Warm season grass establishment systems in 1999 with 2000 residual year yields at Rosemount, MN Becker, Roger L., Craig C. Sheaffer, Douglas W. Miller, Douglas R. Swanson, and Bradley D. Kinkaid. The objective of this study was to observe the effects of various herbicide treatments and cultural establishment methods on weed control, crop injury, and establishment of five warm season grass species and a prairie wildflower mixture. The experiment was established in 1999 at Rosemount, MN on a Waukegon silt loam soil. The previous crop was soybeans. The plot area was chisel plowed the previous fall. In April 1999, 50 lbs/A N was applied and the plot area was disked once. On June 15, the area was disked once, field cultivated once, and tilled with a C-shank field cultivator/cultipacker. Oat treatments were seeded with a drill at 64 lbs/A. Big bluestem (cv. 'Bison'), sideoats grama (cv. 'Pierre'), Indiangrass (cv. 'Holt'), little bluestem (variety not stated), switchgrass (cv. 'Sunburst'), and a wildflower mix were seeded with a cone type seeder on June 16 at rates of 10, 10, 10, 7, 5, and 5 pounds pure live seed per acre, respectively. The experimental design was a split block. Whole plots were grass species or the wildflower mix planted in strips 5 feet wide. Sub plots consisted of preemergence or postemergence herbicide treatments or combinations of oat cover crop and clipping treatments. The sub plot treatments were applied to strips 10 feet wide across the six whole plot strips. Preemergence herbicide treatments were applied on June 17. The sethoxydim treatment was applied on July 7 to 5" to 7" oats, warm season grass species were emerging and were up to two inches tall. All other postemergence herbicide applications were made on July 13 to 1 to 3 inch warm season grasses. The clipping treatment was applied late July (after emergence of warm season grasses) when weeds were 12-20 inches tall and the oats were in the late boot stage. Yields were measured on July 27, 2000.

Application data

Treatment	Preemergence	Postemergence	Postemergence
Date Treated	6-17-99	7-7-99	7-13-99
Time		6:00 am	
Colq			
Density (#/ft^2)	--	--	1
Height (inch)	--	--	1.6
Ebns			
Density (#/ft^2)	--	--	4.6
Height (inch)	--	--	0.5-4
Rrpw			
Density (#/ft^2)	--	--	1.8
Height (inch)	--	--	3-5
Vele			
Density (#/ft^2)	--	--	0.2
Height (inch)	--	--	3-5
Grass species			
Height (inch)	--	2-5	1.5-9
Gift			
Density (#/ft^2)	--	--	2.2
Yeft			
Density (#/ft^2)	--	--	2.2
Smgr			
Density (#/ft^2)	--	--	1.2
Bygr			
Density (#/ft^2)	--	--	0.8
Wocg			
Density (#/ft^2)	--	--	0.2
Oats			
Height (inch)	--	5-7	--
Stage	--	4 leaf	--
Tillers	--	1-2	--

Application data (cont.)

Treatment	Preemergence	Postemergence	Postemergence
Date Treated	6-17-99	7-7-99	7-13-99
Wind (mph)	0-2 W	calm	10 S
Temperature (°F)			
Air	66	62	69
Soil	66	68	63
Soil Moisture	moist at 1"	--	moist at 0.75"
Relative Humidity (%)	43	70	63
Cloud Cover (%)	0	0	80
Rainfall before Application			
Week 1 (inch)	1.28	2.68	0.53
Rainfall after Application			
Week 1 (inch)	0.95	0.52	0.55
Week 2 (inch)	0.58	0.56	3.75

Wildflowers were a commercial mix[a] containing:

Species	%	Species	%
Purple coneflower	10.8	Indian blanket	2.75
Lance-leaved coreopsis	10.6	Prairie coneflower	2.33
Blue flax	8.84	Evening primrose	2.00
Dames's rocket	8.51	Catchfly	2.00
Scarlet flax	7.45	Corn poppy	1.96
Cornflower	5.98	Prairie aster	1.95
Black-eyed susan	5.85	Blazing star	1.93
Blanketflower	5.58	Showy evening primrose	1.92
Annual baby's breath	5.13	Plains coreopsis	1.41
Shasta daisy	4.85	New England aster	0.99
Purple prairie clover	3.83	Baby snapdragon	0.57

[a] Peterson Seed Company
P.O. Box 346
Savage, MN 55378

Evaluations in 2000 showed that warm season native grasses did not establish well with any treatment in 1999 compared to the 1998 study that was reported in (N. Cent. Weed Sci. Soc. Res. Rpt. 56:68-75). Injury with imazapic was pronounced with many plots having no, or unacceptable stands of warm season grass seedlings (Tables 1,2, and 3). Annual grass weeds consisted of giant foxtail, yellow foxtail, woolly cupgrass, wild proso millet, large crabgrass and barnyardgrass. Giant foxtail was the most common species with scattered but intense patches of woolly cupgrass second most prevalent. Broadleaf weeds were common lambsquarter, redroot pigweed, velvetleaf, and eastern black nightshade. Common lambsquarter was the only species uniform enough to rate separately. The wildflower species were a prairie mix obtained from Peterson Seed Co., Shakopee, MN.

Imazapic treatments generally provided excellent grass control and good to excellent broadleaf control (Table 3). Preemergence applications of imazapic provided higher common lambsquarter control compared to post-emergence applications with both the 70 DF and the 2 L formulations. For reasons that are not clear, the 70 DF formulation of imazapic resulted in lower control of giant foxtail when applied preemergence and a trend for lower control when applied postemergence compared to equivalent rates of imazapic applied as the 2L formulation. The was also a trend for the 70 DF formulation to result in lower

control of common lambsquarter applied PRE or POST compared to equivalent rates of the 2 L formulation.

In general, control of giant foxtail and other annual grasses was slightly better with POST applications compared to PRE applications of imazapic, but common lambsquarter control was slightly better with PRE applications compared to POST applications of imazapic. Generally speaking, the scattered velvetleaf, redroot pigweed, and eastern black nightshade broadleaves were all controlled with any of the rates of imazapic used whether preemergence or postemergence. The addition of 2,4-D to imazapic did not alter annual grass weed control applied preemergence indicating that there was no residual impact of 2,4-D when soil applied, nor any antagonism of annual grass control when applied postemergence. 2,4-D did improve the performance of imazapic on common lambsquarter when applied postemergence at both the 0.0625 and the 0.125 lb ai rate but did not alter control of other broadleaf species. The addition of 2,4-D did not alter wildflower stand or species diversity when applied POST or PRE. Postemergence applications of imazapic resulted in a trend for lower wildflower stand reduction and a significantly improved species diversity for wildflower establishment compared to preemergence applications.

The use of glyphosate at planting, though applied to tilled, bare ground, did not have any putative impacts on wildflower growth and development or species number and absent injury, allowed higher levels of warm season grass establishment compared to imazapic treatments. This resulted in desirable species competition reducing presence of annual weeds and does not reflect control of annual weeds with glyphosate. The use of no herbicides, clipping, oat companion crop or oat mulch residue systems (removing oat with sethoxydim) resulted in higher species diversity and increased stands of wildflowers compared to all PRE applications of imazapic and compared to some POST treatments of imazapic. The highest species diversity of wildflowers was achieved in the oat mulch treatment. Two wildflower species notable by their absence in the imazapic treatments were Dame's rocket and evening primrose. Dame's rocket is a mustard species and therefore intolerance to imazapic is not surprising.

For the warm season grass species, imazapic tended to show increased stand reduction injury when applied PRE compared to POST. This was most apparent with switchgrass and sideoats grama species (Table 1). All warm season grass species showed a trend for lower stand reductions when 2,4-D was added to imazapic when imazapic was applied postemergence. This appears to be a beneficial antagonism of 2,4-D on postemergence activity of imazapic on warm season grass species. The results of this study indicate that rate of 0.047 lb ai imazapic should be used for the establishment of switchgrass species, the lowest rate tested in this study. Sideoats grama should have the same 0.047 rate recommendation if imazapic is to be applied preemergence, but 0.0625 lb ai imazapic could be recommended postemergence. The 0.0625 lb postemergence rate appears to be the best use rate for both preemergence and postemergence applications of imazapic for indiangrass, big bluestem, and little bluestem (Tables 2 and 3). As noted for the performance of imazapic on weed control, the 70 DF formulation of imazapic also appeared to cause less desirable warm season grass injury compared to the same rate of imazapic applied as a 2L formulation. The no herbicide, clip as needed, and oat companion crop clipped as needed treatments did not result in herbicide injury, however the competition from annual weeds did significantly impact warm season grass stand establishment and did cause lingering growth reduction of desirable grass seedlings that did establish. Overall, competition from weeds from not using imazapic was more detrimental to establishment of warm season grasses, except switchgrass, than was desirable grass species injury from the use of imazapic. The same can not be said for the establishment of a broad number of species of wildflowers. The oat mulch system treatment had severe injury on warm season grass species because the native species were beginning to emerge at the time of sethoxydim application to control the oat companion crop resulting in high mortality of warm season grass seedlings. (Department of Agronomy and Plant Genetics, University of Minnesota, St. Paul).

Table 1. Warm season grass establishment systems in 1999 with 2000 residual yields at Rosemount, MN (Becker et al.).

		Side Oats Grama			Switchgrass		
		6/14/00			6/14/00		
Treatment	Rate	S.R.[1]	G.R.[2]	Yield	S.R.	G.R.	Yield
	(lb ai/A)	------ (%) ------		(Ton/A)	------ (%) ------		(Ton/A)
(Preemergence June 17)							
Imazapic 2L + Silkin[3]	0.047 + 0.25%	70	8	1.43	63	11	1.97
Imazapic 2L + Silkin	0.063 + 0.25%	78	26	0.88	82	20	1.99
Imazapic 2L +2,4-D amine + Silkin	0.063 + 0.125 + 0.25%	81	18	0.59	88	20	1.39
Imazapic 2L + Silkin	0.125 + 0.25%	99	35	0.05	98	68	0.00
Imazapic 2L +2,4-D amine + Silkin	0.125 + 0.25 + 0.25%	99	20	0.01	98	61	0.01
Imazapic 70DF +Silkin	0.063 + 0.25%	28	12	1.84	52	12	3.28
Glyphosate[4]	1.0	38	45	1.10	62	34	2.38
(Postemergence July 13)							
Imazapic 2L +Silkin	0.047 + 0.25%	28	33	1.67	66	20	3.07
Imazapic 2L +Silkin	0.063 + 0.25%	25	36	1.35	74	30	2.32
Imazapic 2L +2,4-D amine + Silkin	0.063 + 0.125 + 0.25%	6	10	2.60	46	10	3.43
Imazapic 2L + Silkin	0.125 + 0.25%	64	48	0.36	89	26	0.89
Imazapic 2L +2,4-D amine + Silkin	0.125 + 0.25 + 0.25%	49	37	1.01	73	16	2.24
IImazapic 70DF +Silkin	0.063 + 0.25%	14	28	1.63	48	10	3.11
Check	--	30	41	0.80	70	44	1.77
No herbicide + clip	--	51	59	0.85	75	52	1.39
Oat companion + clip	--	61	64	0.38	76	60	1.18
Oat companion + (sethoxydim + COC)[5]	(0.188 + 1.25%)	86	73	0.13	99	98	0.01
LSD (0.05)		27	28	0.84	29	27	1.00

[1] S.R. = Stand reduction.
[2] G.R. = Growth reduction.
[3] Silkin = surfactant.
[4] Glyphosate = Roundup Ultra used as a postemergence burndown preplant.
[5] Poast Plus 1E + Class crop oil concentrate applied postemergence July 7, 1999

Table 2. Warm season grass establishment systems in 1999 with 2000 residual yields at Rosemount, MN (Becker et al.).

		Indiangrass			Big Bluestem		
		6/14/00			6/14/00		
Treatment	Rate	S.R.[1]	G.R.[2]	Yield	S.R.	G.R.	Yield
	(lb ai/A)	------ (%) ------		(Ton/A)	------ (%) ------		(Ton/A)
(Preemergence June 17)							
Imazapic 2L + Silkin[3]	0.047 + 0.25%	28	8	2.76	63	4	2.82
Imazapic 2L + Silkin	0.063 + 0.25%	70	2	2.28	64	25	1.87
Imazapic 2L +2,4-D amine + Silkin	0.063 + 0.125 + 0.25%	54	10	1.74	80	16	2.36
Imazapic 2L + Silkin	0.125 + 0.25%	85	38	1.21	88	60	1.22
Imazapic 2L +2,4-D amine + Silkin	0.125 + 0.25 + 0.25%	93	47	0.49	94	69	0.72
Imazapic 70DF +Silkin	0.063 + 0.25%	48	11	1.67	42	8	2.37
Glyphosate[4]	1.0	71	73	0.25	51	34	0.61
(Postemergence July 13)							
Imazapic 2L +Silkin	0.047 + 0.25%	52	36	0.76	41	36	2.08
Imazapic 2L +Silkin	0.063 + 0.25%	64	38	1.32	59	41	1.80
Imazapic 2L +2,4-D amine + Silkin	0.063 + 0.125 + 0.25%	21	11	2.52	38	14	2.89
Imazapic 2L + Silkin	0.125 + 0.25%	62	28	0.92	81	42	1.93
Imazapic 2L +2,4-D amine + Silkin	0.125 + 0.25 + 0.25%	60	22	2.78	56	36	2.50
IImazapic 70DF +Silkin	0.063 + 0.25%	50	40	1.22	42	24	2.13
Check	--	72	66	0.29	44	20	0.37
No herbicide + clip	--	80	77	0.48	70	42	0.58
Oat companion + clip	--	96	77	0.12	62	69	0.28
Oat companion + (sethoxydim + COC)[5]	(0.188 + 1.25%)	99	90	0.00	99	93	0.00
LSD (0.05)		25	28	0.93	34	33	0.88

[1] S.R. = Stand reduction.
[2] G.R. = Growth reduction.
[3] Silkin = surfactant.
[4] Glyphosate = Roundup Ultra used as a postemergence burndown preplant.
[5] Poast Plus 1E + Class crop oil concentrate applied postemergence July 7, 1999

Table 3. Warm season grass establishment systems in 1999 with 2000 residual yields at Rosemount, MN (Becker et al.).

		Little Bluestem 6/14/00			Weed Control (8/31/99)			Wildflowers 6/14/00
Treatment	Rate	S.R.[1]	G.R.[2]	Yield	Grass	Colq	Brdlfs	S.R.
	(lb ai/A)	------ (%) ------		(Ton/A)	---------- (%) ----------			
(Preemergence June 17)								
Imazapic 2L + Silkin[3]	0.047 + 0.25%	34	8	2.22	88	99	98	87
Imazapic 2L + Silkin	0.063 + 0.25%	45	14	2.64	96	99	99	86
Imazapic 2L +2,4-D amine + Silkin	0.063 + 0.125 + 0.25%	58	9	1.82	96	98	99	87
Imazapic 2L + Silkin	0.125 + 0.25%	81	55	1.10	99	99	83	94
Imazapic 2L +2,4-D amine + Silkin	0.125 + 0.25 + 0.25%	80	38	0.77	99	99	99	99
Imazapic 70DF +Silkin	0.063 + 0.25%	49	44	1.45	42	78	99	80
Glyphosate[4]	1.0	93	86	0.14	31	16	0	69
(Postemergence July 13)								
Imazapic 2L +Silkin	0.047 + 0.25%	56	37	2.12	95	58	99	68
Imazapic 2L +Silkin	0.063 + 0.25%	51	50	1.72	96	49	99	79
Imazapic 2L +2,4-D amine + Silkin	0.063 + 0.125 + 0.25%	46	9	2.53	98	97	99	70
Imazapic 2L + Silkin	0.125 + 0.25%	66	53	1.86	99	76	99	92
Imazapic 2L +2,4-D amine + Silkin	0.125 + 0.25 + 0.25%	45	19	2.39	99	99	99	83
IImazapic 70DF +Silkin	0.063 + 0.25%	73	67	1.14	76	35	99	70
Check	--	77	73	0.50	20	15	10	59
No herbicide + clip	--	82	70	0.30	31	60	50	60
Oat companion + clip	--	94	84	0.16	66	84	95	54
Oat companion + (sethoxydim + COC)[5]	(0.188 + 1.25%)	99	90	0.01	50	0	0	50
LSD (0.05)		23	28	0.95	30	22	16	ns

[1] S.R. = Stand reduction.
[2] G.R. = Growth reduction.
[3] Silkin = surfactant.
[4] Glyphosate = Roundup Ultra used as a postemergence burndown preplant.
[5] Poast Plus 1E + Class crop oil concentrate applied postemergence July 7, 1999