# EVALUATION OF HERBICIDES FOR WEED CONTROL IN FORB SEED PRODUCTION

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## Introduction

Native forb seed is needed to restore rangelands of the Intermountain West. Commercial seed production is necessary to provide the quantity of seed needed for restoration efforts. A major limitation to economically viable commercial production of native forb seed is weed competition. Weeds are adapted to growing in disturbed soil, and native forbs are not competitive with these weeds. The use of preemergence and postemergence herbicides for forb weed control is important, because forbs are fall planted. Fall planting results in nearly simultaneous forb and weed emergence early in the spring, complicating weed control. There is a considerable body of knowledge about the relative efficacy of different herbicides to control target weeds, but few trials have tested the tolerance of native forbs to commercial herbicides.

**This work sought to discover products that could eventually be registered for use for native forb seed production.** The information in this report is for the purpose of informing cooperators and colleagues in other agencies, universities, and industry of the research results. Reference to products and companies in this publication is for the specific information only and does not endorse or recommend that product or company to the exclusion of others that may be suitable. Nor should any information and interpretation thereof be considered as recommendations for the application of any of these herbicides. **Pesticide labels should always be consulted before any pesticide use. Considerable efforts may be required to register these herbicides for use for native forb seed production.**

***The four trials reported here had certain procedures in common.***

The trials were conducted on a field of Nyssa silt loam with a pH of 8.3 and 1.1 percent organic matter. Before planting, drip tape (T-Tape TSX 515-16-340) was buried at 12-inch depth midway between 2 rows (30-inch rows). The drip tape was buried in alternating inter-row spaces (5 ft apart). The flow rate for the drip tape was 0.34 gal/min/100 ft at 8 psi with emitters spaced 16 inches apart, resulting in a water application rate of 0.066 inch/hour.

# Trial 1: Tolerance of Native Forbs to Preemergence Herbicides, 2009-2010

This trial tested the tolerance of native forb species to conventional preemergence and postemergence herbicides in the field.

## Methods for Trial 1

The trial was conducted on a part of the field where soybean was the previous crop. After the soybean harvest in the fall of 2009, the stubble was flailed and the field was plowed, disked, and groundhogged.

The experimental design was a randomized complete block with eight herbicide treatments (Table 1) replicated four times. Each plot consisted of 8 single rows 5 ft long with 1 forb species planted per row. The herbicides were applied on November 30, 2009 using a $CO_2$ sprayer with 8002 nozzles at 30 PSI applying 20 gal/acre. The results of a tetrazolium test were used to adjust the seeding rate to 30 viable seeds/ft of row. Seed of the eight forb species (Table 2) was planted on the soil surface on December 1, 2009. After planting, a thin layer of sawdust was applied over the seed row. The sawdust was applied at approximately 0.18 oz/ft of row (198 lb/acre). Row cover (N-sulate, DeWitt Co., Inc., Sikeston, MO) that covered four rows was applied with a mechanical plastic mulch layer after the sawdust application. The field was irrigated to apply 2 inches of water on December 7. On April 7, 2010, the row cover was removed from the three *Lomatium* species and *Astragalus filipes* and stand counts were made in each plot. On April 20, 2010, the row cover was removed from *Eriogonum umbellatum, Penstemon acuminatus, P. deustus,* and *P. speciosus*, and stand counts were made in each plot.

## Results and Discussion for Trial 1

Emergence was poor and uneven for all species (Table 3). Both *Penstemon acuminatus* and *P. deustus* had zero emergence for all treatments. There were statistically significant differences in stand between treatments only for *Eriogonum umbellatum* and *Penstemon speciosus*. For these two species only Kerb® and Treflan® resulted in lower stand than the untreated check. The uneven emergence casts doubt on the validity of the results.

Table 1. Forb preemergence herbicide treatments.

| Herbicide treatment | Formulation | Application rate |
|---|---|---|
| | | lb ai/acre |
| Untreated | | |
| Prefar | 4 EC | 5 |
| Kerb | 50 WP | 1 |
| Treflan | 4 EC | 0.375 |
| Prowl $H_2O$ | 3.8 SC | 0.75 |
| Balan | 1.5 lb ai/gal | 1.2 |
| Outlook | 6 EC | 0.656 |
| Lorox | 50 DF | 0.5 |

Table 2. Forb species submitted to preemergence herbicides. Malheur Experiment Station, Oregon State University, Ontario, OR.

| Species | Common name |
|---|---|
| *Astragalus filipes* | Basalt milkvetch |
| *Eriogonum umbellatum* | Sulphur-flower buckwheat |
| *Penstemon acuminatus* | Sand penstemon |
| *Penstemon deustus* | Hotrock penstemon |
| *Penstemon speciosus* | Royal or sagebrush penstemon |
| *Lomatium dissectum* | Fernleaf biscuitroot |
| *Lomatium triternatum* | Nineleaf desert parsley |
| *Lomatium grayi* | Gray's lomatium |

Table 3. Emergence of eight forb species in the spring of 2010 in response to preemergence herbicide treatments applied in the fall of 2009. Malheur Experiment Station, Oregon State University, Ontario, OR.

| Herbicide | *Eriogonum umbellatum* | *Penstemon acuminatus* | *Penstemon deustus* | *Penstemon speciosus* | *Lomatium dissectum* | *Lomatium triternatum* | *Lomatium grayi* | *Astragalus filipes* |
|---|---|---|---|---|---|---|---|---|
| | % emergence | | | | | | | |
| Untreated | 37.3 | 0.0 | 0.0 | 7.3 | 6.8 | 26.0 | 4.0 | 66.0 |
| Prefar | 38.7 | 0.0 | 0.0 | 2.5 | 10.3 | 26.5 | 3.7 | 32.3 |
| Kerb | 0.7 | 0.0 | 0.0 | 0.0 | 4.7 | 17.2 | 3.3 | 19.8 |
| Treflan | 12.0 | 0.0 | 0.0 | 0.0 | 4.3 | 24.2 | 5.3 | 33.8 |
| Prowl $H_2O$ | 19.1 | 0.0 | 0.0 | 1.0 | 8.5 | 24.3 | 4.2 | 30.3 |
| Balan | 12.4 | 0.0 | 0.0 | 0.7 | 10.8 | 26.3 | 2.8 | 32.5 |
| Outlook | 14.2 | 0.0 | 0.0 | 5.7 | 12.0 | 21.2 | 2.2 | 21.0 |
| Lorox | 13.8 | 0.0 | 0.0 | 11.2 | 6.3 | 24.0 | 2.8 | 26.5 |
| Average | 18.5 | 0.0 | 0.0 | 3.5 | 8.0 | 23.7 | 3.5 | 32.8 |
| LSD (0.05) | 25.30 | NS | NS | 7.2 | NS | NS | NS | NS |

# Trial 2: A Preliminary Evaluation of Activated Charcoal to Protect Forbs from a Preemergence Herbicide

## Introduction

A preliminary trial at the Malheur Experiment Station showed that some forb species are tolerant to some pre-emergence applied herbicides (Shock et al. 2007b). The use of a pre-emergence herbicide for forb weed control is important, because forbs are fall planted. Fall planting results in simultaneous forb and weed emergence early in the spring, complicating weed control. Research at the Malheur Experiment Station in 2009 showed that activated charcoal could protect direct-seeded onions from two pre-emergence-applied herbicides (Felix and Ishida 2010).

This preliminary trial evaluated activated charcoal to protect seed of eight forb species from Prowl® herbicide.

## Methods for Trial 2

The trial was conducted on a part of the field where soybean was the previous crop. After the soybean harvest in the fall of 2009, the stubble was flailed and the field was plowed, disked, and groundhogged.

The experimental design was a randomized complete block with two treatments: charcoal treated and untreated check. The treatments were replicated four times. Each plot consisted of 8 single rows 5 ft long with 1 forb species planted per row. The results of a tetrazolium test were used to adjust the seeding rate to 30 viable seeds/ft of row. Seed of the eight forb species (Table 4) was planted manually on the soil surface on December 1, 2009. After planting, a thin layer of sawdust alone (untreated check) or sawdust mixed with activated charcoal (Gro-Safe®, Norit Americas, Atlanta, GA) was applied over the seed row. The sawdust for both treatments was applied at approximately 198 lb/acre. For the charcoal treatment, the charcoal was mixed with the sawdust at 25 percent of charcoal by weight. The charcoal applied in the sawdust was equivalent to 48 lb charcoal/acre.

After planting and the sawdust application, both treatments had Prowl $H_2O$® (3.8 SC) broadcast at 0.75 lb ai/acre on December 1, 2009. The Prowl was applied using a $CO_2$ sprayer with 8002 nozzles at 30 PSI and applying 20 gal/acre. Row cover (N-sulate, DeWitt Co., Inc., Sikeston, MO) that covered four rows was applied with a mechanical plastic mulch layer after the herbicide application. The field was drip-irrigated to apply 2 inches of water on December 7. On April 7, 2010 the row cover was removed from the three *Lomatium* species and *Astragalus filipes* and stand counts were made in each plot. On April 20, 2010, the row cover was removed from *Eriogonum umbellatum, Penstemon acuminatus, P. deustus,* and *P. speciosus,* and stand counts were made in each plot.

## Results and Discussion for Trial 2

Activated charcoal applied with the sawdust over the seed row resulted in higher emergence than sawdust alone (untreated check) for *Eriogonum umbellatum*, *Penstemon acuminatus*, *P. deustus*, *P. speciosus*, and *Astragalus filipes* (Table 4). For *Lomatium triternatum*, the charcoal had a detrimental effect on emergence. These results suggest that activated charcoal might allow the use of a preemergence herbicide in forb weed control for selected species. Further research is needed to refine these procedures.

Table 4. Emergence of eight forb species in the spring of 2010 in response to Prowl herbicide applied with and without activated charcoal in the fall of 2009. Malheur Experiment Station, Oregon State University, Ontario, OR.

| Charcoal | *Eriogonum umbellatum* | *Penstemon acuminatus* | *Penstemon deustus* | *Penstemon speciosus* | *Lomatium dissectum* | *Lomatium triternatum* | *Lomatium grayi* | *Astragalus filipes* |
|---|---|---|---|---|---|---|---|---|
| | % emergence | | | | | | | |
| yes | 34.8 | 5.5 | 3.0 | 34.8 | 24.3 | 27.2 | 9.2 | 45.0 |
| no | 16.3 | 0.0 | 0.7 | 3.3 | 27.3 | 45.5 | 5.8 | 1.5 |
| LSD (0.05) | 0.8 | 4.9 | 1.9 | 13.6 | NS | 13.5 | NS | 22.1 |

# Trial 3: Native Perennial Forb Tolerance to Repeated Annual Applications of Postemergence Herbicides, 2007-2010

# Methods for Trial 3

### Plant Establishment

Seed of seven Great Basin forb species (Table 5) received in October 2005 was planted November 1, 2005. The field had been disked, groundhogged, and marked in rows 30 inches apart. The 7 forb species were planted in individual rows 435 ft long and 30 inches apart. Planting depths were similar to those used in the irrigation trial (Shock et al. 2007a) and varied by species. The preceding crop was wheat. Prior to planting, 1 drip tape was inserted 12 inches deep equidistant between pairs of rows to be planted. The drip tape was supplied with irrigation water using filtration and other common drip-irrigation practices (Shock 2006).

### 2006 Postemergence Treatments

The lower 200 ft of the field was staked out to make 5-ft-wide plots perpendicular to the forb rows, crossing all seven species. Eight treatments including the untreated check were replicated four times in a randomized complete block design (Table 6). Treatments were applied May 24, 2006 at 30 psi, 2.63 mph, in 20 gal/acre using 8002 nozzles with 3 nozzles spaced 20 inches apart. Plant injury in 2006 was rated visually on May 31, June 15, and June 30.

In 2006 the trial was irrigated very little because of ample rainfall. Very few plants flowered and seed was not harvested in 2006.

### Spring of 2007

By March 30, 2007 it was difficult if not impossible to distinguish any effects of the 2006 postemergence herbicide applications on any of the seven forb species. These observations suggest that some degree of phytotoxic damage may be acceptable in establishing native forb seed fields if effective weed control is achieved.

### 2007 Postemergence Treatments

The same treatments as in 2006 were applied again to the same plots on April 24, 2007. The same application specifications as in 2006 were used in 2007. Plant injury was rated visually on May 1, 11, 25, and June 12.

Drip irrigations were applied every 2 weeks starting on April 10 and ending on May 29 (total of 4 irrigations). Each irrigation applied 1 inch of water.

Seed of *Eriogonum umbellatum, Penstemon acuminatus, P. deustus,* and *P. speciosus* was harvested by hand as the seed reached maturity. The seed was cleaned and weighed. *Lomatium dissectum, L. triternatum,* and *L. grayi* did not flower in 2007.

## 2008 Postemergence Treatments

The same treatments as in 2006 were applied again to the same plots on March 13, 2008. The same application specifications as in 2006 were used in 2008.

Drip irrigations were applied every 2 weeks starting on April 5 and ending on June 24 (total of 4 irrigations). Each irrigation applied 1 inch of water.

Seed of *Eriogonum umbellatum, Penstemon acuminatus, P. deustus, P. speciosus,* and *Lomatium triternatum* was harvested by hand as the seed reached maturity from the 5 ft of row across the plot width. The seed was cleaned and weighed. *Lomatium dissectum* and *L. grayi* had only a few flowers in 2008.

## 2009 Postemergence Treatments

The same treatments as in 2006 were applied again to the same plots on March 20, 2009. The same application specifications as in 2006 were used in 2009.

Drip irrigations were applied every 2 weeks starting on May 22 and ending on June 24 (total of 4 irrigations). Each irrigation applied 1 inch of water.

Seed of *Lomatium dissectum* and *Lomatium grayi* was harvested by hand as the seed reached maturity from the 5 ft of row across the plot width. The seed was cleaned and weighed.

## 2010 Postemergence Treatments

The same treatments as in 2006 were applied again to the same plots on April 7, 2010. The same application specifications as in 2006 were used in 2010.

The trial was not irrigated in 2010.

Seed of *Eriogonum umbellatum, Lomatium dissectum,* and *L. triternatum* was harvested by hand as the seed reached maturity from the 5 ft of row across the plot width. The seed was cleaned and weighed.

## General Considerations

The focus of the evaluations was forb tolerance to the herbicides, not weed control. Therefore, weeds were removed as needed in each year. In 2008, 2009, and 2010 the weeds of each species were counted in each plot (data not shown).

For each species the effects of herbicides on plant stand and injury were evaluated independently from the effects on other species. Treatment differences were compared using ANOVA and protected least significant differences at the 95 percent confidence LSD (0.05) using NCSS Number Cruncher software (NCSS, Kaysville, UT).

# Results and Discussion Trial 3

All observations made on the herbicides tested are strictly preliminary observations. Herbicides that were observed to be damaging to the forbs as reported here might be helpful if used at a lower rate or in a different environment. The herbicides were relatively safe for the forbs in these trials but they might be harmful if used at higher rates or in a different environment. Nothing in this report should be construed as a recommendation.

### 2007 Postemergence Treatments

For *Eriogonum umbellatum,* applications of Buctril®, Caparol®, and Lorox® resulted in lower seed yields than the untreated check (Table 6). For *Penstemon acuminatus,* applications of Buctril, Select®, Caparol, and Lorox resulted in lower seed yields than the untreated check. For *P. deustus* and *P. speciosus*, applications of Buctril, Goal®, Caparol, and Lorox resulted in lower seed yields than the untreated check.

### 2008 Postemergence Treatments

There was no significant difference in seed yield between the reapplied herbicide treatments and the check for *Eriogonum umbellatum, Penstemon acuminatus, P. deustus,* and *P. speciosus* in 2008 (Table 7). For *Lomatium triternatum,* seed yield was reduced for the Buctril treatment, despite the early application. The *Lomatium* spp. break dormancy early in the growing season, and *L. triternatum* could have been susceptible at the early application date. Buctril, applied later in 2007, also reduced seed yield of *L. triternatum.*

### 2009 Postemergence Treatments

Root rot caused severe damage to plant stands of *Penstemon acuminatus* and *P. speciosus*. *Penstemon deustus, Lomatium triternatum,* and *Eriogonum umbellatum* produced very little seed in 2009. *Lomatium dissectum* and *L. grayi* produced seed in 2009. There was no significant difference in seed yield between any of the applied herbicides and the check in 2009 for *Lomatium dissectum* and *L. grayi* (Table 8).

### 2010 Postemergence Treatments

The *Penstemon* species had a compromised stand in 2010 due to root rot. Herbicide effects were not evaluated on these species and seed was not collected. *Lomatium grayi* did not produce seed in 2010. There was no significant difference in seed yield between any of the applied herbicides and the check in 2010 for *Lomatium dissectum* and *L. triternatum* (Table 9). For *Eriogonum umbellatum,* applications of Buctril and Goal in 2010 resulted in lower seed yields than the untreated check.

# Summary for Trial 3

All seven species tested were tolerant to Prowl and Outlook® applied as postemergence treatments at the rate, timing, and soils used in these trials. All species were also tolerant to postemergence applications of Select at the rate, timing, and soils used in these trials. Prowl and Outlook are broad-spectrum, soil-active herbicides that can prevent weed emergence during the season. Select is a foliar-contact grass herbicide. The use of these three herbicides may provide the basis for an effective weed control program for seed production of these seven native forb

species if they become registered options. Further tests are warranted to describe the range of safety for these herbicides and whether or not they have any undesirable interactions.

Table 5. Forb species planted at the Malheur Experiment Station, Oregon State University, Ontario, OR, and their origins.

| Species | Common name | Origin | Year |
|---|---|---|---|
| *Eriogonum umbellatum* | Sulphur-flower buckwheat | Shoofly Road, Owyhee Co., ID | 2004 |
| *Penstemon acuminatus* | Sharpleaf or sand-dune penstemon | Bliss Dam, Elmore Co., ID | 2004 |
| *Penstemon deustus* | Scabland or hot-rock penstemon | Blacks Cr. Rd., Elmore Co., ID | 2003 |
| *Penstemon speciosus* | Royal or sagebrush penstemon | Leslie Gulch, Malheur Co., OR | 2003 |
| *Lomatium dissectum* | Fernleaf biscuitroot | Mann Creek, Washington Co., ID | 2003 |
| *Lomatium triternatum* | Nineleaf biscuitroot or nineleaf desert parsley | Hwy 395, Lake Co., OR | 2004 |
| *Lomatium grayi* | Gray's biscuitroot or Gray's lomatium | Weiser R. Rd., Washington Co, ID | 2004 |

Table 6. Seed yield of native forbs in response to annually repeated postemergence herbicides last applied on April 24, 2007. Seed yields may not be representative since they are from small one-row plots without borders. Malheur Experiment Station, Oregon State University, Ontario, OR.

| Treatment | Rate | Mode of action | *Eriogonum umbellatum* | *Penstemon acuminatus* | *Penstemon deustus* | *Penstemon speciosus* |
|---|---|---|---|---|---|---|
| | lb ai/acre | | ---------- lb/acre ---------- | | | |
| Untreated | -- | | 91.7 | 520.4 | 903.1 | 55.3 |
| Buctril 2.0 EC | 0.125 | foliar | 38.1 | 305.7 | 348.5 | 24.6 |
| Goal 2XC | 0.125 | foliar | 42.6 | 417.8 | 333.0 | 20.9 |
| Select 2.0 EC | 0.094 | foliar | 57.6 | 304.6 | 927.3 | 51.2 |
| Prowl $H_2O$ 3.8 C | 1.0 | soil | 115.0 | 509.4 | 747.6 | 52.9 |
| Caparol FL 4.0 | 0.8 | foliar | 27.3 | 162.9 | 86.8 | 15.7 |
| Outlook 6.0 EC | 0.656 | soil | 75.1 | 502.6 | 835.1 | 56.6 |
| Lorox 50 DF | 0.5 | soil/foliar | 35.6 | 264.9 | 108.5 | 20.0 |
| LSD (0.05) | | | 51.8 | 183.4 | 334.8 | 29.7* |

*LSD (0.10)

Table 7. Seed yield of native forbs in response to annually applied postemergence herbicides last applied on March 12, 2008. Seed yields may not be representative since they are from small one-row plots without borders. Malheur Experiment Station, Oregon State University, Ontario, OR.

| Treatment | Rate | Mode of action | *Eriogonum umbellatum* | *Penstemon deustus* | *Penstemon acuminatus* | *Penstemon speciosus* | *Lomatium triternatum* |
|---|---|---|---|---|---|---|---|
| | lb ai/acre | | ---------- lb/acre ---------- | | | | |
| Untreated | -- | | 365.1 | 330.2 | 93.9 | 487.5 | 981.5 |
| Buctril 2.0 EC | 0.125 | foliar | 285.5 | 309.1 | 195.6 | 781.7 | 187.9 |
| Goal 2XC | 0.125 | foliar | 279.7 | 427.0 | 173.3 | 728.1 | 820.8 |
| Select 2.0 EC | 0.094 | foliar | 263.0 | 421.3 | 107.8 | 814.7 | 1062.1 |
| Prowl $H_2O$ 3.8 C | 1.0 | soil | 385.0 | 345.4 | 112.6 | 608.4 | 922.7 |
| Caparol FL 4.0 | 0.8 | foliar | 298.5 | 267.2 | 184.6 | 785.3 | 1069.8 |
| Outlook 6.0 EC | 0.656 | soil | 354.8 | 420.1 | 110.3 | 569.0 | 987.0 |
| Lorox 50 DF | 0.5 | soil/foliar | 368.4 | 360.4 | 140.0 | 672.2 | 888.1 |
| LSD (0.05) | | | NS | NS | NS | NS | 388.7 |

Table 8. Seed yield of two native forbs in response to annually repeated postemergence herbicides last applied on March 20, 2009. Seed yields may not be representative since they are from small one-row plots without borders. Malheur Experiment Station, Oregon State University, Ontario, OR. (This was the third consecutive year these forbs received the same herbicide treatments.)

| Treatment | Rate | Mode of action | *Lomatium dissectum* | *Lomatium grayi* |
|---|---|---|---|---|
| | lb ai/acre | | ---------- lb/acre ---------- | |
| Untreated | -- | | 83.4 | 32.6 |
| Buctril 2.0 EC | 0.125 | foliar | 83.3 | 20.8 |
| Goal 2XC | 0.125 | foliar | 88.0 | 28.2 |
| Select 2.0 EC[a] | 0.094 | foliar | 78.1 | 38.2 |
| Prowl $H_2O$ 3.8 C | 1.0 | soil | 85.6 | 28.6 |
| Caparol FL 4.0 | 0.8 | foliar | 66.1 | 27.8 |
| Outlook 6.0 EC | 0.656 | soil | 80.9 | 26.6 |
| Lorox 50 DF | 0.5 | soil/foliar | 104.5 | 31.2 |
| LSD (0.05) | | | NS | NS |

Table 9. Seed yield of three native forbs in response to annually repeated postemergence herbicides last applied on April 7, 2010. Seed yields may not be representative since they are from small one-row plots without borders. Malheur Experiment Station, Oregon State University, Ontario, OR.

| Treatment | Rate | Mode of action | *Eriogonum umbellatum* | *Lomatium triternatum* | *Lomatium dissectum* |
|---|---|---|---|---|---|
| | lb ai/acre | | ---------- lb/acre ---------- | | |
| Untreated | -- | | 831.1 | 485.6 | 475.3 |
| Buctril 2.0 EC | 0.125 | foliar | 354.5 | 317.1 | 462.8 |
| Goal 2XC | 0.125 | foliar | 271.5 | 534.7 | 421.6 |
| Select 2.0 EC | 0.094 | foliar | 625.6 | 384.8 | 449.1 |
| Prowl $H_2O$ 3.8 C | 1.0 | soil | 773.7 | 403.9 | 488.7 |
| Caparol FL 4.0 | 0.8 | foliar | 470.5 | 296.3 | 449.1 |
| Outlook 6.0 EC | 0.656 | soil | 853.5 | 322.0 | 413.4 |
| Lorox 50 DF | 0.5 | soil/foliar | 460.7 | 487.5 | 533.3 |
| LSD (0.05) | | | 373.4 | NS | NS |

# Trial 4: Native Perennial Forb Tolerance to Rates and Mixtures of Postemergence Herbicides, 2008-2010

## Methods for Trial 4

In the fall of 2006 *Eriogonum umbellatum, Penstemon acuminatus, P. deustus,* and *P. speciosus* were each planted in areas 10 ft wide and 220 ft long (Table 10). The seeds were planted in 4 rows 30 inches apart. The field previously had been disked, ground hogged, and marked in rows 30 inches apart. Planting depths were similar to those used in the irrigation trial (Shock et al. 2007a) and appropriate to each species. Prior to planting, one drip tape was inserted 12 inches deep equidistant between pairs of rows to be planted. A total of 4 drip irrigations applying 1 inch of water each were applied every 2 weeks in 2009 and 2010. Drip irrigations were applied from April 10 to May 29 in 2008 and from May 22 to June 24 in 2009. Each irrigation applied 1 inch of water. The trial was not irrigated in 2010.

On March 12, 2008, March 20, 2009, and on April 7, 2010, 13 herbicide treatments (Table 2) were applied to plots 4 rows wide and 5 ft long. The treatments consisted of different rates and combinations of the soil-active herbicides Prowl and Outlook. The treatments were arranged within each species in randomized complete block designs with four replicates. Treatments were applied at 30 psi, 2.63 mph, in 20 gal/acre using 8002 nozzles with 6 nozzles spaced 20 inches apart.

Seed of each species was harvested at maturity. Seed was harvested from the middle two rows in each plot of *Eriogonum umbellatum, Penstemon acuminatus,* and *P. speciosus* in 2008. Plant populations of *P. deustus* prior to herbicide applications were not adequate for data on seed yield to be meaningful. For *P. deustus,* only observations on herbicide damage were made. In 2009 and 2010, only seed of *E. umbellatum* was harvested. *Penstemon acuminatus* and *P. speciosus* stands were severely reduced in 2009 due to root rot.

### General Considerations

The focus of the evaluations was forb tolerance to the herbicides, not weed control. Therefore, weeds were removed as needed.

The effects of herbicides for each species on plant stand and injury were evaluated independently from the effects on other species. Treatment differences were compared using ANOVA and protected least significant differences at the 95 percent confidence LSD (0.05) using NCSS Number Cruncher software (NCSS, Kaysville, UT).

Table 10. Forb species planted at the Malheur Experiment Station, Oregon State University, Ontario, OR and their origins.

| Species | Common name | Origin | Year |
|---|---|---|---|
| *Eriogonum umbellatum* | Sulfur-flower buckwheat | Shoofly Road, Owyhee Co., ID | 2004 |
| *Penstemon acuminatus* | Sharpleaf or sand-dune penstemon | Bliss Dam, Elmore Co., ID | 2004 |
| *Penstemon deustus* | Scabland or hot-rock penstemon | Blacks Cr. Rd., Elmore Co., ID | 2003 |
| *Penstemon speciosus* | Royal or sagebrush penstemon | Leslie Gulch, Malheur Co., OR | 2003 |

## Results and Discussion of Trial 4

All observations made on the herbicides tested are strictly preliminary observations. Herbicides that damaged forbs as reported here might be helpful if used at a lower rate or in a different environment. The herbicides were relatively safe for the forbs in these trials but they might be harmful if used at higher rates or in a different environment. Nothing in this report should be construed as a recommendation.

Symptoms of herbicide injury were not observed in any of the plants in 2008, 2009, or 2010. Foliar injury would not be expected since all herbicides tested (except Select) were soil active and were applied early. There were no significant differences in seed yield between the herbicide treatments and the untreated check for *Eriogonum umbellatum, Penstemon acuminatus,* and *P. speciosus* (Tables 11 and 12).

## Summary of Trial 4

All four species tested were tolerant to Prowl and Outlook applied as postemergence treatments at the rate, timing, and soils used in these trials. Prowl and Outlook are broad-spectrum, soil-active herbicides that will prevent weed emergence during the season. Select is a foliar-contact grass herbicide. The use of these three herbicides may provide the basis for an effective weed control program for seed production of these four species. Further tests are warranted to describe the range of safety for these herbicides and whether or not they have any undesirable interactions.

Table 11. Seed yield of two forbs in response to post emergence herbicides applied on March 12, 2008, Malheur Experiment Station, Oregon State University, Ontario, OR. All herbicides except Select are soil active.

| Treatment | Rate | *Penstemon speciosus* | *Penstemon acuminatus* |
|---|---|---|---|
| | (lbs ai/acre) | ---------- lb/acre ---------- | |
| Weed free, untreated control | | 820.9 | 557.9 |
| Select 2.0 EC[a] | 0.094 | 876.7 | 491.0 |
| Prowl | 0.95 | 644.2 | 403.7 |
| Prowl | 1.19 | 1242.0 | 506.1 |
| Prowl | 1.43 | 941.0 | 573.0 |
| Outlook | 0.84 | 992.5 | 463.1 |
| Outlook | 0.98 | 860.4 | 348.1 |
| Prowl + Outlook | 0.95 + 0.66 | 653.7 | 472.3 |
| Prowl + Outlook | 0.95 + 0.84 | 965.4 | 483.6 |
| Prowl + Outlook | 0.95 + 0.98 | 827.3 | 466.4 |
| Prowl + Outlook | 1.19 + 0.66 | 917.0 | 627.8 |
| Prowl + Outlook | 1.19 + 0.84 | 835.0 | 434.4 |
| Prowl + Outlook | 1.19 + 0.98 | 707.4 | 460.0 |
| LSD (0.05) | | NS | NS |

[a]applied with Herbimax adjuvant at 1% v/v.

Table 12. Seed yield of *Eriogonum umbellatum* in response to repeated postemergence herbicides applied on March 12, 2008, March 20, 2009, and April 7, 2010. Malheur Experiment Station, Oregon State University, Ontario, OR. All herbicides except Select are soil active.

| Treatment | Rate | 2008 | 2009 | 2010 |
|---|---|---|---|---|
| | (lbs ai/acre) | ---------- lb/acre ---------- | | |
| Weed free, untreated control | | 276.5 | 430.0 | 622.6 |
| Select 2.0 EC[a] | 0.094 | 149.1 | 475.2 | 618.1 |
| Prowl | 0.95 | 387.2 | 440.8 | 549.7 |
| Prowl | 1.19 | 533.1 | 596.6 | 736.5 |
| Prowl | 1.43 | 250.6 | 596.4 | 988.8 |
| Outlook | 0.84 | 319.8 | 474.5 | 725.2 |
| Outlook | 0.98 | 143.5 | 501.4 | 627.4 |
| Prowl + Outlook | 0.95 + 0.66 | 300.9 | 555.5 | 795.5 |
| Prowl + Outlook | 0.95 + 0.84 | 440.0 | 763.8 | 861.3 |
| Prowl + Outlook | 0.95 + 0.98 | 330.9 | 569.1 | 614.8 |
| Prowl + Outlook | 1.19 + 0.66 | 244.0 | 699.8 | 618.5 |
| Prowl + Outlook | 1.19 + 0.84 | 336.7 | 556.0 | 592.2 |
| Prowl + Outlook | 1.19 + 0.98 | 285.6 | 506.2 | 684.3 |
| LSD (0.05) | | NS | NS | NS |

[a]applied with Herbimax adjuvant at 1 percent v/v.

## Conclusions

Prowl and Outlook herbicides were found to not harm growth and seed production of some forb species when applied post emergence. These results can support a potential future registration process for these herbicides. In addition, activated charcoal was found to have the potential of allowing the use of soil-active herbicides applied pre-emergence. These results can support a potential future registration process for the use of activated charcoal in forb seed production.

## References

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