	Group 4	2,4-D (3.8 lb ae) [isooctyl ester]	Nufarm	corn, sorghum, soybean, small grains
Yukon 67.5WDG	Group 2 Group 4	halosulfuron (12.5%) + dicamba (55%)	Gowan	corn (field), grain sorghum

*AS=aqueous suspension, DF=dry flowable, EC=emulsifiable concentrate, F=flowable, G=granule, L=liquid, ME or CS= micro-encapsulated, HFP=high flash point formulation, S=water solution, SC=soluble concentrate, SE=soluble emulsion, SG=soluble granule, WDG=water dispersible granule, WDL=water dispersible liquid, WP=wettable powder.

Glyphosate Products Labeled For Use in Grain Crops Including Postemergence Applications in Roundup Ready Corn and Soybeans

PRODUCT	Salt Form ¹	Surfactant may be needed? ²	Rate Equivalent 0.56 lb a.e./A	Rate Equivalent 0.75 lb a.e./A	Rate Equivalent 1.13 lb a.e./A
3 lb ae/gal					
Alecto 41 HL	IPA	Yes	24 oz	32 oz (2 pt)	3 pt
Buccaneer	IPA	Yes	24 oz	32 oz (2 pt)	3 pt
Buccaneer Plus	IPA	Yes	24 oz	32 oz (2 pt)	3 pt
Cornerstone	IPA	Yes	24 oz	32 oz (2 pt)	3 pt
Cornerstone Plus	IPA	Yes	24 oz	32 oz (2 pt)	3 pt
Credit Extra	IPA	No	24 oz	32 oz (2 pt)	3 pt
Glyfos	IPA	Yes	24 oz	32 oz (2 pt)	3 pt
Glyfos X-TRA	IPA	No	24 oz	32 oz (2 pt)	3 pt
Glyphogan	IPA	Yes	24 oz	32 oz (2 pt)	3 pt
Glyphosate 4	IPA	Yes	24 oz	32 oz (2 pt)	3 pt
Glyphosate 41%	IPA	Yes	24 oz	32 oz (2 pt)	3 pt
Gly Star Original	IPA	Yes	24 oz	32 oz (2 pt)	3 pt
Gly Star Plus	IPA	No	24 oz	32 oz (2 pt)	3 pt
GlySupreme Plus	IPA	No	24 oz	32 oz (2 pt)	3 pt
Gly-4 Plus	IPA	No	24 oz	32 oz (2 pt)	3 pt
Honcho / Honcho Plus	IPA	Yes	24 oz	32 oz (2 pt)	3 pt
Hoss Ultra	IPA	No	24 oz	32 oz (2 pt)	3 pt
Mad Dog / Mad Dog Plus	IPA	Yes	24 oz	32 oz (2 pt)	3 pt
Mirage / Mirage Plus	IPA	Yes	24 oz	32 oz (2 pt)	3 pt
Rattler / Rattler Plus	IPA	Yes	24 oz	32 oz (2 pt)	3 pt
Showdown	IPA + MOA	No	24 oz	32 oz (2 pt)	3 pt
Roundup Original	IPA	Yes	24 oz	32 oz (2 pt)	3 pt
3.75 lb ae/gal					
Buccaneer 5	IPA	Yes	19 oz	26 oz (1.6 pt)	2.4 pt
4 lb ae/gal					
Duramax	DMA	---	18 oz	24 oz (1.5 pt)	2.25 pt
Cinco	IPA	Required	18 oz	24 oz (1.5 pt)	2.25 pt
Durango DMA	DMA	---	18 oz	24 oz (1.5 pt)	2.25 pt
4.17 lb ae/gal					
Touchdown Total	K	---	17 oz	23 oz (1.4 pt)	2.2 pt
Traxion	---	---	17 oz	23 (1.4 pt)	2.2 pt
4.5 lb ae/gal					
Credit Xtreme	IPA + K	No	16 oz	21 oz (1.3 pt)	2 pt
Roundup PowerMAX	K	Yes	16 oz	21 oz (1.3 pt)	2 pt
Roundup Weather MAX	K	No	16 oz	21 oz (1.3 pt)	2 pt
5 lb ae/gal					
Touchdown Hi-Tech	K	Required	14 oz	19 oz (1.2 pt)	1.8 pt

¹ IPA = Isopropylamine salt DMA=Dimethylamine K = Potassium salt MOA = Monoammonium salt

² For products that may need a surfactant, a Non-Ionic Surfactant at 0.25% v/v is the typical recommendation. Consult the herbicide product label to verify when a surfactant is needed and the type and rate of surfactant to include. Ammonium Sulfate (AMS) may also be included to improve glyphosate activity.