Title: Screen Herbicides for Efficacy and Safety in Three Native Grass Species

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Three trials were conducted at the WSU Mount Vernon NWREC on three native perennial grass species: Alaska brome, *Bromus sitchensis*), blue wildrye (*Elymus glaucus*), and Roemer's fescue (*Festuca idahoensis* ssp. *roemeri*): (1) a fall transplanting with herbicides applied postemergence (POST) to the grasses and weeds, (2) a spring transplanting with herbicides applied POST to the grasses and weeds, and (3) a spring transplanting with herbicides applied preemergence (PRE) and POST to the weeds.

Materials and Methods.

For all trials, grass species were initially sown into trays of potting soil in the greenhouse approximately five months before transplanting into the field. Plots for all trials measured 8 by 10 ft and were located at the WSU Mount Vernon NWREC.

(1) Fall transplanting with herbicides applied POST. The three grass species were transplanted October 10, 2006 and the first herbicide applications were applied December 28, 2006. Weeds and grasses were mown and a second herbicide treatment was applied to the same plots July 26, 2007. Initial grass stand counts were made and weed control was estimated June 26, 2007, and percent vegetation cover was estimated February 16, 2008.

(2) Spring transplanting with herbicides applied POST. The three grass species were transplanted May 14, 2007 and the first herbicide applications were applied June 19, 2007. Weeds and grasses were mown and a second treatment was applied to the same plots October 26, 2007. Grass injury and weed control were estimated June 26, 2007 and February 16, 2008; grass stand counts were made February 16, 2008.

(3) Spring transplanting with herbicides applied PRE and POST. The three grass species were transplanted June 26, 2007 and the PRE herbicide applications were applied June 27, 2007. The POST herbicides (Milestone and Transline) were applied August 9, 2007. Grass herbicides were applied to all plots within a replicate (Poast to Rep 1, Fusilade to Rep 2, and Select to Rep 3) August 30, 2007 in order to determine relative susceptibility of these species to these POST grass herbicides. Grass stand counts, grass injury, and weed control was estimated February 16, 2008.

The experimental design for all experiments was a randomized complete block with three replicates. A general linear models procedure was used to analyze the data. Means were separated using Fisher's Protected LSD (P = 0.05).

Results.

General observations:

1. Grass seedlings were ready to transplant generally by two to three months after seeding in the flats. Five months resulted in larger transplants, but some foliar rot in these transplants was evident in the first planting (the Fall, 2006 transplanting experiment). Clipping the grass plants in the flats when they were about 6 inches tall (the two Spring, 2007 transplanting experiments) about one month prior to transplanting in the field resulted in large transplants that seemed healthier going to the field.

2. Mechanized transplanting worked well in these experiments (Fall, 2006 and Spring, 2007, PRE experiments), as did hand-transplanting (Spring, 2007, PRE and POST experiment). If the site is suitable for cultivation prior to transplanting, a mechanized transplanter will be more efficient than hand-transplanting and the cultivation operation itself may greatly enhance perennial weed control (particularly if the weedy, non-native perennial vegetation is sprayed with Roundup about a week prior to cultivation). Cultivation should be considered as required for this equipment to be used, however, so if cultivation is not possible either due to regulations or physical nature of the site (rockiness, shallow soil, puddled water, etc.), transplanting by hand will be necessary. In either case, however, success of the grass planting will likely be enhanced by transplanting over seeding, and far less seed will be necessary to grow transplants than for seeding, whether using a drill or broadcast on the soil surface.

3. Even in plots with very poor weed control during the first summer after transplanting, annual weed growth is not expected to be a major concern, provided the native perennial grasses have successfully established. Many plots here had appreciable white clover coverage which, together with the grasses, may limit additional annual weed seed germination. White clover can be treated with several effective herbicides after the transplanted grasses are well-established, so presence of clover may end up being an advantage. Annual blue grass is difficult to remove from perennial grasses, but given that these grasses will be large and not grazed or harvested, they should close canopy in two to three years and likely eliminate the annual bluegrass over time. Once white clover and annual bluegrass are no longer present (and hopefully, all perennial grasses and broadleaf weeds are no longer present), transplanting with desirable native forb species should be possible.

(1) Fall transplanting with herbicides applied POST. Initial establishment from this transplanting date (October 31) was poor (Table 1). Blue wildrye establishment was quite sporadic, ranging from 1 to 3 living plants/row at 16 months after transplanting (MAT) (5 plants were transplanted initially). Alaska brome fared better, with establishment ranging from 1.7 to 4.3 living plants/row, while Roemer's fescue completely failed to establish. This effect was likely due to the lateness of the planting and not due to herbicide effects, as the trend was evident regardless of which herbicide was used and in the non-treated check plots. The quality of the transplants may also have been suspect, as grass canopy in the greenhouse flats was excessively thick prior to cutting (about one month prior to transplanting). Some foliage had died and may have resulted in

a transplant susceptible to diseases in the field, or a transplant already infected with a pathogen. Farmers considering seeding grass are advised to do so before the end of September, and it appears that transplanting of Roemer's fescue and blue wildrye may be similarly negatively affected by fall conditions. Alaska brome, however, established fairly well in this trial, so fall transplanting may be a good option for that species.

The following are descriptions from observations made in the second February after transplanting, following two applications of herbicide and one mid-season mowing during the first summer:

* Aim slightly injured Alaska brome at 8 MAT but gave very poor initial weed control. The only plants in the 100% cover at 16 MAT were Alaska brome seedlings (?) and white clover.
* Nortron slightly injured Alaska brome at 8 MAT but gave very poor weed control. Resultant cover at 16 MAT was about 69%, with common groundsel, pineapple-weed, and purple deadnettle the predominant weeds. Some Alaska brome seedlings (?) were also present.
* Karmex did not injure any of the grass species at 8 MAT but gave good weed control. Resultant cover at 16 MAT was 32%, with ivyleaf speedwell, common chickweed, creeping bentgrass, and white clover the predominant weed species. Some Alaska brome seedlings (?) were also present.
* Chateau slightly injured Alaska brome at 8 MAT but gave excellent poor weed control. Resultant cover at 16 MAT was about 23%, with some white clover and some Alaska brome seedlings (?) present.
* Goal did not injure any of the grass species at 8 MAT but gave fair weed control. Resultant cover at 16 MAT was 85%, with common chickweed and white clover the predominant weed species. Alaska brome seedlings (?) were also present.
* Bronate did not injure any of the grass species at 8 MAT but gave very poor weed control. The only plants in the 100% cover at 16 MAT were white clover and creeping bentgrass. Many Alaska brome seedlings (?) were also present.
* Weedar + Banvel slightly injured Alaska brome at 8 MAT but gave very poor initial weed control. Weeds in the 97% cover at 16 MAT were white clover and the grass weeds creeping bentgrass, annual bluegrass, and annual ryegrass. Alaska brome seedlings (?) were also present.
* Beacon did not injure any of the grass species at 8 MAT; in fact, this was the treatment resulting in the greatest establishment of blue wildrye (3 plants/row). It gave very poor weed control, however. Resultant cover at 16 MAT was 47%, with annual ryegrass, white clover and creeping bentgrass the predominant weeds present. Many Alaska brome seedlings (?) were also present.
* Starane did not injure any of the grass species at 8 MAT but gave very poor weed control. Resultant cover at 16 MAT was 93%, with annual ryegrass, white clover, annual bluegrass, and several mustard weeds (tall hedgemustard, western bittercress, and shepherd's-purse) present. There were also many Alaska brome seedlings (?) present.

Table 1. Effect of POST herbicides on three native perennial grasses transplanted in the fall[1].

Treatment[2]	Rate	Grass[3] stand			Weed control[4]	Vegetation cover[5]
		AB	RF	BW		
	product/a	no./row	no./row	no./row	%	%
Aim	2 fl.oz	2.3	0.0	1.7	7	100
Nortron	2.9 pt	1.7	0.0	1.3	0	69
Karmex	2 lbs	3.3	0.0	1.0	55	32
Chateau	11 oz	2.3	0.0	1.0	95	23
Goal	1 pt	3.7	0.0	1.0	73	85
Bronate	2 pts	4.3	0.0	1.0	22	100
Weedar + Banvel	2 pts + 2 pts	3.0	0.0	1.3	8	97
Beacon	0.76 oz	3.3	0.0	3.0	35	47
Starane	10.7 fl.oz	3.7	0.0	1.3	0	93
Non-treated	---	4.0	0.0	1.3	0	100
$LSD_{0.05}$	---	0.7			18	23

[1]Grasses transplanted October 10, 2006.
[2]Herbicides applied December 23, 2006 and July 26, 2007; Beacon was mixed with 0.25% (v/v) nonionic surfactant (R-11) prior to each application.
[3]Grasses: AB = Alaska brome, RF = Roemer's fescue, BW = blue wildrye; stand evaluated June 26, 2007.
[4]Weed control estimated June 26, 2007.
[5]Percent vegetation cover estimated February 16, 2008.

(2) Spring transplanting with herbicides applied POST. Native grass establishment was excellent in this trial (Table 2). All species successfully established in non-treated check plots (5 plants per row were initially transplanted), all Alaska brome plants established in treated plots. With the exception of plots treated with Karmex (0 plants per row established), Nortron (3.7 plants), or Beacon (4 plants), Roemer's fescue establishment was also 5 plants per row. Blue wildrye was slightly injured by Nortron or Starane (4.3 plants established per row), but other treatments resulted in from 4.7 to 5 established plants per row.

The following are descriptions of observations made in February, at 9 months after transplanting and about four months after the second of two herbicide applications:

* Aim didn't cause much injury to any species. Summer weed control was fair initially (70%), but was very poor (22%) by February. Aim may help with burndown of broadleaf weeds, but will likely require addition of a residual herbicide if initial weed control is to be maintained.
* Nortron caused slight to severe injury to these species, although damage was generally not enough to cause plant death. Weed control was poor (25 and 63% in June and February, respectively), so this product does not seem to be the best choice for these types of applications during the transplanting year.
* Karmex caused severe damage to Roemer's fescue, resulting in complete plant kill. Alaska brome and blue wildrye showed injury from Karmex application, but plants still survived. Weed control with Karmex was excellent at 92%, so perhaps Karmex is best used only after grasses have fully established.
* Chateau caused slight to moderate injury to these species, but all plants survived the treatments.

Weed control was fair at 75%, so this product may be one to consider for this registration.

* Goal caused moderate to severe injury to these grass species, but resulted in 82% and 68% weed control in June and February, respectively. Grass establishment was excellent, similar to non-treated plants.
* Bronate did not injure any of the grass species, but weed control went from 73% in June to 27% in February. Bronate will likely require addition of a residual herbicide to provide adequate weed control.
* Weedar + Banvel caused only slight injury to Roemer's fescue and blue wildrye while weed control was still 77% in February after two applications. This combination (same as for the pre-mix Weedmaster) looks to promising for this use and is currently registered.
* Beacon caused slight grass injury, but reduced the establishment of only Roemer's fescue. Weed control in February was 83% and looks promising for registration of this use.
* Starane did not injure any of the grass species but gave 53% weed control in February. Starane used in early and followed by other products might be a good strategy for weed management on these sites.

Table 2. Effect of POST herbicides on three native perennial grasses transplanted in the spring[1].

Treatment[2]	Rate	Grass[3] injury 1			Grass[3] injury 2			Grass[3] stand			Weed control	
		AB	RF	BW	AB	RF	BW	AB	RF	BW	6/26/07	2/16/08
	Product/a	%	%	%	%	%	%	no./row	no./row	no./row	%	%
Aim	2 fl.oz	5	17	2	20	36	33	5.0	4.7	5.0	70	22
Nortron	2.9 pt	0	22	3	67	87	77	5.0	3.7	4.3	25	63
Karmex	2 lbs	2	7	2	40	100	73	5.0	0.0	4.7	40	92
Chateau	11 oz	15	20	0	37	73	43	5.0	5.0	5.0	64	75
Goal	1 pt	28	40	23	33	67	50	5.0	4.7	4.7	82	68
Bronate	2 pts	2	20	2	27	47	37	5.0	5.0	5.0	73	27
Weedar + Banvel	2 pts + 2 pts	7	18	3	30	53	47	5.0	5.0	4.7	55	77
Beacon	0.76 oz	0	15	2	47	50	50	5.0	4.0	5.0	32	83
Starane	10.7 fl.oz	3	20	2	20	30	33	5.0	5.0	4.3	55	53
Non-treated	---	0	10	0	23	37	30	5.0	5.0	5.0	0	0
$LSD_{0.05}$	---	4			11			0.5			25	16

[1]Grasses transplanted May 14, 2007.

[2]Herbicides applied June 19, 2007 and October 26, 2007; Beacon was mixed with 0.25% (v/v) nonionic surfactant (R-11) prior to each application.

[3]Grasses: AB = Alaska brome, RF = Roemer's fescue, BW = blue wildrye; injury estimated June 26, 2007 and February 16, 2008; stand evaluated February 16, 2008.

(3) Spring transplanting with herbicides applied PRE and POST. Late-June was likely too late to transplant these seedlings without supplemental irrigation, as grass stand was generally lower than in the preceding trial (mid-May transplanting) (Table 3). Roemer's fescue performed the best with plant counts ranging from 4.3 to 5 plants per row (five plants were transplanted per row). Karmex treatment, however, resulted in only 1.3 Roemer's fescue plants per row establishing. Establishment ranged from 1.3 to 3.7 plants per row for Alaska brome and from 2.7 to 4 for blue wildrye. All species showed greater injury in February when treated with herbicide than did non-treated grass plants, although some of the damage could have resulted from grass herbicide application in August. Alaska brome was particularly susceptible to Fusilade

application (94% injury and 0.6 plants per row) compared to injury from Poast or Select (Table 4). Roemer's fescue was injured 41 to 64% by grass herbicides, while blue wildrye was severely damaged by all three herbicides (73 to 88% injury). Based on establishment numbers, it appears that Select is the softest grass herbicide on all three species (4.8, 4.4, and 4.5 plants per row for Alaska brome, Roemer's fescue, and blue wildrye, respectively), although Roemer's fescue also tolerates Fusilade fairly well (4.5 plants per row).

Table 3. Effect of PRE and POST herbicides on three native perennial grasses transplanted in the spring[1].

Treatment[2]	Timing	Rate	Grass[3] stand			Grass[3] injury		
			AB	RF	BW	AB	RF	BW
		product/a	number/row	number/row	number/row	%	%	%
Dual Magnum	PRE	1 pt	3.7	4.3	4.7	67	50	77
Goal	PRE	13 fl.oz	3.7	4.3	3.7	80	60	80
Karmex	PRE	2 lbs	1.3	1.3	4.0	60	77	83
Axiom	PRE	10 oz	2.7	4.7	2.7	70	57	77
Prowl	PRE	5 pt	3.0	5.0	4.3	70	33	77
Milestone	POST	7 fl.oz	2.7	5.0	2.7	77	50	83
Transline	POST	10.7 fl.oz	3.7	4.0	3.7	63	57	80
Non-treated	---	---	3.3	4.3	4.0	53	40	67
$LSD_{0.05}$	---	---	0.9			9		

[1]Grasses transplanted June 25, 2007.
[2]PRE herbicides applied June 26, 2007; POST herbicides (Milestone and Transline) applied August 9, 2007; all plots within a given replicate were also treated with Poast (Rep 1), Fusilade (Rep 2), or Select (Rep 3) mixed with crop oil (1%, v/v) POST August 30, 2007.
[3]Grasses: AB = Alaska brome, RF = Roemer's fescue, BW = blue wildrye; stand evaluated February 16, 2008. Injury includes winter senescence and damage from grass herbicides applied the previous fall.

Table 4. Effect of Fuslilade, Poast, and Select (POST) on three native perennial grasses transplanted in the spring[1] (non-replicated data).

Treatment[2]	Rate	Grass[3] stand at 6 MAT			Grass[3] injury at 6 MAT		
		AB	RF	BW	AB	RF	BW
	product/a	number/row	number/row	number/row	%	%	%
Fusilade	8 fl.oz	0.6	4.5	2.9	94	41	88
Poast	2.5 pt	3.6	3.5	3.8	54	54	73
Select	6 fl.oz	4.8	4.4	4.5	55	64	74

[1]Grasses transplanted June 26, 2007.
[2]Herbicides applied August 30, 2007; all were mixed with 1% (v/v) crop oil concentrate prior to application.
[3]Grasses: AB = Alaska brome, RF = Roemer's fescue, BW = blue wildrye; injury and stand evaluated February 16, 2008.

Conclusions.

Transplanting Alaska brome, Roemer's fescue and blue wildrye appeared to be most successful in mid-May, as opposed to late-June or early-October. Once in the ground, various products resulted in good weed control with various levels of grass injury and little negative effect on establishment. Products that looked the best were:

Fall-transplanting (Table 1):

Alaska brome: Final grass stand was good, but stand and weed control were maximized with two (dormant and summer) POST applications of Goal, Karmex, Beacon, or Bronate.

Roemer's fescue: No seedlings established in this planting.

Blue wildrye: Final grass stand was poor, but stand and weed control were maximized with two (dormant and summer) POST Beacon applications.

May transplanting (Table 2):

Alaska brome: Final grass stand was excellent at 8 MAT regardless of herbicide; weed control was maximized with two (spring and summer) POST applications of Goal, Bronate, or Aim.

Roemer's fescue: Final grass stand was excellent at 8 MAT except when treated with Karmex or Nortron; weed control was maximized with two (spring and summer) POST applications of Goal, Bronate, or Aim.

Blue wildrye: Final grass stand was excellent at 8 MAT except when treated with Nortron; weed control was maximized with two (spring and summer) POST applications of Goal, Bronate, or Aim.

June transplanting (Table 3):

Alaska brome: Final grass stand was good at 8 MAT except when treated with Karmex POST the day after transplanting.

Roemer's fescue: Final grass stand was excellent at 8 MAT except when treated with Karmex POST the day after transplanting.

Blue wildrye: Final grass stand was good at 8 MAT except when treated with Axiom POST the day after transplanting.

June transplanting (Table 4):

Grass herbicides (Fusilade, Poast, and Select) applied POST at 2 months after transplanting caused severe injury to all grass species by 6 MAT; it appeared, however, that Alaska brome tolerated Poast and Select better than Fusilade, that Roemer's fescue tolerated Fusilade and Select better than Poast, and blue wildrye tolerated Select better than Fusilade or Poast.