



PRODUCTION

Herbicide Selectivity and Performance

no. 0.563

by P. Miller and P. Westra ¹

Quick Facts...

Crop rotation and conservation tillage allows for a wider selection in herbicides.

Herbicide rotation and combination help prevent weeds from developing herbicide resistance.

Mode of action, selectivity, application timing and symptoms are important factors in herbicide selection and use.

The current trend in multiple crop rotations and conservation tillage practices allows growers to use a greater variety of herbicides to effectively manage weeds. These herbicides represent diverse modes of action and chemical and biological characteristics. As a result, the spectrum of weeds controlled and the environmental behavior of these management tools are quite varied.

Mode of action. How herbicides affect plant growth and development is called their mode of action. Table 1 describes the mode of action for the herbicide families described in this fact sheet.

Application timing. Mode of action can affect application timing. Herbicides that inhibit growth are best applied before the target weed species emerges. This can be pre-emergence, pre-plant incorporated, or post-emergence.

Selectivity. Mode of action is important in understanding why certain plants are affected by an herbicide and others are not. For example, herbicides that regulate growth are generally effective on broadleaved plants but not on grass species.

Symptoms. Mode of action becomes an important consideration when evaluating treatment success. The symptoms these plants exhibit show how the herbicide affected a specific biochemical or metabolic process.

Herbicide Rotation

New herbicides are introduced on a regular basis. As the number of chemicals with the same mode of action increases, the potential for their application becomes more likely. As a result, mode of action rotation becomes important. Certain species of plants have developed tolerance or resistance to herbicides. Although two herbicides may differ chemically, they may still possess the same mode of action. The term resistance means a species' ability to tolerate or resist the effect of herbicides that differ chemically but have the same mode of action.

Current research supports the importance of crop rotations in managing weeds within a particular cropping sequence. Mode of action rotation is equally important in managing weed species and ensuring the continued effectiveness of herbicides in irrigated and dryland cropping systems.

To minimize the potential for encouraging weeds that are tolerant or resistant to one family of herbicides, use combinations or premixes of herbicides that display more than one mode of action. Before using, see herbicide labels for rotational restrictions and precautions.

Dinitroanilines

Key performance features. These growth inhibitors are applied pre-emergence or pre-plant incorporated. Prowl, Sonalan and Treflan control grasses

and a few broadleaf species. They persist in the soil for 90, 40 to 60, and 30 to 45 days, respectively.

Dinitroaniline activity is largely determined by clay and organic matter content. Greater clay and organic matter content requires a greater quantity of dinitroaniline.

Some herbicide losses could occur from volatilization. Incorporate Treflan within 24 hours, and Prowl and Sonalan within seven days after application. Timely incorporation, whether through rainfall or tillage, is important to maintain adequate herbicidal activity.

Sunlight can cause herbicide loss. If the active ingredient is unprotected on the soil surface, a large portion may be lost from ultraviolet degradation.

Plant injury symptoms. Dinitroanilines affect root development. Effects include swollen root tips and stunted lateral and secondary roots. Dinitroanilines primarily kill germinating seedlings, not established plants.

Thiocarbamates

Key performance features: These growth inhibitors are applied pre-plant incorporated. Eptam, Eradicane, and Sutan + generally control seedling grasses and a few annual broadleaf species. They persist in the soil for 15 to 45, 15 to 45, and 21 days, respectively.

Higher soil temperature, coarse-textured (sandy) soils, and increased soil moisture favor faster vaporization than do lower soil temperatures, fine-textured (clay) soils, and decreased soil moisture.

Major losses can occur from volatilization. To maintain effectiveness, incorporate thiocarbamates immediately. This usually means tillage, unless adequate rain falls.

Table 1: Classification scheme for organic herbicide families.

Family	Herbicides	Mode of Action	Application Timing	Selectivity ¹	
				Grasses	Broadleaf
Dinitroanilines	Treflan/Prowl/ Sonalan	growth inhibitor	mostly pre- and preplant emergence	yes	few
Thiocarbamates	Sutan+/Eptam/ Eradicane	growth inhibitor	mostly preplant emergence	seedlings	a few annuals
Chloroacetamides	Lasso/Dual/ Frontier/Harness/ Surpass/Ramrod	growth inhibitor	mostly pre- and preplant emergence	yes	a few
Triazines	Aatrex/Bladex/ Evik/Milogard/ Igran/Sencor/Lexone	photosynthesis inhibitor	mostly post- and pre-emergence	some	yes
Substituted ureas	Lorox	photosynthesis inhibitor	mostly post- and pre-emergence	many	yes
Organic P compounds	Roundup/ Touchdown	amino acid inhibitor	mostly postemergence	nonselective	nonselective
Dipyridiniums	Cyclone/ Gramoxone Extra	cell disruptor	mostly postemergence	nonselective	nonselective
Sulfonylureas	Accent/Beacon/ Permit/Ally/ Harmony/Pinnacle/ Peak/Glean/Amber/ Basis/Battalion	amino acid inhibitor	mostly postemergence	yes	yes
Imidazolinones	Pursuit/Assert	amino acid inhibitor	mostly postemergence	many	yes
Benzonitriles	Buctril	cell disruptor	mostly postemergence	no	yes
Phenoxy	2,4-D/MCPA	growth regulator	mostly postemergence	no	most
Benzoic Acids	Banvel	growth regulator	mostly postemergence	no	most
Picolinic Acids	Tordon/Stinger	growth regulator	mostly postemergence	no	most

¹Value indicated in these column are used for generalizations of herbicidal activity with respect to chemical family.

Modes of Action

Growth inhibitors prevent plant cell growth.

Photosynthesis inhibitors stop the process of using light energy for plant growth and development.

Amino acid inhibitors prevents plants from making three essential amino acids.

Cell disruptors dry out the above-ground plant parts they contact.

Growth regulators mimic naturally occurring plant hormones and cause uncontrolled growth.

Application Timing

Pre-emergence: Before the weeds emerge from the soil.

Preplant incorporated: Incorporated into the soil before the crop is planted, and by definition, before weed emergence.

Postemergence: Applied after the weed emerges from the soil.

Postdirected: Applied in a band where the weeds are, not to the crop itself.

Other Terms

Volatility: Loss of herbicide through evaporation.

Epinasty: Curling or bending of plant parts.

Chlorosis: Yellowing or blanching of plant parts that are normally green.

Necrosis: Death or decay of tissue.

Soil activity: The herbicide kills primarily germinating seedlings, not established plants.

Foliar activity: The herbicide kills only germinated plants.

Soil persistence: How long an herbicide is effective in the soil.

Because different crops usually require different herbicides, lack of crop rotation can lead to accelerated degradation and a resulting loss of herbicide effectiveness.

Plant injury symptoms. Thiocarbamates affect shoot development. Plants have twisted shoots and a compact appearance. Thiocarbamates primarily kill germinating seedlings, not established plants.

Chloroacetamides

Key performance features. These growth inhibitors are applied pre-emergence or, occasionally, preplant incorporated. Lasso, Dual, Frontier, Harness, Surpass and Ramrod generally control grasses and a few annual broadleaf species. They persist in the soil for 45 to 90, 15 to 50, 15 to 45, 10 to 25, 10 to 25, and 30 to 45 days, respectively.

Chloroacetamide activity is determined largely by soil clay and organic matter content. Soils with greater clay and organic matter require a higher dose.

Some herbicide losses can occur from volatilization. Incorporation generally is not critical, however. If rain doesn't fall within three to seven days, some loss could occur.

Plant injury symptoms. Affected plants show stunted root development, swollen root tips, chlorosis and whitening of lower leaves, leaf tip burn, and stunted growth. The chloroacetamides kill germinating seedlings, not established plants.

Triazines

Key performance features. These photosynthesis inhibitors are applied at various times:

- Pre-emergence: Atrazine, Bladex, Evik, Milogard, Igran, Sencore, Lexone.
- Postemergence: Atrazine, Bladex, Evik, Igran.
- Preplant incorporated: Bladex, Milogard.
- Postdirected: Evik.

All chlorine-substituted triazines (Atrazine, Bladex and Milogard) are more crop selective than the sulfur (mercapto)-substituted triazines (Igran, Evik, Sencor, Lexone).

Sunlight plays a minor role in triazine losses. Should the active ingredient stay unprotected on the soil surface, a relatively small portion may be lost due to ultraviolet degradation.

Water and soil pH are very important. As pH falls, triazines last a shorter time; as pH increases, they last longer.

Triazine activity is largely determined by soil clay and organic matter. Greater clay and organic matter require a higher dose. These herbicides have plant-back restrictions, which vary with region and crop species. In most Colorado soils, the length of residual weed control is as follows:

- Atrazine: 90 to 180 days.
- Bladex: 60 to 75 days.
- Evik: 30 to 90 days.
- Milogard: 180 to 360 days.
- Igran: 21 to 75 days.
- Sencore, Lexone: 30 to 90 days.

Lack of herbicide rotation or tank-mixing can encourage resistant weeds.

Plant injury symptoms. The triazines primarily kill germinating seedlings, not established plants. They do possess some foliar activity if an adjuvant is used. The triazines cause chlorosis and drying of green tissue, and

yellowing of leaf tips and margins. Lower leaves may be affected first, while new leaves may be unaffected.

Substituted Urea

Key performance features. These photosynthetic inhibitors are applied pre-emergence, postemergence or, occasionally, postdirected. Lorox generally controls many annual grasses and a few annual broadleaf species. It persists in soil for roughly 60 days.

Plant injury symptoms. Plants show chlorosis and drying of green tissue and yellowing of leaf tips and margins. Lower leaves may be affected first, and newer leaves may be unaffected.

Organic Phosphorus

Key performance features. These amino acid inhibitors are applied only postemergence. Roundup and Touchdown generally control annual and perennial grasses and broadleaf species. They are non-selective and will kill any living plant tissue they come in contact with. They persist in the soil for more than 200 days, although they are not effective for weed control.

Sunlight plays a minor role in herbicide losses. Soil adsorption plays a major role in herbicide tie-up, but its composition is relatively unimportant. When these herbicides come in contact with soil, they are inactivated and not effective for weed control.

Plant injury symptoms. Affected plants yellow, wilt and exhibit epinasty (twisting), progressing from new to older tissues. Some deformation of new growth can occur. These herbicides exhibit foliar activity only. The major avenue of dissipation is irreversible soil adsorption.

Dipyridiniums

Key performance features. These cell disruptors are applied post-emergence. Cyclone and Gramoxone Extra generally control grasses and a few annual broadleaf species. They persist in the soil for more than 500 days, although they are not readily plant available.

Ultraviolet degradation plays a minor role in herbicide losses. Soil adsorption plays a major role in herbicide tie-up.

Plant injury symptoms. Affected plants look burned and wilted, with mottled yellowing of leaves followed by wilting and rapid drying. The growing point on affected plants may emerge green and healthy, even though more mature leaf tissue is dead. The dipyridiniums exhibit foliar activity only.

Sulfonylureas

Key performance features. The aromatic amino acid inhibitors Accent, Beacon, Ally, Harmony, Pinnacle, Peak, Amber and Finesse are applied postemergence. Glean is applied either pre-emergence or postemergence.

Accent, Beacon and Pinnacle control a few annual grasses and many broadleaf species, while Ally, Harmony, Peak, Amber and Finesse control many broadleaf species.

Sunlight plays a minor role in sulfonylurea losses. If the active ingredient stay unprotected on the soil surface, a relatively small portion of the herbicide may be lost due to ultraviolet degradation.

Water and soil pH is very important. As the pH falls, sulfonylureas last a shorter time; as pH increases, they last longer.

Sulfonylurea activity is largely determined by soil clay and organic matter. Greater clay and organic matter require a higher dose.

Sulfonylureas exhibit a wide range in crop and weed sensitivities. Plant-back restrictions that vary with region and crop species. In most Colorado soils, the length of residual weed control is as follows:

- Accent: 20 days.
- Beacon: 20 days.
- Ally: 30 to 60 days.
- Harmony: 30 days.
- Pinnacle: 30 days.
- Peak: 40 days.
- Glean: 60 to 90 days.
- Amber: 20 to 30 days.
- Permit: 45 to 90 days.

Lack of herbicide rotation or tank-mixing can encourage resistant weeds.

Plant injury symptoms. Affected plants exhibit chlorosis, necrosis, stunting, epinasty and shortening of internodes. Sulfonylureas kill germinating seedlings. They also exhibit foliar activity. Herbicide symptoms develop slowly. Some deformation of new growth can occur.

Imidazolinones

Key performance features. The aromatic amino acid inhibitors Pursuit and Assert are applied pre-emergence or postemergence. They generally control many annual grasses and broadleaf species.

Water and soil pH is very important. As pH falls, imidazolinones last a shorter time; as pH increases, they last longer.

Imidazolinone activity is largely determined by soil clay and organic matter. Greater clay and organic matter content require a higher dose.

The imidazolinones exhibit a range of crop and weed sensitivities. Plant-back restrictions vary with region and crop species. In most Colorado soils, the length of residual weed control is as follows:

- Pursuit: 30 to 60 days.
- Assert: 45 to 75 days.

Sunlight plays a minor role in imidazolinone losses. If the active ingredient stays unprotected on the soil surface, a relatively small portion of the herbicide may be lost due to ultraviolet decomposition.

Lack of herbicide rotation or tank-mixing can encourage resistant weeds.

Plant injury symptoms. Same as sulfonylureas.

Benzonitriles

Key performance features. These contact herbicides are applied post-emergence. Butrill controls many broadleaf species. It persists in the soil 10 to 20 days, although it's not readily plant available.

Water and soil pH have little effect on persistence. Environmental conditions do affect it. The herbicide persists longer in cool, dry conditions than in warm, moist conditions.

Plant injury symptoms. Affected plants show chlorosis, burn, necrosis and wilting, similar to triazines. Butrill possesses no soil activity.

Phenoxy

Key performance features. These growth regulator herbicides are applied postemergence. 2,4-D and MCPA generally control many broadleaf species and few or no annual grasses. They persist in the soil for roughly 15 and 30 days, respectively.

Water and soil pH have little effect on persistence, but solution pH does control the extent to which the herbicide enters the plant via the cuticle. The herbicides persist longer in cool, dry conditions than in warm, moist conditions.

Plant injury symptoms. Affected plants show rapid epinasty, tissue proliferation and slow die-back. 2,4-D and MCPA possess foliar and some soil activity.

Benzoic Acids

Key performance features. This growth regulator is applied postemergence. Banvel controls many broadleaf species and no annual grasses. It persists in the soil for 10 to 30 days.

Water and soil pH are not important in determining persistence. Solution pH controls the extent to which the herbicide enters the plant via the cuticle. The herbicide persists longer in cool, dry conditions than in warm, moist conditions.

Plant injury symptoms. Affected plants show rapid epinasty, tissue proliferation and slow die-back. Banvel possesses foliar and some soil activity.

Picolinic Acids

Key performance features. These growth regulators are applied postemergence. Tordon and Stinger generally control many broadleaf species and no annual grasses. They persist in the soil for 140 to 180 and 30 to 60 days, respectively.

Water and soil pH have little effect on persistence. Solution pH controls the extent to which the herbicide enters the plant via the cuticle. These herbicides persist longer in cool, dry conditions than in warm, moist conditions.

Plant injury symptoms. Affected plants show rapid epinasty, uncontrolled plant growth, and slow die-back. Tordon and Stinger possess foliar and some soil activity.

References

For more explicit herbicide recommendations, see XCM-205, *1998 Colorado Weed Management Guide*, from Colorado State University Cooperative Extension and Agricultural Experiment Station. It is available for \$4.90 from The Other Bookstore, 115 General Services Building, Fort Collins, Colorado 80523; (970) 491-6198.

Other fact sheets in this series are:

- 0.558, *Herbicide Formulations*.
- 0.559, *Herbicide Surfactants and Adjuvants*.
- 0.562, *Herbicide Behavior in Soils*.
- 0.564, *How Surfactants Work*.

¹P. Miller, Colorado State University post-doctoral research fellow, and P. Westra, Cooperative Extension weed science specialist and professor, bioagricultural sciences and pest management.

Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Milan A. Rewerts, Director of Cooperative Extension, Colorado State University, Fort Collins, Colorado. Cooperative Extension programs are available to all without discrimination. No endorsement of products mentioned is intended nor is criticism implied of products not mentioned.