Herbicides used in potato production: mode of action classification group, site of action, chemical group, common and product names, and resistance risk. (following WSSA)

Group Code	Primary Target Site of Action	Chemical Group	Common Name	Product Name	Resistance Risk
1	Acetyl CoA carboxylase (ACCase) inhibitors	cyclohexanediones	clethodim sethoxydim	Select Poast	Medium Medium
2	Acetolactate synthase (ALS)	sulfonyl ureas	rimsulfuron	Matrix	High
5	Photosystem II inhibitors	triazinones	metribuzin	Sencor	High
7	Photosytem II inhibitors	ureas	linuron	Lorox, several	High
22	Photosystem I electron diverters	bipyridiliums	diquat	Reglone	Low to Medium
14	Protoporphyrinogen oxidase (protox)	triazolinones	sulfentrazone	Spartan	Low
10	Glutamine synthetase	Phosphinic acids	glufosinate-amonium	Rely	Low
3	Microtubule assembly inhibitors	dinitroanilines	pendimethalin	Prowl, several	Low to Medium
9	EPSP synthase inhibitors	glycines	glyphosate	Roundup, several	Low
15	Inhibition of cell division (VLCFA's)	chloroacetamides	dimethenamid-p metolachlor S-metolachlor	Outlook Stalwart, several Dual Magnum	Low
8	Lipid synthesis, not ACCase	thiocarbamates	EPTC	Eptam	Low

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NATIONAL POTATO COUNCIL

Herbicides

A Practical Approach to Resistance Management for Weeds in Potato Cropping Systems

Intensive use, overuse, or misuse of a herbicide can select individual plants with complete or partial loss of product efficacy. This reduces the utility of the affected herbicide in a crop, and also compromises future efforts to manage resistance. Proper weed management practices can minimize the risk of herbicide resistance.

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Herbicide mode of action, site of action.

Mode of action describes the process by which a herbicide inhibits plant growth. *Site of action* defines the specific location, such as an enzyme, within the plant where the herbicide expresses activity. Herbicides are grouped according to family (triazines) and site or mode of action (e.g. acetolactate synthesis (ALS) inhibitors). Herbicides within a family have similar chemical structure and typically the same site or mode of action.

Weed biotypes and herbicide resistance.

Weeds have naturally occurring genetic variation within a given species. Biotypes are related weeds that have similar genotypes conferring a unique trait. *Resistance* is the inherited ability of a plant population to survive a herbicide to which the original population was susceptible. A small proportion of plants in any weed population can be resistant to a given herbicide. Development of resistance in a field is a process of selection. Resistant biotypes increase in proportion when the same herbicide or herbicides with the same site of action are used repeatedly. Weeds resistant to different herbicides with the same site of action are termed *cross-resistant*. *Multiple resistance* occurs when weeds are resistant to two or more herbicides with different sites of action.

Common lambsquarters and redroot pigweed biotypes resistant to triazines exist in potato production areas. Russian thistle and kochia biotypes resistant to ALS inhibitors also have developed. Finally, giant foxtail and large crabgrass resistant to ACCase inhibitors occur in the Midwest. Loss of herbicide efficacy due to selection of resistant biotypes has led to control failures and increased production risks.

Recognizing resistance

Resistance may be first recognized when expectations of weed control are not met following application of the labeled rate of herbicide to a weed species normally controlled by that herbicide. Loss of efficacy will increase over time. Resistance may appear suddenly with significant loss of control. Resistance may be recognized when:

- There are no apparent herbicide application problems or unusual weather conditions.
- Other normally controlled species are controlled.
- Lack of herbicide injury symptoms on weed escapes adjacent to dead or dying weeds of the same species.
- Previous history of herbicide failure on the same species in the same field with the same herbicide or herbicide with a common mode of action.
- Records indicate the repeated use of one herbicide or herbicides with the same site of action.

If you believe that herbicide resistance has occurred, collect suspected resistant plants and/or seed from those plants to have resistance confirmed. Contact your area ag retail representative, crop advisor, herbicide manufacturer representative, and/or university extension weed specialist for plant collection and testing information.

Factors that affect resistance

Nearly 300 herbicide resistant grass and broadleaf weed biotypes have been recorded in nearly 50 countries world-wide. Resistance to some herbicide classes has occurred more frequently than to others. Likewise, some weed species are more prone to developing resistance. Herbicide and plant factors affecting herbicide resistance development include the type(s) of herbicide used, frequency of use, whether herbicides are applied alone or tank-mixed or if herbicides with the same site of action are alternated with other herbicide sites of action within a crop rotation, the initial frequency of the resistant biotype in the population; genetic diversity of the target weed; the ability of herbicide resistant biotypes to survive, compete, and reproduce; crop rotational practices; and cultural practices. The spread of resistant weeds from one area of production to another is affected by weed seed dispersal mechanisms; mechanism of gene transfer in the affected species; method of pollination; and equipment sanitation practices.

Effective strategies for proactive management of herbicide resistant weeds

Proactive resistance management is critical for the retention of herbicide efficacy in potato cropping systems. Use of an integrated crop and weed management strategy will help to reduce the risk of selecting for weed resistance to herbicides.

Resistance management tools:

- Integrate multiple methods of weed management i.e. cultivation, cultural methods such as use of competitive crops and crop varieties, biocontrol, properly selected herbicides.
- Where possible, extend crop rotation intervals to avoid buildup of dominant weed species associated with particular crops.
- Use diverse crops in the rotation that allow for varying weed management options and/or use of herbicides with different modes/sites of action.
- Rotate summer annual crops with winter annual crops or perennial crops to allow for different timing of tillage and herbicide applications.
- Monitor fields frequently to evaluate the effectiveness of the management system, particularly look for escaped weeds.
- Prevent seed production from weed escapes (cultivate, hand weed, mow, burn, remove).
- Practice good crop hygiene by elimination of new sources of weed seed, i.e. planting certified seed, weed control in field borders and rights of way, cleaning equipment between fields, screening weed seed from irrigation water.
- Keep complete herbicide/weed control histories for each field.
- Apply herbicides correctly and accurately and use labeled rates.
- Follow label guidelines for application of all herbicides. Labels of newly registered herbicide products often include detailed information on resistance management along with the Herbicide Group Code.

Resistance management tools:

- Rotate herbicide applications between products with different modes/sites of action to reduce likelihood of resistance to a specific class. For effective resistance management, the rotation partners must be active against the target weed.
- In a given year, use formulated mixtures or tank-mixes of effective herbicides having different sites of action. For effective resistance management, both tank-mix partners must be active against the target weed.
- Be alert for control failures and report control difficulties so that the possibility of resistance can be monitored and evaluated.
- Local and regional cooperation in resistance management is essential.

What to do in cases of confirmed herbicide resistance

- In cases where a control failure has been confirmed as resistant before the end of a growing season, limit seed production from resistant weeds by eradicating the remaining weed population.
- Limit the movement of resistant populations from field to field by cleaning equipment before moving to the next field,
- Avoid using the herbicide mode of action to which resistance has been confirmed when possible. If that mode of action must be used for control of other weed species, tank mix or sequentially apply with herbicides having a different mode site of action that has activity on the resistant weed population
- If the crop in the field with the resistant weed population is to be grazed or cut for feed, be careful not to transfer resistant seed via manure
- Seek advice from your ag retail representative, crop advisor, herbicide manufacturer representative, and/or university extension weed specialist to assist in the long term planning of weed control in these fields
- Once resistant weed numbers are at a controllable level, continue implementing an integrated weed management system. Herbicide resistant management strategies will be necessary to ensure satisfactory weed control. Problems with resistance will reoccur quickly (1-2 yr) if the same herbicide class is re-used as the solely control strategy.