

Using **MATRIX** in Weed Management Systems for Potatoes

Matrix is a new sulfonyl-urea herbicide for weed management in potatoes. It is active at very low rates, has low potential for groundwater contamination, and has low mammalian toxicity. In addition, Matrix may be applied either preemergence or postemergence for control of many common broadleaf and grassy

weeds, including hairy nightshade. Matrix also may be tank-mixed with Eptam, Prowl, Dual, and/or Lexone/Sencor¹ to broaden the spectrum of weed control (table 1). These characteristics make it a useful tool in integrated weed management systems for potatoes.

This publication provides information on how Matrix controls weeds (its mode of action), its effectiveness on various weed species, and how to use it to maximize its strengths and avoid potential hazards of misuse.

¹ Lexone and Sencor both contain the same active ingredient, metribuzin.



Don Morishita



Don Morishita

Fig 1. Hairy nightshade (left) has smooth to wavy leaf margins while cutleaf nightshade (right) has deeply cleft lobes on its leaves. Matrix provides good control of hairy nightshade but does not control cutleaf nightshade.

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Mode of action

Rimsulfuron, the active ingredient in Matrix, is an ALS-inhibitor and kills susceptible plants by inhibiting a key enzyme in amino acid synthesis. The enzyme, acetolactate synthase, is commonly abbreviated ALS. When ALS is inhibited, cell division ceases, and plants stop growing and slowly die. Initial symptoms include stunting and yellowing of the new growth; plants then turn brown and die, usually within seven to twenty-one days after treatment. Potatoes are tolerant to Matrix because they rapidly detoxify (breakdown) the herbicide before it reaches the ALS target site.

Although many weeds are susceptible to Matrix, biotypes of kochia and several other weeds that are resistant to ALS-inhibitor herbicides are present in Idaho. *These resistant biotypes will not be controlled by Matrix.*

Effectiveness on various weed species

Matrix controls a broad spectrum of weeds when applied either preemergence or postemergence (table 1). However, some weed species are controlled better with one application timing versus the other. For example, common lambsquarters control is much better when Matrix is applied preemergence rather than postemergence. In contrast, quackgrass and crabgrass control are better when Matrix is applied postemergence rather than preemergence. A few common annual weeds are not effectively controlled by Matrix, including cutleaf nightshade, Russian thistle, and wild buckwheat, and require the use of tank-mixtures for control (see tank-mixtures section).

Because *Matrix does not control cutleaf nightshade* but is effective on hairy nightshade, it is important to know which nightshade species infests your fields. Hairy nightshade

has smooth to wavy leaf margins with moderately to densely hairy leaves and stems. Cutleaf nightshade has deeply cleft lobes on its leaves; this characteristic is present even at the seedling stage (see figure 1 for identification). Leaves and stems of cutleaf nightshade are sparsely to moderately hairy.

At present, cutleaf nightshade populations are relatively low in most potato fields in southern Idaho. However, relying solely on Matrix for hairy nightshade control may cause a species shift to cutleaf nightshade and allow it to replace hairy nightshade as the predominant nightshade species in potatoes.

Tank-mixtures Knowing your field history is key to selecting the best tank-mix partner for Matrix. Tank-mixtures broaden the weed control

spectrum and reduce the potential for developing herbicide resistant weed populations. Several herbicides are labeled for tank-mixing with Matrix, including Lexone/Sencor, Eptam, Prowl, and Dual. Matrix may be used in 2-way mixtures with each of these herbicides and in 3-way mixtures with Lexone², Eptam, Prowl, and Dual (table 2). Matrix tank-mixtures with Lexone/Sencor and/or Eptam may be applied either pre- or postemergence, but Matrix tank-mixtures with Prowl and/or Dual are labeled only for preemergence use because postemergence use may cause unacceptable potato injury.

² At publication, Lexone was the only metribuzin product labeled for use in 3-way mixtures with Matrix.

Table 1. Effectiveness of Matrix and Matrix tank mixtures on weeds in potatoes.

	Preemergence					Postemergence		
	Matrix					Matrix		
	Matrix	Matrix + Lexone/	Matrix + Sencor	Matrix + Prowl	Matrix + Eptam	Matrix	Matrix + Lexone/	Matrix + Sencor
Grasses								
Barley, volunteer	G	G	G	G	G	G	G	G
Barnyardgrass	G	G	G	G	G	G	G	G
Crabgrass, large	F	F-G	G	G	G	G	G	G
Foxtail, green	G	G	G	G	G	G	G	G
Foxtail, yellow	G	G	G	G	G	G	G	G
Nutsedge, yellow	NI	NI	NI	NI	F	F	F	F
Oats, volunteer	G	G	G	G	G	G	G	G
Oats, wild	G	G	G	G	G	G	G	G
Quackgrass	NI	NI	NI	F	NI	G	G	G
Wheat, volunteer	G	G	G	G	G	G	G	G
Broadleaves								
Buckwheat, wild	P	F	NI	NI	NI	P	F	NI
Cocklebur, common	F	G	F	F	F	F	G	F
Knapweed, Russian	NI	NI	NI	NI	NI	NI	NI	NI
Kochia	G	G	G	G	G	G	G	G
Lambsquarters, common	F-G	G	G	G	G	P-F	G	F
Mustard, wild	G	G	G	G	G	G	G	G
Nightshade, cutleaf	N	P	P	G	F	N	P	NI
Nightshade, hairy	F-G	G	G	G	G	G	G	G
Pigweed, redroot	G	G	G	G	G	G	G	G
Pigweed, prostrate	G	G	G	G	G	G	G	G
Purslane	G	G	G	G	G	F	G	F-G
Smartweed	F	G	F	F	F	F	G	F
Thistle, Canada	NI	NI	NI	NI	NI	F	F	F
Thistle, Russian	P	G	G	P	P	P	G	P

G=good; F=fair; P=poor; N=no control; NI=indicates no information

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Table 2. Currently labeled Matrix tank-mixtures

Preemergence		Postemergence ^a	
2-way mixtures	3-way mixtures	2-way mixtures	3-way mixtures
Matrix + Lexone/Sencor	Matrix + Lexone ^b + Prowl	Matrix + Lexone/Sencor	Matrix + Lexone ^b + Eptam
Matrix + Eptam	Matrix + Lexone + Dual	Matrix + Eptam	
Matrix + Dual	Matrix + Lexone + Eptam		
Matrix + Prowl	Matrix + Prowl + Eptam		
	Matrix + Dual + Eptam		
	Matrix + Prowl + Dual		

^a Always use a nonionic surfactant at 0.125 percent v/v (1 pint per 100 gallons of water) when using Matrix in combination with Lexone and/or Eptam postemergence.

^b At publication, Lexone was the only metribuzin product labeled for use in 3-way mixtures with Matrix.

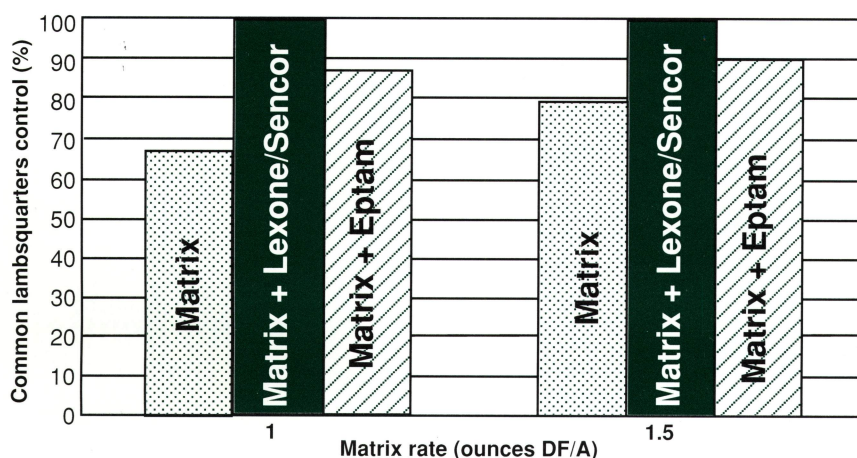


Fig 2. Postemergence common lambsquarters control with Matrix alone is not commercially acceptable. However, a Matrix + Lexone/Sencor tank-mix provides excellent common lambsquarters control. When metribuzin-sensitive varieties are grown, a Matrix-Eptam tank-mix will provide adequate postemergence lambsquarters control *if* lambsquarters are very small (cotyledon to 2-leaf stage) at the time of application. The Lexone/Sencor rate used in these studies was 0.38 pounds 75% DF per acre; the Eptam rate used was 3.5 pints per acre.

Matrix should be used in combination with Lexone/Sencor when metribuzin-tolerant potato varieties are grown. The Matrix + Lexone/Sencor tank-mix provides much better control of weeds like common lambsquarters (figure 2), Russian thistle, and wild buckwheat than Matrix applied alone. Furthermore, since Lexone/Sencor has a different mode of action than Matrix and is effective on ALS-inhibitor resistant kochia, the Matrix + Lexone/Sencor tank-mix is an effective resistance management tool. When metribuzin-sensitive potato varieties are grown, Matrix should be mixed with Prowl, Dual, or Eptam, depending on other weeds present in the field. A Matrix + Prowl tank-mix will be more effective on Russian thistle and ALS-inhibitor resistant kochia than Matrix + Eptam or Matrix + Dual.

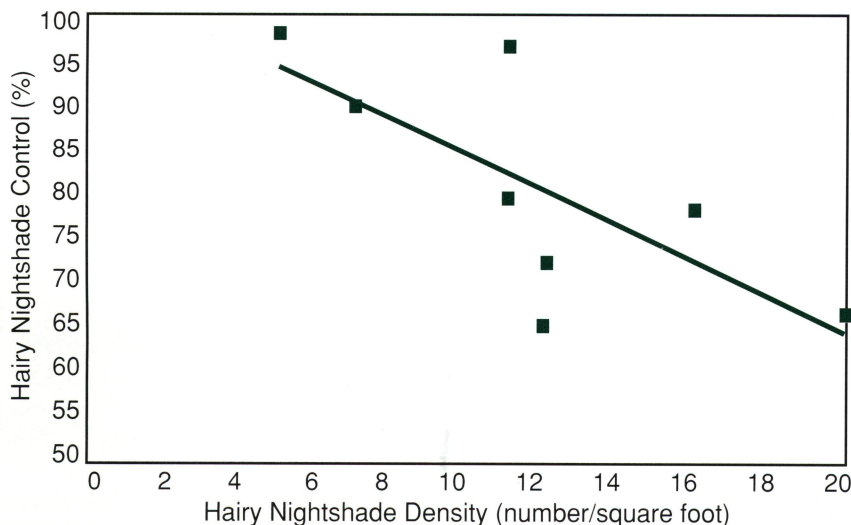


Fig 3. Preemergence hairy nightshade control with Matrix + Lexone/Sencor decreases as hairy nightshade populations increase.

Hairy nightshade control Matrix may be used either preemergence or postemergence for hairy nightshade control. Best control with *postemergence* application is achieved when Matrix or Matrix + Lexone/Sencor is applied to seedling nightshade in the cotyledon to 4-leaf stage. Good coverage is essential for control.

Hairy nightshade control with Matrix applied *preemergence* may be greatly influenced by hairy-nightshade populations. University of Idaho research has shown that in

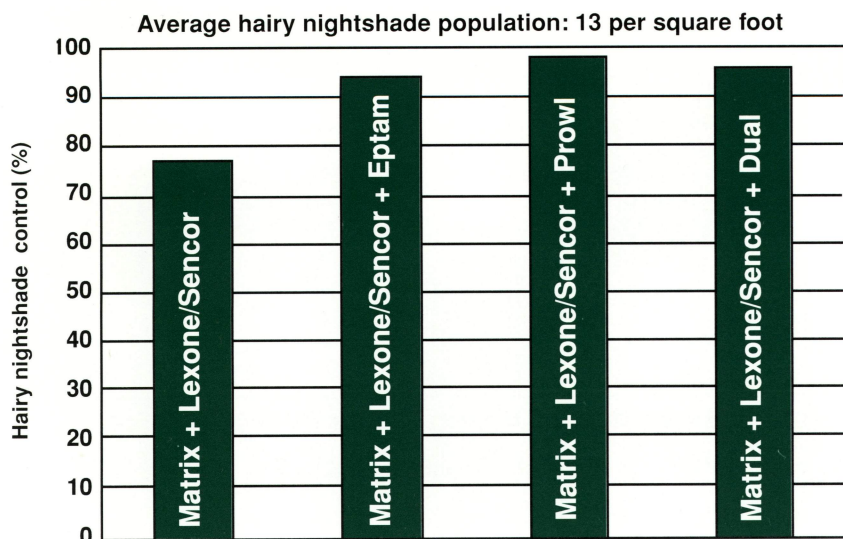


Fig 4. In fields heavily infested with hairy nightshade, tank-mixing Matrix or Matrix + Lexone with Prowl, Dual, or Eptam increases preemergence hairy nightshade control.

fields previously infested with light to moderate hairy nightshade populations, Matrix + Lexone/Sencor provides season-long control. However, hairy nightshade control with a Matrix + Lexone/Sencor mixture may drop below 85 percent in fields moderately to heavily infested with this weed (figure 3). Tank-mixing Matrix or Matrix + Lexone² with Prowl, Dual, or Eptam will improve preemergence hairy nightshade control in heavily infested fields (figure 4).

When Prowl, Dual, or Eptam are used preemergence in combination with Matrix or Matrix + Lexone², the choice of which of these tank-mix partners to use depends on which other problem weeds are present in the field. While all three partners improve hairy nightshade control with Matrix, they have different strengths on other weeds. For example, when cutleaf nightshade is known to infest a field, or when quackgrass or wild oats are also a major problem, Eptam would be a logical partner because it has greater efficacy on these weeds than Prowl or Dual (see *Eptam for Weed Control in Potatoes*, CIS No. 1009 for information on proper use of Eptam). On the other hand, in fields infested with both hairy nightshade and yellow nutsedge, Dual applied before planting followed by Matrix or Matrix + Lexone applied

postemergence to the nutsedge should provide good control. When hairy nightshade and kochia and/or Russian thistle are problem weeds, Prowl would be an effective tank-mix partner.

Rates of Lexone, Prowl, Dual, or Eptam to use in combination with Matrix will vary with soil type. Commonly recommended tank-mix partner rates when Matrix is used preemergence on medium-textured soils with 1 to 1.5 percent organic matter in southern Idaho are:

- Lexone/Sencor - 0.5 pound 75% DF per acre
- Eptam - 3.5 to 4.5 pints per acre
- Dual - 1.5 pints per acre (preemergence only)
- Prowl - 1.8 pints per acre (preemergence only)

Herbicide resistant weeds Resistance management strategies must be employed when using Matrix because ALS-inhibitor resistant biotypes of kochia, prickly lettuce, and Russian thistle are present in Idaho. These resistant biotypes cannot be controlled by Matrix. Thus, it is particularly important to always tank-mix Matrix with a herbicide with a different mode of action that is effective on the resistant species (see tank-mixtures section). In addition, cultural

practices such as tillage, preventing weed escapes from going to seed, and good sanitation can aid in delaying development of herbicide resistant weed populations.

Using herbicides with different modes of action within and between crop seasons also can aid in delaying the build-up and possible dominance of herbicide resistant weed biotypes. In crops grown in rotation with potatoes, reduce the use of ALS inhibitors to avoid selection of resistant weed biotypes. Common ALS inhibitors used in crops grown in potato rotations include Harmony Extra, Express, Ally, Accent, Beacon, Assert, and Pursuit. For a complete discussion of the development of herbicide resistant weed populations and resistance management strategies, see *Herbicide-Resistant Weeds and Their Management*, PNW Bulletin No. 437.

General application information

Matrix is registered for use on commercial potatoes, but *cannot be used on potatoes grown for seed*. It can be applied by ground or through sprinkler irrigation systems, but cannot be applied by air. Always avoid spray drift to adjacent crops. Matrix is very active even at low doses and many crops, such as small grains, canola, sugarbeets, peas, onions, and others, are sensitive to Matrix drift.

Ground application Apply Matrix in 10- to 40-gallons total spray per acre at 20 to 40 pounds per square inch using either flat-fan or flood-jet nozzles. When using flood nozzles, the spray pattern should overlap 100 percent for optimum product performance. Because Matrix is active at very low rates, 1- to 1.5-ounces product per acre, it is important to carefully calibrate sprayers before application.

Chemigation When chemigating, apply Matrix in 1/4 to 3/4 inch of water per acre (1/4 to 1/2 inch on

Advantages and limitations of various application timings

Preemergence application

Advantages:

Little to no injury to potatoes

More tank-mix options than with postemergence treatments, especially when metribuzin-sensitive varieties are grown (table 2)

Better common lambsquarters control than with postemergence application, especially when metribuzin-sensitive varieties are grown

When chemigated, Matrix performance is more consistent with preemergence vs postemergence application

Limitations:

In a wet spring, heavy rainfall may move some soil-applied herbicide out of the weed-seed germination zone, which may allow some weeds to escape control

If a maximum labeled rate of Matrix is used preemergence, Matrix *cannot* be used postemergence to control escaped weeds. Thus, the grower loses the option to use Matrix postemergence to control troublesome weeds like hairy nightshade

The earlier Matrix is applied, the longer the time for herbicide breakdown before row closure when the competitiveness of the potato crop itself contributes substantially to weed control

Postemergence application

Advantages:

Can apply Matrix when and where needed for weed control

Provides consistently good control of seedling hairy nightshade

Quackgrass and crabgrass control are better than with preemergence application

Less time for herbicide breakdown before row closure

Limitations:

May cause temporary injury to potatoes, especially under stressful environmental conditions

Weather conditions may interfere with proper application timing

Fewer tank-mix options are available compared to preemergence application (table 2)

Split application

Advantages:

Provides excellent control of a broad spectrum of weeds and is particularly effective on quackgrass

Allows flexibility of postemergence control of escaped weeds

May be particularly useful for growers who build hills when planting and do not wish to cultivate further

Limitations:

Higher cost due to extra Matrix applied and to second trip across field

Timing of postemergence application(s) may be difficult in dammer-diked fields

If control with first application breaks just before row closure, potatoes will be large and more susceptible to injury from the second Matrix application

Greater potential for crop injury than a single preemergence or postemergence application, especially when Matrix is tank-mixed with Lexone/Sencor at each application

Timing the second Matrix application to avoid stressful environmental conditions is key to reducing injury potential, especially when Matrix is tank-mixed with Lexone/Sencor at each application

sandy soils) as a continuous injection in center-pivot and self-propelled, wheel-move systems. For hand-line and solid-set sprinkler irrigation systems, inject Matrix at the beginning of the set and apply water for activation (i.e. 1/4 to 3/4 inch). Research in Idaho has shown that when Matrix is chemigated, weed control generally is more consistent when the herbicide is applied before weeds emerge and when the maximum labeled rate of 1.5-ounces product per acre is used. If Matrix is chemigated after weeds emerge, it is very important to make the application when weeds are small, cotyledon to two-leaf stage, in order to achieve acceptable weed control.

Application timing

Matrix may be applied preemergence before weeds emerge, postemergence when weeds are small (i.e. less than 1 inch tall for most species), as a split preemergence-plus-postemergence application, or as a split postemergence-plus-postemergence application. Matrix application timing depends on several factors, including other management practices employed. A point to consider is that research at the University of Idaho has shown that preemergence applications of Matrix may cause less potato injury than postemergence applications.

Typically, postemergence Matrix applications cause a temporary, mild, mottled yellowing of potato foliage, especially on newer growth (figure 5). Under stressful environmental conditions, such as cool, wet weather, or hot, or humid weather, postemergence applications of Matrix also may cause some leaf malformations, including leaf crinkling and/or a pinched appearance to the leaves (figure 6), and stunted growth. Plants typically recover from this injury within seven to ten days after treatment, with no effect on U.S. Number 1 yield (figure 7). Later applications to taller potatoes often cause more injury than early applications to smaller potatoes. To reduce the

Potato varietal tolerance to Matrix

Research in the U.S. and Canada has shown that a number of commonly grown potato varieties have good tolerance to Matrix. However, growers should note that Matrix tolerant varieties may not be tolerant to metribuzin (Lexone/Sencor).

Variety	Matrix Tolerance	Metribuzin (Lexone/Sencor) Tolerance ^a
Russet Burbank	Tolerant	Tolerant
Ranger Russet	Tolerant	Tolerant
Russet Norkotah	Tolerant	Tolerant
Norchip	Tolerant	Moderately tolerant
Gemchip	Tolerant	Moderately susceptible
Shepody	Tolerant	Susceptible
Atlantic	Tolerant	Susceptible

^a Tolerance to metribuzin applied preemergence (*Characteristics of Potato Varieties in the Pacific Northwest*, PNW 454).

When using Matrix for the first time on an untested variety, limit the initial use to a small area. If no crop injury symptoms occur seven days after treatment, the balance of the acreage may be treated.

Rotational crop intervals

Matrix usually has a half-life (time for half of the chemical in the soil to degrade) of 8 to 20 days, depending on temperature and moisture conditions. Matrix degradation is faster under warm, moist conditions than under cool, dry conditions. The following intervals between application of Matrix and planting a subsequent crop should be observed:

Rotation crop	Interval (months)
barley, spring	9
beans, dry	10
beans, succulent	10
corn, field	anytime
corn, popcorn	10
corn, sweet	10
cover crops	4
(erosion control)	
oats, spring	9
potatoes	anytime
sugar beets	10
sunflowers	10
soybeans	10
tomatoes	1
wheat, spring	9
wheat, winter	4
crops not listed	12

potential for Matrix injury to potatoes, the herbicide should be applied only if there have been at least three successive days of sunny weather before application.

Preemergence application Apply Matrix after hilling or drag-off before potatoes and weeds emerge and incorporate with 1/4 to 3/4 inch of water as soon as possible after application, but no later than one week after application. Matrix is not volatile, but needs to be moved into the weed-seed germination zone and activated by water. If any weeds are present, use a nonionic surfactant at a rate of 0.125 to 0.25 percent (1 to 2 pints per 100-gallons spray solution) when applying

Matrix with a ground rig. Matrix can be used at 1- to 1.5-ounces product per acre when applied preemergence.

Postemergence application Apply Matrix to small, actively growing weeds after crop emergence but before the crop exceeds 14 inches height. Small weeds less than 1 inch in height or diameter are controlled best, except for certain grasses such as quackgrass and wild oats that may be controlled better when they are larger (4 to 6 inches tall).

Always use a nonionic surfactant at 1 to 2 pints per 100-gallons spray solution when Matrix is applied alone. When Matrix is mixed with Lexone/Sencor or Eptam, use 1 pint

of nonionic surfactant per 100-gallons spray solution. Apply Matrix + Lexone/Sencor before potatoes are 14 inches tall; apply Matrix + Eptam before potatoes exceed 4 to 6 inches in height. For maximum postemergence activity with Matrix or Matrix mixtures, wait 4 to 6 hours but no more than 7 days to apply 1/4-to 3/4-inch water. Matrix may be used at 1 to 1.5 ounces per acre when applied postemergence. *Postemergence Matrix applications should be made before June 30.*

Split application Two strategies are available for split applications of Matrix: Matrix may be applied preemergence followed by a

Precautions

- ▶ Do not use Matrix on potatoes grown for seed
- ▶ Do not apply Matrix by air
- ▶ Avoid spray drift to adjacent crops
- ▶ Thoroughly clean sprayer after Matrix use as spray tank residues may injure crops other than potatoes
- ▶ Do not contaminate any body of water, including irrigation water, that may be used on other crops
- ▶ Do not apply Matrix within 60 days of harvest
- ▶ Always study the label directions before using Matrix or companion herbicides. If recommendations for the companion herbicide conflict with the Matrix label, do not use it as a tank-mix with Matrix. Remember, the label is the law.

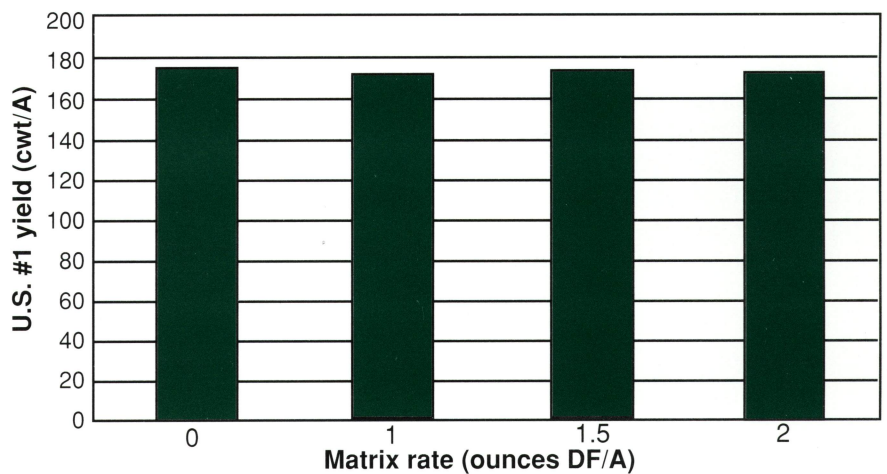


Fig 7. In weed-free trials, Matrix applied at labeled use rates and timings has not affected U.S. Number 1 tuber yields even when foliar injury (Figures 5,6) has occurred.



Mary Guttieri

Fig 5. Matrix applied postemergence to potatoes may cause a mottled yellowing of potato foliage, especially on newer leaves.



Mary Guttieri

Fig 6. Under stressful environmental conditions, Matrix applied postemergence may also cause leaf crinkling and/or a pinched appearance to leaves.

postemergence application 14 to 28 days later, or it may be applied early postemergence followed by a second postemergence application 14 to 28 days later. Because the second application must be made before the crop exceeds 14 inches height, the pre + post split may be more useful under Idaho cropping

conditions than the post + post split. When Matrix is applied as a pre-plus-post or post-plus-post split application, the rate may not exceed 1 ounce per acre at each application. The total amount of Matrix applied each season may not exceed 2-ounces product per acre. When Matrix + Lexone/Sencor is used in

the split application strategy, it is very important for the postemergence application(s) to be made when there have been at least three consecutive sunny days in order to avoid the potential for substantial injury from both Lexone/Sencor and Matrix.

Further readings

Eptam for Weed Control in Potatoes	
CIS 1009	50 cents
Herbicide-Resistant Weeds and Their Management	
PNW 437	50 cents
Characteristics of Potato Varieties in the Pacific Northwest	
PNW 454	\$5.00
To order, contact the University of Idaho Cooperative Extension system office in your county or write or call	
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