University of Idaho
College of Agricultural and Life Sciences

CIS 1136

Chateau Herbicide for Use in Potatoes

by Pamela J.S. Hutchinson

Chateau (flumioxazin), an N-phenylphthalimide herbicide registered for use in potatoes in the states of CA, CO, ID, MN, MT, NC, ND, NE, NV, OR, SD, TX, VA, WA, and WY, also is labeled for use in almond, cotton, grape, mint, nonbearing fruit and nut trees, onion, pistachio, strawberry, sweet potato, bearing pome and stone fruit trees, and fallow land and for nonselective vegetation control to maintain bare ground in noncrop areas on farms, in orchards, and in vineyards.

This herbicide is labeled under other trade names, such as Valor, to maintain bare ground on farms and for use in cotton, peanut, soybean, sugarcane, and sweet potato for emerged weed burndown before planting and residual weed control prior to crop emergence. Under the trade name Sureguard it is labeled for use in container- and field-grown ornamentals, conifers, and deciduous trees. As Payload it is labeled to maintain bare ground in noncrop areas.

Chateau can be used in a weed management program to provide hairy nightshade control. This bulletin provides information on the use of Chateau in potatoes.

Mode of action

N-phenylphthalimide herbicides such as Chateau control or suppress susceptible weeds by inhibiting protoporphyrinogen oxidase (PPO), an enzyme catalyzing the last step in chlorophyll synthesis. At the time of this publication, no other herbicides with the same mode of action were labeled for use in potatoes.

PPO inhibitors are classified as group 14 mode-of-action herbicides along with other herbicides such as Aim (carfentrazone) and Goal (oxyfluorfen). Chlorophyll production inhibition causes a chain of events within the plant that includes a buildup of toxic intermediate compounds, cell membrane disruption, and lipid peroxidation.

Herbicide characteristics

Activation and metabolism by plants. Research has shown that light is required for Chateau activity. As a result, if this herbicide is incorporated too deeply below the soil surface where light infiltration is reduced, its effectiveness also can be reduced.

Chateau is taken up by plant roots and shoots, and translocation to other plant parts does not occur or is very limited. Tolerant plants, such as potatoes, usually can rapidly metabolize Chateau to nonlethal compounds.

As with many soil-applied herbicides, Chateau cannot be taken up by germinating weeds unless it is in the soil-water solution. Consequently, moisture is required to "activate" the herbicide.

Dissipation in soil. Loss of Chateau due to volatilization or photolysis (degradation in the presence of light) is minimal. Degradation by soil microbes is the most common means of Chateau dissipation in the soil.

Mobility in soil. Chateau has low solubility compared with most other herbicides used in potato production. For instance, Chateau solubility in the soil-water solution in typical Idaho

soils at pH of 7.0 to 8.0 is relatively low—1.79 ppm—compared with Eptam (EPTC) at 370 ppm, Matrix (rimsulfuron) at 7,300 ppm, Outlook (dimethenamid-p) at 1,174 ppm, and Sencor (metribuzin) at 1,220 ppm. Prowl (pendimethalin), on the other hand, has a solubility of 0.5 ppm. Low herbicide solubility usually leads to low mobility in the soil profile. In other words, Chateau will most likely not move out of the weed-seed germination zone.

Another characteristic affecting an herbicide's mobility is its ionic charge in the soil. Chateau is nonionic in soil so, regardless of soil pH, it does not become positively or negatively charged. Negatively charged herbicides can be repelled by negatively charged soil colloids, and, as a result, they move in the soil profile with soil water. Because Chateau remains neutral, it is not repelled, and therefore has very low mobility in soil.

Use rate, application timing, and incorporation

Rate. Chateau is formulated as a water-dispersible granule (WDG) with 51% (w/w) of the active ingredient, flumioxazin. It only can be applied to potatoes preemergence at 1.5 oz/A of formulated product. ***Do not apply more than 1.5 ounces per acre during a single application or per year***.

Application timing. Chateau can be applied preemergence by ground or by air[1]. The best application timing is shortly after a hilling operation performed prior to potato emergence. ***According to the Chateau label, and extremely important in application timing, a minimum of 2 inches of settled soil must cover the vegetative portion of the potato plant at application time or crop damage can occur***. Harrowing or cultivation after Chateau application will reduce weed control.

In irrigated potato production, Chateau should be sprinkler-incorporated as soon after application as possible and before the most advanced potato sprouts are within 2 inches of the settled soil surface. Use enough irrigation water to move it into the upper soil surface where weed seeds germinate. The minimum sprinkler incorporation amount listed on the label is 0.25 inches. Adequate rainfall occurring in one or a few closely spaced rainfall events soon after Chateau application may effectively move the herbicide into the upper soil surface. Mechanical incorporation is not recommended.

Dry weather following applications of Chateau may reduce its effectiveness since moisture is necessary to activate the herbicide for residual weed control. When adequate moisture is received after dry conditions, Chateau will control susceptible germinating weeds; however, it may not control weeds that germinate after application but before an activating rainfall or irrigation, or weeds that emerge through cracks resulting from dry soil.

Crop injury caused by rain splash of soil treated with Chateau has occurred on other crops, such as cotton. The rainfall event usually needs to be intense, with large droplets, and occur soon after Chateau application but before a less intense rainfall or irrigation.

The Chateau label includes the following statement: "Many weather related factors, including high wind, splashing or heavy rains or cool conditions at or near potato emergence, may result in potato injury in fields treated with Chateau. On occasion this has resulted in a delay in maturity. User should assume these risks before using Chateau."

Other application information

Application restrictions. Chateau cannot be applied to furrow- (rill) irrigated potatoes. Do not apply Chateau to frozen or snow-covered soil.

Sprayer cleanup before Chateau applications. The spray equipment used for Chateau applications must be cleaned according to the manufacturer's directions for the last product used before Chateau. If two or more products were tank-mixed prior to Chateau application, the most restrictive cleanup procedure should be followed.

Ground application. To ensure uniform coverage, follow these practices:

- Use 10 to 30 gallons of spray solution per acre using standard sprayers equipped with flat fan or flood nozzles designed to deliver the desired spray pressure and spray volume.

[1] At the time of this publication, a request to include application by chemigation on the Chateau label had been submitted to the EPA; however, the request had not yet been approved

- Space nozzles uniformly and check them frequently for accuracy.

Aerial application. To obtain satisfactory application, observe the following directions:

- Apply Chateau in 5 to 10 gallons of water per acre.
- Do not apply this product by air within 40 feet of nontarget plants including nontarget crops.
- Do not apply this product by air within 40 feet of streams, wetlands, marshes, ponds, lakes, and reservoirs.
- Refer to the Chateau potato label for recommendations to avoid spray drift.

Sprayer cleanup after Chateau applications. Spray equipment, including mixing vessels and nurse tanks, must be cleaned each day following Chateau application. Refer to the Chateau potato label for specific sprayer cleanup instructions.

Spray equipment, including all tanks, hoses, booms, screens, and nozzles, should be thoroughly cleaned before being used to apply other pesticides. Equipment with Chateau residue remaining in the system may result in crop injury to the subsequently treated crop.

Weeds suppressed or controlled

Apply Chateau to soil-covered potatoes for the preemergence suppression of the weeds listed in table 1. Note that only weed suppression is stated on the label.

Table 1. Weeds suppressed by soil residual activity of Chateau applied preemergence to weeds and soil-covered potatoes at 1.5 oz/A as stated on the Chateau label.

Common weed name	Scientific name
Common lambsquarters	*Chenopodium album*
Nightshades	
Black	*Solanum nigrum*
Eastern black	*Solanum ptycanthum*
Hairy	*Solanum sarrachoides*
Palmer amaranth	*Amaranthus palmeri*
Pigweeds	
Redroot	*Amaranthus retroflexus*
Smooth	*Amaranthus hybridus*
Spiny amaranth	*Amaranthus spinosus*
Tumble	*Amaranthus albus*
Wild mustard	*Brassica kaber*
Wild radish	*Raphanus raphanistrum*

Hairy nightshade. Chateau should be used to target hairy nightshade control in tank mixtures with other preemergence potato herbicides. Chateau in two-way combinations with Sencor, Eptam, Prowl H_2O, or Dual Magnum provided greater than 90% season-long hairy nightshade control in University of Idaho weed control trials conducted at the Aberdeen Research & Extension Center in 2004 and 2005 (figure 1).

Other broadleaf weeds. Weeds present in a potato field other than hairy nightshade will dictate which other herbicides to include in the tank with Chateau. For instance, season-long redroot pigweed control was only 78 to 85% with Chateau in two-way combinations with Eptam, Prowl H_2O, or Dual Magnum or in three-way tank mixtures with Prowl H_2O + Dual Magnum or Prowl H_2O + Eptam in University of Idaho research trials (figures 2, 3, and 4). However, Chateau in a three-way mixture with Dual Magnum + Eptam or with Sencor in two- or three-way mixtures provided 97 to 100% redroot pigweed control in the same trials (figures 3 and 4). By comparison, Matrix combined in two-way mixtures with the same tank-mix partners, or with Chateau, controlled redroot pigweed 95 to 100% (figure 2).

Similarly, the only Chateau two-way combinations controlling more than 90% of common lambsquarters in these trials were with Prowl H_2O, Sencor, or Matrix. However, three-way tank mixtures with any of the Eptam, Prowl H_2O, Dual Magnum, or Sencor combinations provided greater than 90% control (data not shown). Regardless of the presence of susceptible weed species, if Chateau is used in fields with a history of heavy weed populations, three-way tank mixtures will be required.

Grassy weeds. According to University of Idaho research trial results, Chateau at 1.5 oz/A will not provide control or suppression of any grassy weeds and should be tank-mixed with a grass-control herbicide when grasses are present.

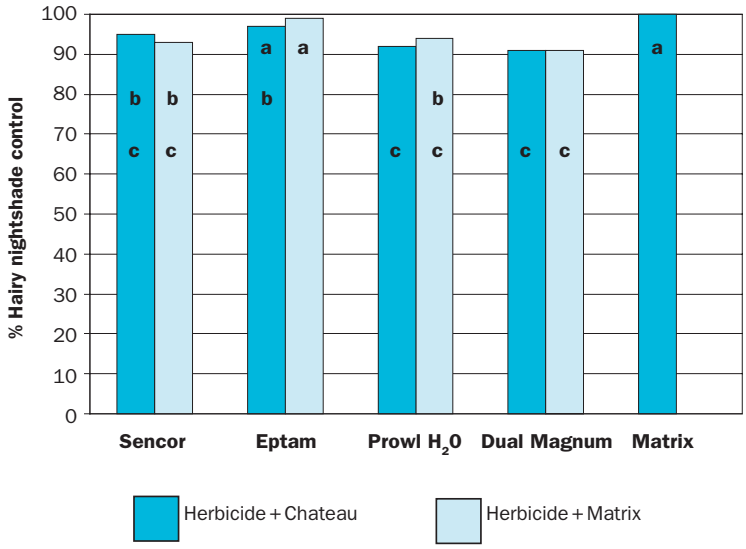

Figure 1. Season-long hairy nightshade control with two-way tank mixtures of Chateau or Matrix at 1.5 oz/A with Sencor (2/3 lb/A), Eptam (4.5 pt/A), Prowl H_2O (2.1 pt/A), or Dual Magnum (1.4 pt /A) or with Chateau + Matrix (1.5 oz/A) at the University of Idaho Aberdeen Research & Extension Center, 2004 and 2005. Data are combined over years. Columns with the same letter(s) are not significantly different according to a Fisher's Protected LSD test performed at P = 0.05.

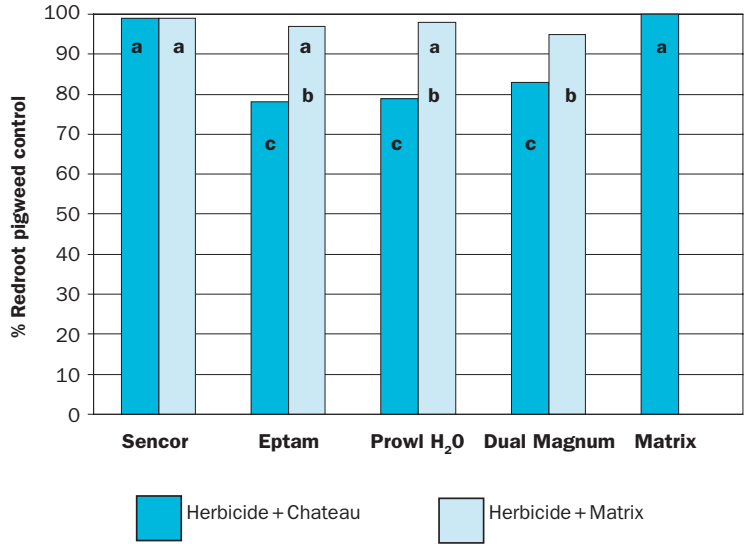

Figure 2. Season-long redroot pigweed control with two-way tank mixtures of Chateau or Matrix at 1.5 oz/A with Sencor (2/3 lb/A), Eptam (4.5 pt/A), Prowl H_2O (2.1 pt/A), or Dual Magnum (1.4 pt/A) or with Chateau + Matrix (1.5 oz/A) at the University of Idaho Aberdeen Research & Extension Center, 2004 and 2005. Data are combined over years. Columns with the same letter(s) are not significantly different according to a Fisher's Protected LSD test performed at P = 0.05.

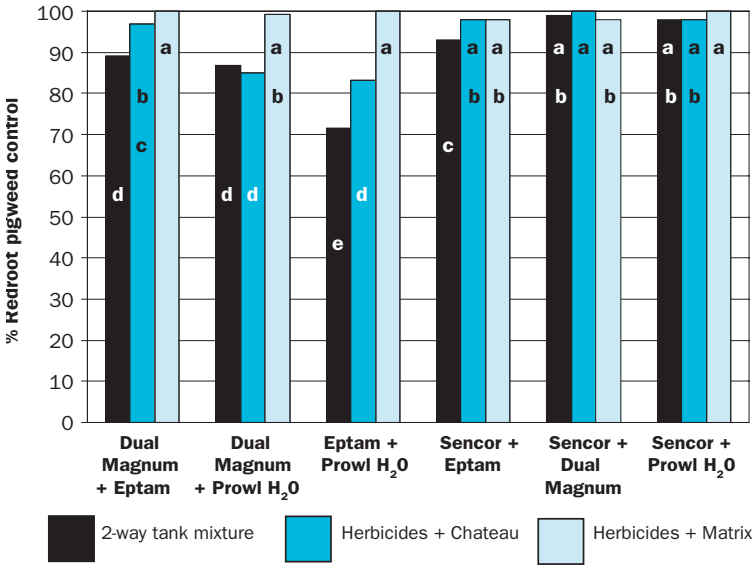

Figure 3. Season-long redroot pigweed control with three-way tank mixtures of Chateau at 1.5 oz/A with Dual Magnum (1.4 pt/A), Eptam (4.5 pt/A), Prowl H_2O (2.1 pt/A), or Sencor (2/3 lb /A) at the University of Idaho Aberdeen Research & Extension Center, 2004 and 2005. Data are combined over years. Columns with the same letter(s) are not significantly different according to a Fisher's Protected LSD test performed at P = 0.05.

Figure 4. Broad-spectrum weed control with a two-way tank mixture of Chateau (1.5 oz/A) + Dual Magnum (1.4 pt/A) (a) compared with a three-way tank mixture of Chateau (1.5 oz/A) + Dual Magnum (1.4 pt/A) + Eptam (4.5 pt/A) (c) at the Aberdeen Research & Extension Center, 2005. Inset (b): Closeup of weeds not controlled by the two-way tank mixture of Chateau + Dual Magnum—redroot pigweed and green foxtail.

Figure 5. Injury caused by Chateau applied preemergence at 2 times (3 oz/A) the labeled rate when vegetative portions of sprouting potatoes were 0.5 to 1 inch below the soil surface (b) compared with hand-weeded, nontreated potatoes (a) at the Aberdeen Research & Extension Center, 2006. Pictures were taken 5 weeks after a preemergence application and 3 weeks after an intense rainfall event of approximately 0.8 inches within 1/2 hour.

Resistance management recommendations

Chateau is a group 14 herbicide. Any weed population may contain plants naturally resistant to Chateau and other group 14 herbicides. Plants resistant to group 14 herbicides in a weed population can be selected for with repeated use of group 14 herbicides as the primary method of control in successive years. These resistant plants may eventually dominate the weed population. This may result in partial or total loss of control of that population by Chateau or other group 14 herbicides.

To delay herbicide resistance development, consider these practices:

- Avoid using Chateau or other group 14 herbicides on the same weed species in a given field in consecutive years.
- Use tank mixtures of herbicides from different mode-of-action groups as long as the products are all registered for the same use, have different modes of action, and are effective at the tank-mix rate on the weed(s) of concern.
- Base herbicide use on a comprehensive integrated pest management (IPM) program.
- Keep a field history of weed populations and monitor these populations for loss of herbicide efficacy in a given field.
- Contact your local extension specialist, certified crop advisors, and/or manufacturer for herbicide resistance management and/or integrated weed management recommendations for potatoes and resistant weed biotypes.

Potato variety tolerance

In 1 out of 3 years of Idaho tolerance trials, Chateau applied preemergence at 3 oz/A—2 times the labeled rate—and at greater rates resulted in reduced tuber yields of Russet Burbank, Russet Norkotah, Ranger Russet, Shepody, Bannock Russet, and Alturas.

This yield reduction occurred in 2001 when high temperatures before row closure caused heat stress. Young potato plants most likely could not deal with heat stress and herbicide stress at the same time and/or could not metabolize the herbicide fast enough to provide crop safety.

Potatoes have been tolerant of Chateau applied preemergence at the labeled rate of 1.5 oz/A when at least 2 inches of settled soil covered any vegetative portion of the potato plants at application time and herbicide incorporation with sprinkler irrigation also was conducted before potato sprouts were closer than 2 inches of the soil surface. Injury such as leaf crinkling and/or slight stunting has been observed some years in University of Idaho research trials with Chateau applied preemergence at 1.5 oz/A or greater, however, no yield losses have occurred.

In a 2006 University of Idaho research trial when Chateau at 1.5 and 3 oz/A (1 times and 2 times the labeled rate) was applied preemergence to Russet Burbank potatoes with sprouts 0.5 to 1 inch below the surface of soil that had just been hilled, significant injury symptoms consisting of stunting and leaf crinkling occurred as the potatoes emerged a few days later. In addition, an intense rainfall of almost 0.8 inches of rain in less than 1/2 hour occurred before the potato plants were 5 inches tall. The resulting rain splash of Chateau-treated soil caused additional burning of the lower potato leaves. Injury was still evident 5 weeks after application and 3 weeks after the rainfall event (figure 5).

APPLICATION WARNING

Chateau application should be made only if 2 inches or more of settled soil covers any vegetative portion of the sprouting potatoes. Chateau should be sprinkler incorporated before sprouts are closer than 2 inches to the soil surface. Mechanical incorporation is not recommended.

Crop failure and replanting

If the potato crop treated with Chateau is lost due to a catastrophe such as hail or other forms of inclement weather, do not replant potatoes. At the time of this publication, specific data on replanting potatoes after crop loss occurrence were not available. As data are accumulated, recommendations may be changed.

Soybeans can be replanted immediately. Field corn, sorghum, sunflowers, and wheat can be planted 30 days after a Chateau application, provided a minimum of 1 inch of rainfall/irrigation has occurred between Chateau application and replanting. Do not retreat the field with Chateau.

Follow-crop restrictions

Many Idaho rotational crops may be planted the growing season following Chateau applied preemergence at 1.5 oz/A to weeds and soil-covered potatoes (table 2). Planting earlier than the recommended rotational interval may result in crop injury.

Table 2. Recommended follow-crop rotation intervals listed on the Chateau label for a Chateau rate of 1.5 oz/A applied preemergence to potatoes and weeds as directed.

Crop[a]	Rotation interval[b]
Soybeans	Immediately
Field corn, sorghum, soybean, sunflower, and wheat	30 days[b]
Barley, dry and snap beans, peas, rye, and sweet corn	3 months
Alfalfa, canola, clover, oats, sugar beet, and all other crops not listed	4 months if soil is tilled prior to planting, 8 months if no tillage is performed

[a] A successful soil bioassay must be performed prior to planting crops not listed.

[b] At least 1 inch of rainfall/irrigation must occur between application and planting or crop injury may occur.

Additional Chateau information

See below for additional information including other crops in which Chateau can be used and herbicides with the same mode of action possibly used in potato cropping systems:

Formulation	51% WDG
Manufacturer/seller	Valent U.S.A. Corporation
EPA registration number	59639-119
States with registration for use in potatoes	CA, CO, ID, MN, MT, NC, ND, NE, NV, OR, SD, TX, VA, WA, WY
Active ingredient/ common name	flumioxazin
Chemical family	N-phenylphthalimide
Mode of action (MOA)	Inhibition of protoporphyrinogen oxidase (PPO), an enzyme catalyzing the last step in chlorophyll synthesis
Herbicide MOA group number	14
Other herbicides used in potatoes with the same MOA	None at publication time
Herbicides with the same MOA used in some possible potato cropping systems rotation crops	• Goal (oxyfluorfen)—onions • ET (pyraflufen-ethyl)—desiccation (vine-kill) product • Aim (carfentrazone)—corn, small grains, desiccation (vine-kill) product • Spartan (sulfentrazone)—asparagus, chickpeas, dry beans, dry peas, flax, lima beans, mint, soybeans, strawberry, sunflowers
Other crops grown in Pacific Northwest and West Coast with registration for use of Chateau	Almond, cotton, grape, mint, nonbearing fruit and nut trees,onion, pistachio, strawberry, sweet potato, bearing pome and stone fruit trees, fallow land, and noncrop areas on farms and in orchards and vineyards for nonselective vegetation control to maintain bare ground
Resistance management recommendations included on the label(s)	Yes
Variety sensitivity	• None listed on the label • Russet Burbank, Ranger Russet, Russet Norkotah, Shepody, Alturas, Bannock Russet tolerant of 1.5 oz/A applied preemergence to soil-covered potatoes (2 inches of settled soil) in University of Idaho trials.
Replant restrictions in case of potato crop failure after application	• Replanting potatoes is not recommended. • Do not retreat the field with Chateau.
Rotational restrictions/ rotational crop guidelines	• See table 2.
Restricted-entry interval (REI) after application	12 hours
Preharvest interval (PHI)	none

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. Due to constantly changing pesticide laws and labels, some pesticides may have been cancelled or had certain uses prohibited. Use pesticides with care. Do not use a pesticide unless both the pest and the plant, animal, or other application site are 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 are used to simplify the information; no endorsement or discrimination is intended.

The author–Pamela J.S. Hutchinson, Potato Cropping Systems Research and Extension Weed Scientist, Aberdeen Research and Extension Center, University of Idaho

University of Idaho Extension

Issued in furtherance of cooperative extension work in agriculture and home economics, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Charlotte V. Eberlein, Director of University of Idaho Extension, University of Idaho, Moscow, Idaho 83844. The University of Idaho provides equal opportunity in education and employment on the basis of race, color, religion, national origin, age, gender, disability, or status as a Vietnam-era veteran, as required by state and federal laws.

January 2007 **$4.00**