Control of spotted knapweed and leafy spurge with chlorsulfuron applied alone or with various herbicides. Rodney G. Lym. (Plant Sciences Department, North Dakota State University, Fargo, ND 58105). Previous research at North Dakota State University found that metsulfuron controls some troublesome weeds, such as scentless chamomile (*Matricaria chamomilla* L.) and fringed sage (*Artemisia frigida* Willd.), which are difficult to control with commonly used auxin-type herbicides in pasture and rangeland. Chlorsulfuron tends to have a wider weed control spectrum and longer residual than metsulfuron. The purpose of this research was to evaluate chlorsulfuron applied alone or with metsulfuron or various auxin herbicides for control of spotted knapweed and leafy spurge.

The spotted knapweed experiments were established on June 9, 2004, on a dense infestation near Hawley, MN. Treatments were applied using a hand-held boom sprayer delivering 17 gpa at 35 psi. The plots were 10 by 30 feet and replicated three times in a randomized complete block design. Spotted knapweed was in the rosette to early-bolt growth stage and 1 to 8 inches tall. The first experiment evaluated spotted knapweed control with chlorsulfuron applied alone or with clopyralid or picloram while the second experiment evaluated chlorsulfuron applied with metsulfuron. Control was based on a visual estimate of percent stand reduction as compared to the untreated check.

Chlorsulfuron applied alone or with metsulfuron did not provide satisfactory control of spotted knapweed (Tables 1 and 2). Spotted knapweed control averaged 93% 12 MAT (months after treatment) when chlorsulfuron was applied with clopyralid or picloram at 4 oz/A. Spotted knapweed control 12 MAT tended to decline when chlorsulfuron was applied with clopyralid at 2 oz/A and only averaged 58% compared to 88% with clopyralid alone.

The third experiment was established to evaluate leafy spurge control with chlorsulfuron applied alone or with metsulfuron. The experiment was established on a dense leafy spurge stand near Walcott, ND, on June 7, 2004. Herbicides were applied as previously described and the experimental design was similar except the plots were 9 by 30 feet.

Chlorsulfuron applied alone or with metsulfuron did not control leafy spurge at any rate evaluated (Table 3). The standard treatment of picloram plus 2,4-D at 3 and 12 MAT provided 73 and 58% leafy spurge control, respectively.

In summary, chlorsulfuron applied alone or with metsulfuron did not provide satisfactory control of either spotted knapweed or leafy spurge. Weed control with chlorsulfuron applied with clopyralid or picloram was not better than the auxin-type herbicides applied alone.

Table 1. Spotted knapweed control with chlorsulfuron applied alone or with picloram applied on June 9, 2004, near Hawley. MN.

Treatment[1]	Rate	Months after treatment 2	3	12
	oz/A	% control		
Chlorsulfuron	0.75	0	0	0
Chlorsulfuron	1.5	7	8	0
Chlorsulfuron + clopyralid	0.75 + 2	56	44	59
Chlorsulfuron + clopyralid	0.75 + 4	85	99	100
Chlorsulfuron + clopyralid	1.5 + 2	63	61	57
Chlorsulfuron + clopyralid	1.5 + 4	88	99	98
Clopyralid	2	73	95	88
Clopyralid	4	95	99	99
Chlorsulfuron + picloram	0.75 + 4	85	97	95
Chlorsulfuron + picloram	1.5 + 4	64	90	79
Picloram	4	56	96	95
LSD (0.05)		18	26	16

[1] Surfactant Kinetic at 0.125% by Helena Chemical Co., Memphis, TN, was applied with all treatments.

Table 2. Spotted knapweed control with metsulfuron and/or chlorsulfuron applied on June 9, 2004, near Hawley, MN.

Treatment[1]	Rate	Months after treatment 2	3	12
	oz/A	% control		
Metsulfuron + chlorsulfuron	0.15 + 0.166	11	3	3
Metsulfuron + chlorsulfuron	0.3 + 0.375	13	10	0
Metsulfuron + chlorsulfuron	0.6 + 0.75	39	22	0
Metsulfuron + chlorsulfuron	0.15 + 0.046	8	3	3
Metsulfuron + chlorsulfuron	0.3 + 0.0938	11	2	3
Metsulfuron + chlorsulfuron	0.6 + 0.188	12	12	3
Metsulfuron + chlorsulfuron	0.0375 + 0.188	2	0	0
Metsulfuron + chlorsulfuron	0.075 + 0.375	8	2	2
Metsulfuron + chlorsulfuron	0.60 + 0.75	23	15	3
Chlorsulfuron	0.188	0	0	0
Chlorsulfuron	0.375	3	0	3
Chlorsulfuron	0.75	8	0	0
Picloram + 2,4-D	8 + 16	100	100	100
LSD (0.05)		5	9	7

[1] Methylated seed oil at 1 qt/A, Scoil by AGSCO, Grand Forks, ND, was applied with treatments except picloram plus 2,4-D.

Table 3. Leafy spurge control with metsulfuron and/or chlorsulfuron applied on June 7, 2004, near Walcott, ND.

Treatment[1]	Rate	Months after treatment		
		2	3	12
	oz/A	% control		
Metsulfuron + chlorsulfuron	0.15 + 0.166	20	5	3
Metsulfuron + chlorsulfuron	0.3 + 0.375	3	2	5
Metsulfuron + chlorsulfuron	0.6 + 0.75	33	13	5
Metsulfuron + chlorsulfuron	0.15 + 0.046	8	3	0
Metsulfuron + chlorsulfuron	0.3 + 0.0938	5	2	3
Metsulfuron + chlorsulfuron	0.6 + 0.188	28	7	0
Metsulfuron + chlorsulfuron	0.0375 + 0.188	0	0	0
Metsulfuron + chlorsulfuron	0.075 + 0.375	3	0	0
Metsulfuron + chlorsulfuron	0.60 + 0.75	7	3	2
Chlorsulfuron	0.188	3	0	0
Chlorsulfuron	0.375	0	0	0
Chlorsulfuron	0.75	0	2	5
Picloram + 2,4-D	8 + 16	91	73	58
LSD (0.05)		33	14	10

[1] Methylated seed oil at 1 qt/A, Scoil by AGSCO, Grand Forks, ND, was applied with all treatments except picloram plus 2,4-D.

Control of invasive weeds with aminopyralid in North Dakota. Rodney G. Lym and Luke W. Samuel. (Plant Sciences Department, North Dakota State University, Fargo, ND 58105). Aminopyralid is a member of the pyridinecarboxylic acid family of herbicides and controls several noxious weed species at lower use rates than other auxin-type herbicides. The purpose of this research was to evaluate various timing and use rates of aminopyralid for control of absinth wormwood, Canada thistle, leafy spurge, and perennial sowthistle.

Aminopyralid was spring- or fall-applied at rates ranging from 0.75 oz ae/A to the maximum potential use rate of 1.75 oz/A in all experiments. Herbicides were applied using a hand-held boom sprayer delivering 17 gpa at 35 psi. Experimental plots were 10 by 30 feet and replicated three or four times in a randomized complete block design at two locations for all species, except leafy spurge had one location. Control of each species was evaluated visually using percent stand reduction compared to the untreated control. Results were compared to a standard herbicide applied at the general use rate for each weed species.

An experiment to evaluate control of absinth wormwood, Canada thistle, and perennial sowthistle with aminopyralid applied alone in the spring or fall was established near Jamestown, ND. Treatments were applied June 4 or October 6, 2003. Spring-applied treatments were to absinth wormwood actively growing and 12 to 24 inches tall, Canada thistle 12 to 18 inches tall, and perennial sowthistle 6 to 12 inches tall. Canada thistle and perennial sowthistle were in the rosette to early bolt growth stage. Fall-applied treatments were to absinth wormwood, Canada thistle, and perennial sowthistle rosettes, which developed after the plants had been mowed in July.

Absinth wormwood control 12 MAT (months after treatment) for spring or 9 MAT for fall treatments by aminopyralid averaged 98% regardless of rate or date or treatment (Table 1). Canada thistle control 12 MAT with spring-applied aminopyralid averaged 85% over all rates, compared to 65% over all rates for fall-applied aminopyralid. Canada thistle control 12 MAT with spring- or fall-applied picloram at 6 oz/A was 90 and 83%, respectively, whereas spring- or fall-applied clopyralid provided 70 and 19% control, respectively. Canada thistle control 15 MAT with spring-applied aminopyralid decreased to approximately 27% on all rates, compared to picloram and clopyralid at 6 oz/A with 40 and 17% control, respectively. Perennial sowthistle control 12 and 9 MAT with spring-applied or fall-applied aminopyralid was approximately 95% regardless of rate.

A second study was established at two locations to further evaluate aminopyralid applied alone or with 2,4-D for absinth wormwood control near Eckelson and near Jamestown. Treatments were applied May 27, 2004, near Eckelson and Jamestown, ND, to 1 to 14 inch tall absinth wormwood.
Absinth wormwood control was similar whether aminopyralid was applied alone or with 2,4-D, but control varied by location (Table 2). Absinth wormwood control 3 MAT averaged 96% at Jamestown but only 84% at Eckelson. Control 12 MAT remained 90% or better at Jamestown when aminopyralid was applied at 1.5 oz/A or higher alone or with 2,4-D while the same treatments at Eckelson only averaged 62%. Absinth wormwood control with the standard treatment of picloram plus 2,4-D at 2 + 8 oz/A was also higher at Jamestown (90%) than Eckelson (36%). The decreased control at the Eckelson compared to Jamestown sites may have been due to high precipitation which caused flooding at Eckelson in the spring of 2005.
A third experiment was established to evaluate Canada thistle and perennial sowthistle control with aminopyralid on unused cropland near Fargo, ND. Herbicides were applied June 2 and October 1, 2003. Spring-applied treatments were on June 2, 2003, to Canada thistle and perennial sowthistle plants 4 to 8 inches tall in the rosette growth stage. Fall-applied treatments were on Oct. 1, 2003, to Canada thistle and perennial sowthistle rosettes, which developed after the plants had been mowed in July.

Canada thistle control was very high whether aminopyralid was spring- or fall-applied , averaging 95% 24 MAT,

and 97% 21 MAT, respectively (Table 3). Concurrently, Canada thistle control with picloram or clopyralid averaged 93 and 97% 24 or 21 MAT, respectively. Perennial sowthistle control with spring-applied aminopyralid over all rates averaged 95% 15 MAT with fall-applied aminopyralid averaged 98% 12 MAT.

A fourth experiment was established to further evaluate Canada thistle control with aminopyralid near Jamestown and Fargo, ND. Spring treatments were applied June 3, 2004 to 14 to 16 inch tall Canada thistle in the early bolt growth stage at Jamestown, and June 4, 2004 to Canada thistle rosettes that were 6 to 8 inches tall at Fargo. The Jamestown site was disturbed in September 2004 so no further evaluations could be made. The fall treatments in Fargo were applied September 30, 2004, to Canada thistle rosettes that were 4 to 8 inches tall after the plants had been mowed in July 2004.

Canada thistle control at Fargo 3 MAT with aminopyralid averaged 98% regardless of rate, but at Jamestown 3 MAT ranged from 81 to 93% when aminopyralid was applied from 1.25 to 1.75 oz/A (Table 4). Canada thistle control 3 MAT by picloram plus 2,4-D at 4 + 30 oz/A was 85 and 89% at Fargo and Jamestown, respectively, while control with clopyralid plus 2,4-D at 4 + 24 oz/A averaged 89 and 59%, respectively. Differences in Canada thistle control may have been due to increased Canada thistle density and cover at Jamestown compared to Fargo.

Leafy spurge control with aminopyralid applied in the spring or fall was evaluated near Ekre, ND. The herbicides were applied June 3, 2003, to 8 to 36 inch tall leafy spurge in the true flower growth stage, or September 15, 2003, to plants in the fall regrowth stage and 18 to 36 inches tall. Aminopyralid did not provide satisfactory control of leafy spurge regardless of herbicide rate or application date (Table 5).

In summary, aminopyralid effectively controlled absinth wormwood, perennial sowthistle, and Canada thistle at much lower use rates than currently used herbicides. Aminopyralid control of Canada thistle may be influenced by Canada thistle density and cover, with generally better control at the low density sites. In general, control of the composite family weeds was similar whether aminopyralid was applied in the spring or fall and whether applied alone or with 2,4-D. Spring- or fall-applied aminopyralid did not control leafy spurge satisfactorily at the proposed use rates.

Table 1. Canada thistle, absinth wormwood, and perennial sowthistle control with aminopyralid and other auxin-type herbicides applied in June or October 2003 near Jamestown, ND.

		Time after treatment / weed species						
		3 MAT[1]			12 MAT			15 MAT
Treatment[2]	Rate	CT[1]	ABS[1]	PS[1]	CT	ABS	PS	CT
Spring applied	– oz/A –	% control						
Aminopyralid	0.75	93	99	98	70	100	85	24
Aminopyralid	1	96	99	98	90	98	78	39
Aminopyralid	1.25	96	100	98	87	100	99	26
Aminopyralid	1.5	92	99	98	91	100	97	30
Aminopyralid	1.75	94	100	98	87	100	99	16
Picloram	6	94	99	99	90	100	100	41
Clopyralid	6	97	99	98	70	100	42	17
Dicamba	16	59	99	96	33	97	54	12
2,4-D	24	49	73	75	36	63	31	36
LSD (0.05)		18	12	18				
Fall applied					9 MAT			12
Aminopyralid	0.75				99	95	100	52
Aminopyralid	1				100	98	96	63
Aminopyralid	1.25				99	99	97	56
Aminopyralid	1.5				100	99	99	74
Aminopyralid	1.75				100	98	100	80
Picloram	6				99	100	100	83
Clopyralid	6				96	78	30	19
Dicamba +	3 + 1.2				80	35	33	9
Dicamba	16				94	100	38	0
LSD (0.05)					25	19	34	31

[1]Abbreviatons: MAT = months after treatment; CT = Canada thistle; ABS = Absinth

[2]Surfactant Activator 90 at 0.25% v/v applied with all treatments, Loveland Industries, Greeley,

[3]Commercial formulation - Overdrive by BASF Corp., Research Triangle Park, NC 27709.

Table 2. Absinth wormwood control with aminopyralid applied alone or with 2,4-D in May 2004 at Eckelson or Jamestown, ND.

		Location / time after treatment			
		Jamestown		Eckelson	
Treatment[1]	Rate	3 MAT[2]	12 MAT	3 MAT	12 MAT
	oz/A	% control			
Aminopyralid	0.75	92	77	88	63
Aminopyralid	1	93	88	64	37
Aminopyralid	1.25	97	67	99	56
Aminopyralid	1.5	99	90	75	57
Aminopyralid	1.75	99	92	98	92
Aminopyralid + 2,4-D	1 + 11.4	98	74	99	87
Aminopyralid + 2,4-D	1.5 + 11.4	98	98	61	36
Aminopyralid + 2,4-D	1 + 0.15	94	86	88	57
Aminopyralid +	0.75 + 11.4	95	86	76	61
2,4-D	15.2	15	11	8	0
Dicamba + 2,4-D[3]	11.5 + 4	54	30	42	35
Picloram + 2,4-D[4]	2.2 + 8	94	90	86	36
LSD (0.05)		15	26	36	NS

[1]Surfactant Activator 90 at 0.25% v/v was applied with all treatments, Loveland Industries,

[2]Abbreviation: MAT = months after treatment.

[3]Commercial formulation - Weedmaster by BASF Corp., Research Triangle Park, NC 27709.

[4]Commercial formulation - Grazon by Dow AgroSciences, Indianapolis, IN 46268.

Table 3. Canada thistle and perennial sowthistle control with aminopyralid and other auxin-type herbicides applied in June or October 2003 at Fargo, ND.

		Time after treatment / weed species						
		3 MAT[1]		12		15 MAT		24 MAT
Treatment[2]	Rate	CT[1]	PS[1]	CT	PS	CT	PS	CT
Spring applied	– oz/A –	% control						
Aminopyralid	0.75	99	99	95	70	92	95	97
Aminopyralid	1	100	97	99	93	95	95	93
Aminopyralid	1.25	100	99	94	98	91	97	92
Aminopyralid	1.5	100	99	93	83	92	95	96
Aminopyralid	1.75	100	100	99	98	97	99	99
Picloram	6	100	100	95	100	92	98	89
Clopyralid	6	95	99	94	96	91	94	94
Dicamba	16	63	88	71	43	85	90	92
2,4-D	24	45	70	57	19	59	36	61
LSD (0.05)		24	6					
Fall applied				9 MAT		12 MAT		21
Aminopyralid	0.75			100	100	98	97	98
Aminopyralid	1			100	99	92	97	95
Aminopyralid	1.25			100	100	99	99	97
Aminopyralid	1.5			100	100	100	98	98
Aminopyralid	1.75			100	100	99	99	96
Picloram	6			99	100	98	98	98
Clopyralid	6			99	98	90	98	95
Dicamba + diflu[1,3]	3 + 1.2			88	3	66	32	89
Dicamba	16			85	73	88	95	78
LSD (0.05)				18	25	16	23	17

[1]Abbreviations: MAT = months after treatment; CT = Canada thistle; PS = perennial sowthistle; diflu = diflufenzopyr.

[2]Surfactant Activator 90 at 0.25% v/v was applied with all treatments, Loveland Industries,

[3]Commercial formulation - Overdrive by BASF Corp., Research Triangle Park, NC 27709.

Table 4. Canada thistle control with aminopyralid and other auxin-type herbicides applied in June or September 2004 at Fargo or Jamestown, ND.

		Location / time after treatment		
		Fargo		Jamestown
Treatment[1]	Rate	3 MAT[2]	12 MAT	3 MAT[3]
Spring applied	— oz/A —		% control	
Aminopyralid	1.25	99	48	81
Aminopyralid	1.5	99	40	93
Aminopyralid	1.75	97	57	93
Picloram + 2,4-D	4 + 30	85	18	89
Clopyralid + 2,4-D[4]	4.5 + 24	89	30	59
Dicamba + 2,4-D	16 + 15	19	0	36
LSD (0.05)		17		21
Fall applied			9 MAT	
Aminopyralid	1.25		100	
Aminopyralid	1.5		100	
Aminopyralid	1.75		100	
Picloram	6		97	
Clopyralid + 2,4-D[4]	4.5 + 24		76	
Dicamba	16		75	
LSD (0.05)			36	

[1]Surfactant Activator 90 at 0.25% v/v was applied with all treatments, Loveland Industries Greeley, CO 80632.

[2]Abbreviations: MAT = months after treatment.

[3]Experiment site was disturbed and no further evaluations were made.

[4]Commercial formulation - Curtail by Dow AgroSciences, Indianapolis, IN 46268.

Table 5. Control of leafy spurge with aminopyralid and other auxin-type herbicides applied in June or September 2003 near Ekre, ND.

		Time after spring-application		Time after fall-application
Treatment[1]	Rate	3 MAT[2]	12 MAT	9 MAT
	– oz/A –		% control	
Aminopyralid	0.75	0	8	11
Aminopyralid	1.25	15	9	50
Aminopyralid	1.75	20	9	58
Picloram + 2,4-	4 + 16	75	51	91
LSD (0.05)		29	18	

[1]Surfactant Activator 90 at 0.25% v/v was applied with all treatments, Loveland Industries,

[2]Abbreviations: MAT = months after treatment.