

# Weed Control and Potato Crop Safety with **Metribuzin**

*Text and photos by Pamela J.S. Hutchinson*

Metribuzin, the active ingredient formerly sold for use in potatoes as Lexone® or Sencor®, is now available as various generic brands formulated either in a 75% by weight active ingredient (ai), dry flowable (DF), or 4 lbs ai per gallon flowable (F), or liquid (L). It has both soil and foliar activity. As part of an integrated weed management system and in combination with other potato herbicides, metribuzin can help provide full-season, broad-spectrum weed control.

Important details about metribuzin use in potatoes are spread out among the many full and state labels, and an updated list of potato variety tolerance to metribuzin is needed. Plus, weed populations resistant to metribuzin have developed in potato growing areas.

Therefore, this University of Idaho Extension publication contains information about metribuzin application timing and use rates in potatoes, behavior in plants and soil, metribuzin-resistant weed population management, intervals for planting rotational crops after metribuzin use, and an updated list noting the susceptibility or resistance of standard and recently released potato varieties to metribuzin (see Table 2, page 10).

## Timing, application and incorporation methods, and rates

Metribuzin can be applied preemergence or postemergence to potatoes or split into a preemergence + postemergence application. It can be used as a split postemergence + post-emergence application in Idaho, Oregon, or Washington only. *In Idaho only, metribuzin can be applied pre-plant incorporated.*

### Metribuzin behavior in plants and soil

Metribuzin is a triazinone herbicide that inhibits photosynthesis in a susceptible plant by binding to a protein of the photosystem II complex, which, in turn, causes a chain of events where, eventually, plant lipids and proteins are attacked and oxidized by highly reactive free radicals.

As a result, chlorophyll and plant pigments are lost causing chlorosis (loss of green in plant) followed by plant cell drying and disintegration. Herbicides with this mechanism of action are referred to in the literature (and on some labels) as Group 5, Photosystem II Inhibitors.

When applied to soil, metribuzin is readily absorbed by roots, after which translocation upward to the shoots and beyond occurs through the xylem. Once susceptible plants emerge through treated soil into the sunlight, they become yellow/chlorotic, then totally brown/desiccated, after 2 to 5 days.

Foliar-applied metribuzin is moderately absorbed into the plant and translocation also is upward. Downward movement through the vascular tissue—phloem—does not occur under typical growing conditions. As with soil application, chlorosis and desiccation occur after the plant foliage encounters the postemergence-applied herbicide. Negligible losses of metribuzin occur through photodegradation or volatilization.

Microbial breakdown is the main means of metribuzin degradation in the soil. Soil adsorption decreases as pH increases, which makes the herbicide more available for degradation. Chemical degradation by hydrolysis does not occur between soil pH 5 to 9.

Metribuzin half-life in soils under optimum degradation conditions can be 14 to 28 days. However, persistence is increased with cool temperature and low soil moisture conditions since both microbial and chemical degradation are limited in those circumstances.

Metribuzin is tightly adsorbed to organic matter. It is readily leached in sandy and sandy-loam soils, especially soils low in organic matter. It is moderately leached in medium-textured soils, and it is not mobile in heavy soils with high organic matter content. See the crop rotation restriction section (page 7) for how soon crops can be planted after metribuzin use in potatoes.

A	Acre	fl oz	Fluid ounce
ai	Active ingredient of herbicide	L	Liquid formulation
24 (c)	An EPA designation that lets states have a "Special Local Needs Label"	lb	Pound
DF	Dry flowable formulation	lb ai/A	Pounds active ingredient per acre
EC	Emulsifiable concentrate	pt	Pint
F	Flowable formulation	oz	Ounce (dry)

### • Abbreviations •

Warning: Red-skinned, early-maturing smooth white-skinned, and other specified potato varieties (Table 2) may be injured by metribuzin, especially when applied postemergence. Regardless of variety, if the crop is stressed or plant growth is slowed for reasons such as cloudy weather before application, herbicide metabolism within the plant also may be slowed resulting in injury. If the variety is tolerant of metribuzin, then this injury will most likely be temporary since metribuzin metabolism usually speeds up once conditions improve.

The following section provides information specific to application timings, rates, incorporation methods, and tank mixtures. Note: When a rate range is given, use a lower rate on coarse-textured soils or soils with low organic matter.

- Coarse-textured soils include sand, loamy sand, or sandy loam soils;
- Medium-textured soils include loam, silt loam, silt sandy clay, or sandy clay loam;
- Fine-textured soils include silty clay, silty clay loam, clay, or clay loam soils.

**Application methods:** Metribuzin can be applied in a broadcast spray by *ground* (in at least 20 gallons per acre finished spray); *aerial* equipment (in at least 5 gallons per acre), or via *chemigation*. Applications made by chemigation should only be through center pivot, solid set, or lateral roll sprinkler systems. Apply the proper rate in 0.25 to 0.75 inch of water (0.25 to 0.5 inch on sandy soil) as a continuous injection in center pivot and self-propelled wheel move systems, or in the last 15 to 30 minutes of set-in solid-set sprinkler irrigation systems.

**Preemergence timing & best results:** University of Idaho potato weed control trials have shown best results when the preemergence application is made shortly after a hilling-type operation, which has eliminated already-emerged weeds.

- Use 0.33 to 1.33 lb 75 DF or 0.5 to 2 pts/A 4F.
- Do not exceed 0.67 75 DF or 1 pt/A 4F on sandy soils or sensitive varieties.
- For wild mustard control only, a lower rate of 0.33 to 0.67 75 DF or 0.5 to 1 pt/A 4F can be used.
- Where chemigation distribution patterns do not overlap sufficiently to provide even application of the desired rate, unacceptable

weed control may result. Where sprinkler distribution patterns overlap excessively, crop injury may result.

- When chemigating, allow sufficient time for pesticide to be flushed through all lines and all nozzles before turning off the irrigation system.

**Preemergence incorporation methods:**

Sprinkler-incorporate ground- or aerial-applied metribuzin with 0.25 to 0.75 inches overhead irrigation water. *Do not mechanically incorporate preemergence-applied metribuzin.* Application and incorporation via chemigation is described above.

Where sprinkler incorporation distribution patterns are not consistent or do not overlap properly enough to provide the desired irrigation amount, unacceptable weed control may result since the herbicide was not incorporated sufficiently.

**Postemergence timing & best results:** For best control, postemergence applications should be made before weeds are 1-inch tall and before potato rows close. As previously mentioned, postemergence applications may cause some chlorosis or minor necrosis on potato leaves, even if the variety is not generally sensitive to metribuzin. These symptoms may be more severe if seed-piece decay is occurring or if the crop is under stress (moisture, disease, mechanical injury, nutrient deficiency, frost damage, excessive heat, etc.). *Do not make postemergence applications prior to rainfall or irrigation on recently cultivated potatoes or within 3 days after periods of cool, wet cloudy weather, or injury may occur.*

- Use 0.67 lb/A 75 DF or 1 pt/A 4F.

**Metribuzin formulations**

Metribuzin 75 DF is a dry formulation of the herbicide that is 75% by weight active ingredient (ai). Metribuzin 4F is formulated as dry herbicide suspended in a liquid, and 4L is a liquid formulation. Both have 4 pounds (lb) ai per gallon.

75 DF lb	4F or 4L pt	lb ai
0.25	0.375 (6 fl oz)	0.1875
0.33	0.5	0.25
0.67	1	0.5
1.33	2	1

- For redroot pigweed and common lambs-quarters control only, a rate of 0.33 to 0.67 lb 75 DF or 0.5 to 1 pt/A 4F can be used postemergence on potatoes and/or weeds.
- Do not use a surfactant/adjuvant with metribuzin applied alone, and refer to the label for surfactant/adjuvant recommendations if it is tank mixed with another herbicide. Otherwise, plant injury may result.
- Avoid tillage after application or the herbicide barrier may be broken, allowing weeds to emerge and grow through nontreated soil.
- If applying with ground or aerial equipment, overhead moisture from rain or sprinkler irrigation within 24 hours after application may decrease control.
- Do not apply metribuzin within 24 hours of another pesticide or mix it with other chemicals unless the most restrictive label permits the combination.
- Sunny weather: Only apply metribuzin postemergence after having sunny weather for at least 3 days and when more sunny weather is forecasted for at least 2 days after application or plant injury may occur. Cloudy conditions can slow plant growth and, in turn, can slow metribuzin metabolism by the plant.
- Do not apply metribuzin within 60 days of potato harvest.
- Caution: Most metribuzin labels state that postemergence applications only can be made on white-skinned potato varieties that are not early maturing and on russeted-skin varieties. Other varieties may be more susceptible to postemergence compared with preplant-incorporated or preemergence metribuzin applications.

**Split applications:** Metribuzin can be applied *once preemergence + once postemergence*. Total application amount per growing season should not exceed 1.33 lb 75 DF or 2 pt/A 4F.

**In Idaho, Oregon, and Washington only, if the dry flowable (DF) metribuzin already has been applied preemergence, two additional postemergence DF applications can be made\*:**

- Make the first postemergence application early in the season while weeds are still less

than 1-inch tall, and allow at least 14 days before the second application.

- On coarse-textured soils with low organic matter, do not exceed 0.5 lb 75 DF or 0.75 pt/A 4F per application.
- On medium and heavy soils only, use 0.67 lb 75 DF or 1 pt/A 4F per application.
- Do not apply metribuzin after June 30 if treated land is to be planted to crops other than potatoes because the herbicide may not be degraded rapidly enough to avoid damaging other crops planted after potato harvest.
- For redroot pigweed and common lambs-quarters control only, a rate of 0.33 to 0.67 lb 75 DF or 0.5 to 1 pt/A 4F can be used.

\*At the time of printing, only metribuzin dry flowable (DF) product labels allow two additional postemergence applications of DF *if a metribuzin DF has been applied preemergence*. Metribuzin flowable (F) or liquid (L) labels only allow the two postemergence applications of the F or L formulated product if the F or L product *has not been applied preemergence*. Check your 4F or 4L product label to see if that restriction is still in place.

**Preplant incorporated timing: Idaho only** per a 24 (c) Special Local Needs label. Apply 0.67 to 1.33 lb 75 DF as a broadcast spray by ground or air or impregnated/coated on dry fertilizer (500 to 1,200 lb/A). Then incorporate evenly 4- to 6-inches deep by double-disking at right angles. Refer to the label(s) for detailed dry fertilizer application information. Use this method only on white-skinned potato varieties that are not early maturing and on russet-skin varieties.

### **Tank mixtures for broad spectrum weed control and resistance weed management**

Metribuzin should be used with other labeled potato herbicides having a different mode of action in order to provide broad spectrum weed control and help prevent or delay development of herbicide resistant weed populations. See the weed resistance section on pages 7, 8 and 9 for more information.

**For hairy nightshade and common lambs-quarters:** Metribuzin alone will only suppress hairy nightshade in most situations. Metribuzin can compliment herbicides, which have been used to target hairy nightshade in potato fields,

such as Chateau® (flumioxazin), Eptam® (EPTC), Matrix® and other rimsulfuron products, or Outlook® (dimethenamid-p).

Even though the four herbicides just mentioned have some activity on common lambsquarters, they do not usually satisfactorily control this weed. Metribuzin does provide season-long common lambsquarters control, however.

Including metribuzin in tank mixtures with one or more of the four herbicides can provide control of both weeds. Since metribuzin has a different mode of action than these four herbicides, the tank mixtures will have activity on both weeds with different modes of action, which can help prevent or delay metribuzin resistance in populations containing those weeds.

**Preemergence and postemergence tank mixtures:** Metribuzin at the labeled use rates can be applied only preemergence in two-way tank mixtures with Chateau, Cinch® (s-metolachlor), Outlook, or Reflex® (fomesafen).

Tank mixtures with metolachlor (various brand names) can be applied preemergence and some brand name labels allow early postemergence application with metribuzin.

Postemergence application with these metolachlor formulations is usually labeled as directed or semi-directed spray only—see the metolachlor labels for other allowed postemergence application methods.

Tank mixtures of metribuzin with Dual Magnum (s-metolachlor), Eptam (see the Eptam label for incorporation timing and rate information), Prowl® (pendimethalin), or Matrix and other rimsulfuron brands labeled in potatoes such as Solida®, can be applied preemergence or early postemergence with metribuzin.

**Rate information** for the Matrix and Solida, Dual Magnum, or Prowl tank mixtures is provided in this section. However, always follow the most restrictive label for rates, and refer to the labels of those products for complete recommendations and restrictions.

- Some tank-mix partner herbicides only can be applied preemergence, so be sure to check the label(s) for proper application timing.
- Check the label(s) for state/county restrictions of Matrix and other herbicides.
- Except for Matrix and metribuzin, none of these herbicides have foliar activity.

- For postemergence applications, follow label instructions for surfactants/adjuvants allowed with a tank mix.

NOTE: Any tank mixture containing metribuzin should be kept agitated and sprayed out immediately rather than allowed to stand for prolonged periods of time.

**Matrix or Solida (rimsulfuron) + metribuzin:** Preemergence—metribuzin can be used at 0.33 to 0.75 lb 75 DF or 0.5 to 1.5 pt/A 4F. Although some rimsulfuron labels may allow metribuzin in the tank mix at rates up to 1.33 lb 75 DF or 2 pt/A 4F, the most restrictive label should be followed.

Postemergence—metribuzin can be used at 0.33 to 0.67 lb 75 DF or 0.5 to 1 pt/A 4F. Also:

- Some rimsulfuron or metribuzin labels allow metribuzin in the tank mix at rates as low as 0.25 lb 75 DF or 0.375 pt (6 fl oz)/A 4F.
- Use a nonionic surfactant (NIS) at a rate of 0.125% v/v (1 pt/100 gallon of water) with rimsulfuron + metribuzin applied postemergence.
- Using crop oil concentrate (COC) or methylated seed oil (MSO) adjuvants is *not* recommended with the postemergence-applied rimsulfuron + metribuzin tank mix.
- For rimsulfuron + metribuzin applied postemergence, rainfall or irrigation of 0.33 to 1 inch no sooner than 4 hours, but not more than 5 days after application, will activate the rimsulfuron herbicide in the soil and help provide control of subsequent flushes of annual weeds.

NOTE: Postemergence applications of rimsulfuron + metribuzin may temporarily yellow potato foliage. Under environmental stress (cool, wet, or hot or humid weather), this mixture, applied postemergence, also may cause leaf malformations and stunted growth. Potatoes recover within 7 to 15 days. *To reduce potential injury, apply this tank mixture only if the weather has been sunny for at least 3 successive days and the forecast is for sunny conditions for at least 2 days after application.*

**Dual Magnum + metribuzin:** Preemergence—metribuzin can be used in this tank mix at 0.5 to 1.33 lb 75 DF or 0.75 to 2 pt/A 4F.

According to the Dual Magnum label, this tank mix may also be applied early postemergence through chemigation (center pivot irrigation systems only) or as a post or semi-post directed spray.

**Prowl + metribuzin:** Preemergence—use metribuzin in this tank mix at 0.67 to 1.33 lb 75 DF or 1 to 2 pt/A 4F.

Early postemergence—apply metribuzin at 0.33 to 0.67 lb 75 DF or 0.5 to 1 pt/A 4F (0.25 to 0.5 lb ai/A) from crop emergence to the 6-inch stages per crop-size restrictions in the Prowl label(s).

**NOTE:** METRIBUZIN ALSO CAN BE APPLIED |PREEMERGENCE ONLY IN THREE-WAY TANK MIXTURES WITH MATRIX + DUAL MAGNUM, EPTAM, OR PROWL, OR WITH DUAL MAGNUM + EPTAM.

*See labels of other potato herbicides not listed here for tank mixture allowances. Read and follow applicable “Restrictions and Limitations and Directions for Use” on all product labels included in a tank mixture. The most restrictive labeling applies to use of tank mixtures.*

**Boundary® 6.5 EC:** Metribuzin is included in Boundary 6.5 EC, an emulsifiable concentrate formulated pre-mix of 5.25 lb ai s-metolachlor +

1.25 lb ai/gallon metribuzin. See the Boundary label for use in potatoes.

- A typical Boundary use rate of 2 pt/A provides 0.3 lb ai/A (0.42 lb/A 75 DF or 10 fl oz/A 4F) of metribuzin, so if higher metribuzin rate is desired, metribuzin can be added to the spray mixture at allowed labeled rates.
- Boundary can be applied early post-emergence through center pivot systems only.
- Two Boundary applications per year are allowed. Do not exceed 1 lb ai per acre per year total metribuzin.

### General remarks and cautions

- Do not apply more than a total of 1.33 lb 75 DF or 2 pt/A 4F metribuzin in a single crop season regardless of the application method or timing.
- Mechanical cultivation after application reduces weed control and may injure potato.
- Do not apply within 24 hours of applying other pesticides.
- Do not apply within 60 days of potato harvest.

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**Figure 1.** Nontreated weedy control on the left compared with control by preemergence application of metribuzin at 0.67 lb/A + Chateau® at 1.5 oz/A on the right in weed control trials. Trials were conducted with Russet Burbank at the University of Idaho Aberdeen Research and Extension Center. Weeds present in the plots and controlled by the mixture included hairy nightshade, common lambsquarters, redroot pigweed, and green foxtail.

**Table 1. Weeds controlled with metribuzin**

	Common name	Latin name	Application timing	
			pre-emergence	post-emergence
<b>Broadleaves</b>	buckwheat, wild	<i>Polygonum convolvulus</i>	C	-
	carpetweed, common	<i>Mollugo verticillata</i>	C	-
	chickweed, common	<i>Stelaria media</i>	C	-
	cocklebur, common	<i>Xanthium strumarium</i>	S	C
	dandelion	<i>Taraxacum officinale</i>	-	S
	dock, curly	<i>Rumex crispus</i>	-	S
	flixweed	<i>Descurainia sophia</i>	C	-
	henbit	<i>Lamium amplexicaule</i>	C	-
	jimsonweed	<i>Datura stramonium</i>	C	-
	kochia <sup>1</sup>	<i>Kochia scoparia</i>	C	S
	knotweed, prostrate	<i>Polygonum aviculare</i>	C	S
	ladysthumb	<i>Polygonum persicaria</i>	-	C
	lambsquarters, common	<i>Chenopodium album</i>	C	C
	mustard, Indian	<i>Brassica juncea</i>	C	-
	mustard, blue	<i>Chorispora tenella</i>	C	C
	mustard, tansy	<i>Descurainia pinnata</i>	C	C
	mustard, tumble	<i>Sisymbrium altissimum</i>	C	C
	mustard, wild	<i>Brassica kaber</i>	C	C
	nightshade sp. <sup>2</sup>	various <i>Solanum</i> sp.	S	S
	pennycress, field	<i>Thlaspi arvense</i>	C	C
	pepperweed, clasping	<i>Lepidium perfoliatum</i>	C	-
	pigweed, redroot*	<i>Amaranthus retroflexus</i>	C	C
	pigweed, tumble	<i>Amaranthus albus</i>	C	C
	pigweed, smooth	<i>Amaranthus hybridus</i>	C	C
	purslane, common	<i>Portulaca oleracea</i>	S	S
	ragweed, common	<i>Ambrosia artemisiifolia</i>	C	C
rocket, yellow	<i>Barbarea vulgaris</i>	C	-	
shepherdspurse	<i>Capsella bursa-pastoris</i>	C	-	
sicklepod	<i>Senna obtusifolia</i>	C	-	
smartweed, Pennsylvania	<i>Polygonum pennsylvanicum</i>	C	C	
spurge, spotted	<i>Euphorbia maculata</i>	C	C	
sunflower, common <sup>1</sup>	<i>Helianthus annuus</i>	S	S	
thistle, Canada <sup>3</sup>	<i>Cirsium arvense</i>	-	S	
thistle, Russian	<i>Salsola iberica</i>	-	C	
velvetleaf	<i>Abutilon theophrasti</i>	-	C	
<b>Grasses and sedges</b>	barnyardgrass <sup>1</sup>	<i>Echinochloa crus-galli</i>	S	S
	bluegrass, annual	<i>Poa annua</i>	-	C
	brome, downy	<i>Bromus tectorum</i>	C	-
	crabgrass, large	<i>Digitaria sanguinalis</i>	C	S
	crabgrass, smooth	<i>Digitaria ischaemum</i>	C	S
	foxtail, green <sup>4</sup>	<i>Setaria viridis</i>	C	S
	foxtail, yellow <sup>4</sup>	<i>Setaria glauca</i>	C	S
	johnsongrass (seedling)	<i>Sorghum halepense</i>	C	-
	nutsedge, yellow	<i>Cyperus esculentus</i>	S	S
	oat, wild <sup>5</sup>	<i>Avena fatua</i>	S	S
	panicum, fall	<i>Panicum dichotomiflorum</i>	C	-
	quackgrass <sup>6</sup>	<i>Elytrigia repens</i>	-	S
	sandbur, field	<i>Cenchrus incertus</i>	S	S
	signalgrass, broadleaf	<i>Brachiaria platyphylla</i>	C	-
	witchgrass	<i>Panicum capillare</i>	S	S
	volunteer grain <sup>5</sup>	various	S	S

C = controlled; S = partial control or suppression; - = not controlled or not labeled.

<sup>1</sup> Weeds that may require two applications for control.

<sup>2</sup> Nightshade sp. common in Idaho such as cutleaf or hairy nightshade will not be consistently controlled by metribuzin, especially plants larger than cotyledon to 2-leaf stage (0.5 inch tall).

<sup>3</sup> Canada thistle is susceptible, however, only the top growth normally dies after postemergence application. Long-term control is inconsistent.

<sup>4</sup> Green or yellow foxtail are not consistently controlled by metribuzin postemergence. For best control, these grasses should be no more than 2-inches tall at application time.

<sup>5</sup> Wild oat and volunteer grain are not consistently controlled by metribuzin. If these grassy weeds have no more than six leaves at application time, some may die. However, do not rely on metribuzin for total control.

<sup>6</sup> Quackgrass growth is often severely inhibited by a metribuzin postemergence application, however, consistent, long-term control is inconsistent.

\* Redroot pigweed populations resistant to metribuzin have been identified in Idaho potato growing areas. See Resistance section, page 7, for further information.

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- Refer to the metribuzin label(s) for proper rate for soil type, dry fertilizer application information, chemigation, spray-tank and injector cleaning, mixing, and all other recommendations, cautions, or special precautions that must be followed.
- Do not apply via low pressure or high volume hand-wand sprayers.

Table 1 lists the broadleaves, grasses, and sedges that can be controlled or suppressed with metribuzin applied correctly at the proper timing and rate. NOTE: *Preemergence* applications are generally better than *postemergence* at controlling common cocklebur, most mustards, shepherd's-purse, or most grass species listed on the label(s). *Postemergence* applications only control Russian thistle. Other weeds listed on the label(s) may be controlled with preemergence or postemergence applications except for barnyard-grass and common sunflower, which may require two applications for control.

### Crop rotation restrictions

The following restrictions apply to how soon certain crops can be planted after metribuzin use in potatoes. The crops mentioned here are ones listed on the label(s) and known to be planted in major potato production areas of the United States. Check the label(s) for a more complete list of cropping restrictions.

Metribuzin degradation in the soil occurs mainly through metabolism by soil microbes; chemical hydrolysis does not occur between pH 5 to 9; and degradation is slowed when temperatures are cool and soil moisture is limited. As previously mentioned for the split postemergence + postemergence application only allowed in Idaho, Oregon, and Washington, do not apply metribuzin after June 30 if any crop other than potatoes is to be planted in the treated field.

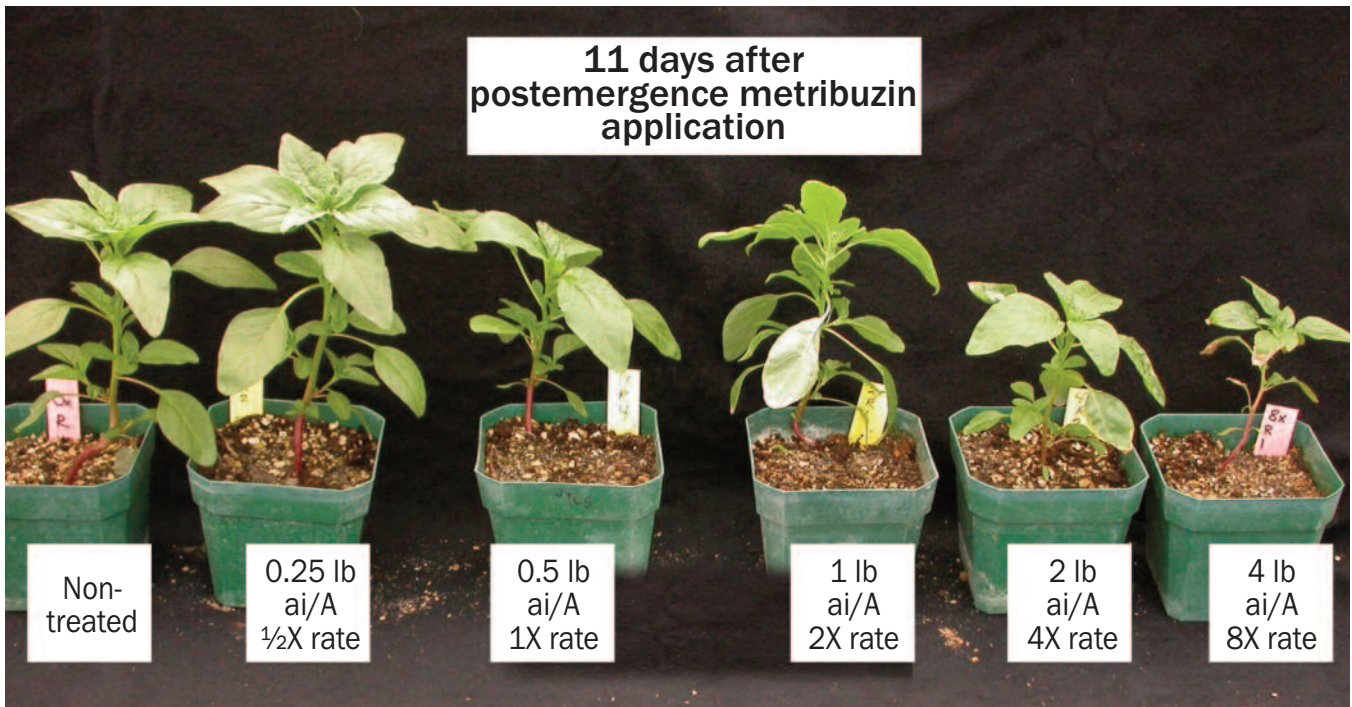
- *Wait 4 months* before planting alfalfa, asparagus, corn, forage grasses, soybeans, or tomatoes.
- Barley, lentils, peas, and wheat may be planted *8 months* after metribuzin application, however, *certain cereal varieties are sensitive to metribuzin* (see cereal section of label/s) and should not be planted the growing season after metribuzin use unless:

- moldboard plowing is deep enough to mix the upper 8 inches of soil and/or
- potato vines left in rows after harvest are uniformly distributed over the soil surface before plowing.
- Do not plant lettuce, cole crops, or cucurbits during the growing season following metribuzin application.
- *Wait 12 months* after application before planting oat, grain sorghum, potato, sunflower, or any other crop not listed on the labels\* (except for root crops).
- Do not plant sugar beets, onions, or other root crops for *18 months* after metribuzin application.
- Cover crops for soil building or erosion control may be planted any time, but do not graze or harvest for food or feed.
- Metribuzin can persist in potato vines, so avoid dragging vines into bunches or windrows at harvest, then plowing. Degradation from these concentrated vines may not occur rapidly enough at the plow depth due to lack of microbial activity and/or chemical hydrolysis in that zone.

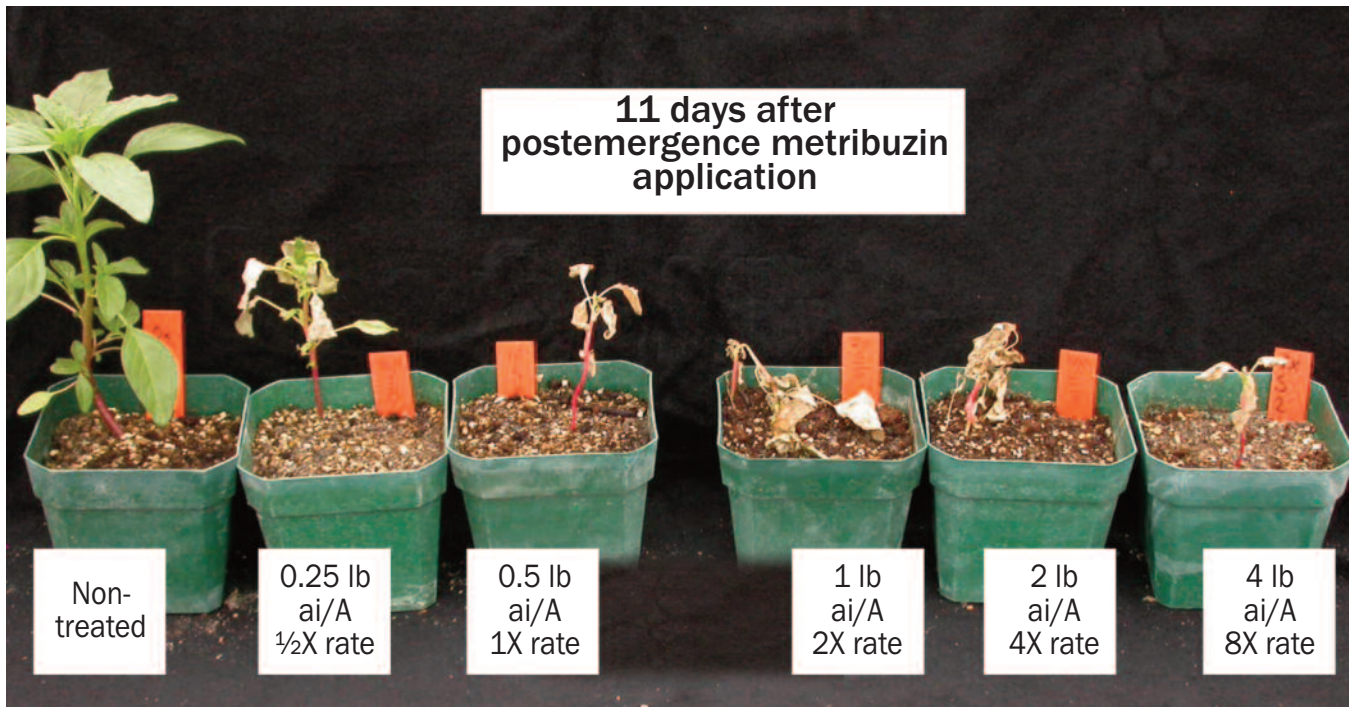
\* Discrepancies exist between various metribuzin labels about which crops can be planted after 12 months. Some state that all crops not listed on the label can be planted 12 months after metribuzin use, except for root crops. Others state that only potato (and rice) can be planted 12 months after, whereas, root crops *as well as all other crops not listed* cannot be planted until 18 months after application. Be sure to follow the specific label restrictions of the product used.

### Resistant weed populations and how to delay or prevent their development

Metribuzin-resistant redroot pigweed populations have been identified in southeastern Idaho. Redroot pigweed grown from seed collected in those populations survived up to eight times the labeled metribuzin 75 DF rate of 0.67 lb/A in a greenhouse trial conducted to confirm resistance (Figure 2). Resistance is thought to have occurred in those fields because of repeated use of metribuzin on potatoes in short, 2-year potato rotations. Resistance in a population can develop in this type of scenario because weeds susceptible to metribuzin or other herbi-



**Figure 2A.** Redroot pigweed grown from seed collected in a suspect metribuzin-resistant population showed little impact from a postemergence application of metribuzin at 0, 1/2, 1, 2, 4, or 8 times the labeled rate of 0.67 lb/A 75 DF or 1 pt/A 4F (from left to right). The greenhouse trial was conducted at the University of Idaho's Aberdeen Research and Extension Center.



**Figure 2B.** Redwood pigweed grown from seed collected in a known metribuzin-susceptible population also received a postemergence application of metribuzin at 0, 1/2, 1, 2, 4, or 8 times the labeled rate of 0.67 lb/A 75 DF or 1 pt/A 4F. In contrast to what occurred when metribuzin was applied to plants growing from resistant redroot pigweed population seed, the susceptible plants were killed by 1X or greater rates of metribuzin, and the 1/2X rate severely injured the weed.



**Figure 3.** Yellowing/chlorosis of the leaf veins caused by a preemergence metribuzin application to a susceptible potato variety. In susceptible varieties, necrosis/burning, stunting, or plant death also may occur and tuber yields and quality may be reduced. These symptoms may also appear on metribuzin-tolerant varieties due to slowed metabolism caused by stress/environmental conditions including cloudy weather just prior to or after postemergence application. The plants usually recover within a week or so and no yield loss occurs.



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cides with the same mode of action die after application. However, the very small number of naturally occurring resistant plants in the population live and produce seed.

Through this selection process, eventually a majority of a given weed species population in a field will be the resistant type because no other control method or herbicide with a different mode of action was used effectively to kill these plants.

The development of resistance can be delayed or prevented by tank-mixing herbicides with different modes of action that have activity on the same weeds and also by rotating herbicide modes of action throughout a crop rotation cycle. If a metribuzin-resistant weed population has been identified or thought to be present in a field, metribuzin and other herbicides with the same mode of action should not be used in any crop planted in that field.

### **Metribuzin injury symptoms and consequences in tolerant and susceptible potato varieties**

Injury may first appear as yellowing/chlorosis in the leaf veins. Height reduction also can develop in affected plants.

Metribuzin metabolism occurs in the veins of the potato leaf, hence, the chlorotic appearance in that area if the herbicide is not being metabolized. Eventually, the metribuzin that has not been metabolized can move beyond the leaf veins into the areas between the veins (interveinal) resulting in a spread of injury symptoms outside the veins.

In contrast, compounds produced when metribuzin is metabolized cannot move past the veins into the area between the veins due to the nature of those compounds and the plant transport mechanism.

A susceptible potato variety does not break the herbicide down quickly enough or at all before injury symptoms, leaf burning/necrosis, stunting, or even plant death occurs. Injury symptoms also can appear on a metribuzin-tolerant variety due to plant stress causing slowed plant growth resulting in slowed metabolism.

**Table 2. Potato variety tolerance to metribuzin**

Variety	Tolerance	Variety	Tolerance
All Blue	R	Jelly	MS
Alpine Russet	R	Kahtadin	MR
Alturas	R	Kennebec	MS
Atlantic	MS	Keystone Russet	S
Bannock Russet	R	Mazama	S
BellaRosa	MS	Modoc	S
Bellchip	S	Norchip	S
Blazer Russet	R	NorDonna	S
Butte	MR	Norland	MR
CalWhite	S	NorValley	MS
Cascade	S	Owyhee Russet	S
Centennial Russet	S	Premier Russet	MR
Cherry Red	MS	Purple Majesty	MR
Chieftan	S	Ranger Russet	R
Chipbelle	S	Red LaSoda	MS
Chipeta	R	Red Norland	S
Classic Russet	R	Red Sunset	R
Clearwater Russet	R	Russet Burbank	R
Dakota Trailblazer	R	Russet Norkotah	R
Dark Red Norland	MS	Sage Russet	MR
Defender	R	Sangre	R
Durango Red	MS	Shepody	VS
FL 1533	MR	Silverton Russet	S
FL 2053	MR	Snowden	MS
Fremont Russet	R	Summit Russet	R
Frontier Russet	R	Superior	MS
Gem Russet	R	Umatilla Russet	R
Gem Star Russet	R	Wallowa Russet	MS
German Butterball	R	White Pearl	S
Highland Russet	R	Western Russet	MS
Hilite Russet	S	White Rose	S
IdaRose	R	Yukon Gem	R
Ivory Crisp	MR	Yukon Gold	MR
NorValley	MS		

S = susceptible, MS = moderately susceptible, VS = very susceptible, R = resistant, MR = moderately resistant.

NOTE: These ratings are based on overall tolerance of each variety to metribuzin. Some varieties may tolerate preplant-incorporated or preemergence more so than postemergence applications. When using metribuzin for the first time on a given variety, always determine variety sensitivity before application to entire acreage.

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Metribuzin-tolerant potato varieties usually recover rapidly—within 1 to 2 weeks—whereas, foliar symptoms persist in susceptible varieties eventually resulting in tuber yield and quality reduction. The longer symptoms persist after metribuzin application, the more likely these losses will occur.

Cloudy conditions just before or after foliar application to a tolerant potato variety also may slow plant metabolism, and, in turn, cause injury symptoms to appear. Once conditions improve, plant growth and metribuzin metabolism resumes in the tolerant variety, and injury is no longer apparent.

### Potato variety tolerance

In general, potato plants can tolerate metribuzin because the herbicide is rapidly metabolized to non-herbicidal compounds within the plant while susceptible species slowly metabolize

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### About the author

Potato Cropping Systems Weed Scientist **Pamela J.S. Hutchinson** is a research and extension faculty member at the University of Idaho Aberdeen Research & Extension Center. She develops potato cropping systems weed management educational texts and programs for growers, extension educators, and other clientele. She also develops potato variety herbicide tolerance, weed control, and herbicide resistance management recommendations based on Idaho-specific research. Contact her at 208.397.4181 or phutch@uidaho.edu.

### Pesticides

ALWAYS read and follow the instructions printed on the pesticide label. The pesticide recommendations in this UI publication do not substitute for instructions on the label. Pesticide laws and labels change frequently and may have changed since this publication was written. Some pesticides may have been withdrawn or had certain uses prohibited. Use pesticides with care. Do not use a pesticide unless the specific plant, animal, or other application site is specifically listed on the label. Store pesticides in their original containers and keep them out of the reach of children, pets, and livestock.

**Trade Names**—To simplify information, trade names have been used. No endorsement of named products is intended nor is criticism implied of similar products not mentioned.

**Groundwater**—To protect groundwater, when there is a choice of pesticides, the applicator should use the product least likely to leach.

metribuzin or do not metabolize it all, resulting in plant death. However, potato varieties may vary in their response to metribuzin. Some potato varieties may even tolerate a preemergence, but not a postemergence, application. When using metribuzin for the first time on a particular variety, always determine variety sensitivity before applying to the entire acreage.

### Generalizations:

- Most russeted-skin varieties are tolerant.
- White-skin varieties that are not early maturing may be susceptible-to-moderately tolerant.
- Applications on red-skinned varieties or early-maturing, smooth-skinned white varieties may cause crop injury, especially under adverse weather conditions, on coarse-textured soils with low organic matter, high soil pH, and/or with the highest rates allowed per acre. See Table 2 for a list of varieties and their tolerance to metribuzin.

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