The Influence of Fall and Spring Herbicide Application on Winter Wheat. Derksen, D. A.; K. J. Kirkland; R. A. Ashford, J. H. Hunter; K. E. Bowren; B.R. Mc Lennon; and H. A. Loeppky.

ABSTRACT

The use of 2,4-D for fall control of winter annuals weeds in winter wheat is recommended in the Canadian prairies but not in other winter wheat production areas. Field research was conducted for 2 years at several locations using 2,4-D, MCPA, dicamba, dicamba plus 2,4-D, bromoxynil, bromoxynil plus MCPA, chlorsulfuron and clopyralid applied fall and spring. Recommended and double recommended rates were tested to establish the existence of a safety margin. Norstar winter wheat was tolerant to fall applications of all herbicides when applied at recommended rates, however, grain yield was reduced at the double rate with 2,4-D, MCPA, bromoxynil, bromoxynil plus MCPA and clopyralid in some station years. Norstar was tolerant to spring applications of all herbicides except MCPA and clopyralid in several station years. Herbicides tested show promise for use in winter wheat production. Caution is warranted for spring application of MCPA and clopyralid.

INTRODUCTION

The use of herbicides for fall winter annual weed control in winter wheat on the Canadian prairies is somewhat controversial. In traditional winter wheat production areas of Europe, the United States and southern Ontario the use of phytohormone type herbicides (phenoxy carbonylic acid and benzoic acid herbicides) in the fall is discouraged due to potential phytotoxic effects which can lead to yield losses.

West German recommendations specify spring application after the winter wheat has tillered (Schwerdle, 1983). North Dakota extension services recommend 2,4-D, MCPA and dicamba for spring application only (Van Der Pay, 1985). Similarly, spring post tillering application of these herbicides is recommended in Ontario (OMAF, 1986). Freyman et al. (1979) and Fowler et al. (1986) demonstrated reduced frost tolerance from applications of 2,4-D and MCPA in controlled environment conditions.

In contrast, field results in Saskatchewan (Fowler) and Manitoba (Schwerdle) have shown that fall applications of 2,4-D and MCPA did not reduce yield at rates as high as 2240 g/ha (4-5 times recommended fall rates). According to the 1986 E.C.W. report, fall herbicide use requires a lower rate and provides better weed control (Expert Committee on Weeds, 1987). Fall application of 2,4-D in winter wheat is recommended in the weed control guide of all three prairie provinces.

In 1986, 2,4-D comprised 71.1 percent of herbicides used in winter wheat (based on surveyed area) with 6.4% fall applied and 93.6% spring applied (Thomas, 1986). The second most frequently

used herbicide was chlorsulfuron at 13.1%, with the remainder of the herbicides comprising less than 2% each. It is interesting to note that in the 1986 winter wheat weed survey, flixweed (Descurainia sophia(L.) Webb.), stinkweed (Thalaspi arvense L.) and shepherds'-purse (Capsella bursa-pastoris (L.) Medic) were in the list of the ten top weeds in terms of relative abundance, even though 97.5% of the treated survey acreage was treated with herbicides which have the potential to control these weeds.

The purpose of this study was to determine the effects of the time of application of phytohormone and other potentially useful herbicides in winter wheat in various locations in Saskatchewan.

MATERIALS AND METHODS

Herbicides used in this study were from 5 herbicides families or related chemical groups. 2,4-D and MCPA are in the phenoxy carboxylic acid group commonly called phenoxy's, dicamba is a benzoic acid herbicide, bromoxynil is a hydroxybenzonitrile herbicide, clopyralid is a chloropicolinic acid and chlorsulfuron is a sulfonil-urea herbicide. 2,4-D, MCPA, dicamba and clopyralid are all considered phytohormone type herbicides. All the herbicides except clopyralid have activity on the winter annual weeds (flixweed, stinkweed and shepherds'-purse). Clopyralid was evaluated because of its potential Canada thistle (Cirsium arvenses (L.) Scop) control. Bromoxynil, a contact herbicide, was evaluated because it is registered in winter wheat for spring use. Chlorsulfuron was evaluated because it has a similar but broader weed spectrum then the phytohormones as well as soil residual properties for the control of late germinating weeds.

Of the five sites involved in the research project, Scott, Regina and Saskatoon are in the dark brown, Melfort is in the black and Indian Head is in the thin black soil zone. All sites were on Agriculture Canada or University of Saskatchewan research farms. In terms of winter survival the 1985-86 winter was considered average and 1986-87 provided good overwintering conditions. Winter kill was not evident at any of the sites in either year.

Norstar winter wheat was used at all sites in both years. Agronomic factors such as seeding rate, date, depth, standing stubble seeding ,stubble height, fertilizer and other production factors were optimized at all sites (based on currently recommended production practices). Winter wheat was seeded into standing stubble (barley, mustard or canola) at all sites except Regina where individual plots were fallowed between spring wheat standing stubble strips. Seeding occurred within the optimal seeding time frame of late August to early September at all sites except Regina 1985 where seeding occurred on October 11. See Table 1 for specific data on seeding dates. The experiments were designed as a split/split plot with 4 replicates. At Indian Head, Scott and Melfort the main plot was fall vs. spring application timing and sub-plots were herbicide rates . At

Saskatoon and Regina the main plot effect was rate. Sub-plots were a minimum of 2 X 5 metres in size. Yield data was analysed within each site year using an analysis of variance with means separation at 95% level according to the least significant difference (L.S.D.) multiple range test.

Sites were weed free or had low weed populations except Melfort 85-86 where winter annual weed infestations were moderate (Table 1). Herbicide rates were based on currently registered or proposed use rate ranges. The high rate in this recommended range was doubled to simulate spray overlaps and indicate potential crop tolerance problems. See Table 2 for specific rates, formulations and the rationale for their inclusion in this test. Herbicide treatments were applied at 110 l/ha of final spray solution with small plot sprayers at each site. The optimal time for spraying is thought to be fall or if neccesary early spring for the control of winter annual weeds. Actual spray dates are listed in Table 1 and varied depending on local conditions such as rainfall and crop growth stage.

Due to local conditions or situations not all experiments were conducted at each site in each year (Tables 3 - 10). Due to drought in Melfort 1987 the winter wheat crop failed.

RESULTS AND DISCUSSION

Normal rates of 2,4-D amine (625 - 850 g/ha) applied in fall or spring did not affect winter wheat yield (Table 3). Yield reductions compared to the check, of 10-25% occurred in two of the nine station years when 1700 g/ha of 2,4-D was applied in the fall, however, no yield reduction occurred from spring application. This response difference to the 1700 g/ha rate resulted in time by rate interactions at two sites in 1986. Significant yield reductions due to fall spraying occurred in only two station years and a significant yield increase associated with fall application occurred in one of the nine station years. Other studies have shown that from 1100 g/ha (Schwerdle) to 2240 g/ha (Fowler) of 2,4-D applied in the fall does not cause a significant yield reduction. Lodging was observed in fall applied 2,4-D plots at Regina in 1986 however, this may have been exacerbated by late planting.

MCPA amine did not significantly affect winter wheat yield in 7 out of 9 station years (Table 4). The only yield reduction due to fall application of MCPA occurred in Saskatoon in 1986 at the 1700 g/ha rate. Unlike 2,4-D, MCPA applied in the spring showed a trend toward yield reductions even at low rates in two station years. An interaction of time by rate was therefore observed at Saskatoon in 1986. Early spring and prior to completion of tillering has been noted as a potentially sensitive stage for winter wheat treated with phenoxy herbicides (Myers, 1953; Swan, 1975). Juxtaposed was the results of Regina (1986) where a benefit from spring application was noted.

Dicamba and dicamba plus 2,4-D applied in the fall or spring

did not significantly reduce yield (Tables 5 & 6). This is in agreement with the results of other researchers (Schwerdle).

Bromoxynil and bromoxynil plus MCPA tested in 8 station years caused no reduction in yield compared to the check when applied at recommended and in most cases double the recommended rate (Tables 7 & 8). This indicates that weed control can be achieved with a good margin of crop safety. Significantly higher yields were recorded in one station year when bromoxynil was applied in the spring rather than in the fall. At Scott in 1986, bromoxynil applied at double the recommended rate resulted in a yield loss when compared to the check, however, an overall increase (rates pooled) in yield from fall application occurred. Bromoxynil plus MCPA applied at double the recommended rate in the fall reduced yield at Regina in 1986.

Chlorsulfuron showed no yield reduction from herbicide rates or application timing (Table 9). This concurs with Schwerdle (1983) and indicates an excellent crop safety margin. Clopyralid treatments to winter wheat resulted in a greater yield reduction from spring compared to fall application (Table 10). Spring application of clopyralid caused a yield reduction only at the 600 g/ha rate in two station years while at Indian Head in 1986 all rates reduced yield. In one station year the 600 g/ha rate reduced yield when fall applied. It should be noted that current evaluation of clopyralid in cereals is recommended at rates of 60 - 100 g/ha, therefore even the 300 g/ha rate is greater than double the recommended rate. This suggests that in most cases control could be achieved without crop injury, although care should be exercised.

In general, none of the eight herbicides caused crop injury, resulting in significant yield reductions when applied at the recommended rates in fall or spring (execpt MCPA and clopyralid in several station years). No significant yield effects were observed at any rate of dicamba, dicamba plus 2,4-D and chlorsulfuron tested at either application time.

Bromoxynil and bromoxynil plus MCPA cuased yield losses only at the high rate (676, 560 & 560 g/ha) in one station year out of eight. Yield reductions were observed with 2,4-D only when fall applied at 1700 g/ha (4 times the current recommended fall rate) in two out of nine station years. MCPA reduced yields at 1700 g/ha applied in the fall in one station year out of nine and reduced yields in the spring at all rates in two years out of nine. Clopyralid and MCPA both caused greater yield reductions when applied in the spring than in the fall. When applied in the fall, only the highest rate of clopyralid (600 g/ha) caused yield reductions and only in one out nine station years. Applied in the spring, the 600 g/ha rate reduced yield in 2 station years and in one station year all rates of clopyralid caused significant yield reductions.

All herbicides tested, 2,4-D, MCPA, dicamba, dicamba plus 2,4-D, bromoxynil, bromoxynil plus MCPA, chlorsulfuron and

clopyralid showed promise for both fall and spring application in winter wheat for control of winter annual weeds and Canada thistle (clopyralid). Only clopyralid and MCPA applied in the spring warrant caution.

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Table 1: Agronomic data

Year	Site	Planting Date	Soil Texture	% Organic Matter	Rainfall as % of Normal April - July	Spray Data						Weed Pressure
						Fall			Spring			
						Date	Temp	Leaf #	Date	Temp	Leaf #	
1986	Indian Head	Sept 4/85	h. clay	3	157	Oct 11	12	3	Apr 24	12	4	nill
	Regina	Oct 11/85	h. clay	2	143	Oct 30	19	1-3	May 25	24	5	nill
	Scott	Aug 27/85	clay loam	4	120	Oct 7	3	4	Apr 21	18		nill
	Saskatoon	Aug 28/85	clay loam	5	116	Oct 15	4	3	Apr 29	5	3 1.	nill
									May 29	33	Z31-32	
	Melfort	Sept 7/85	sl cl loam	12	90	Oct 21	16	1	May 27	24	4	moderate
1987	Indian Head	Aug 28/86	h. clay	3	102	Oct 8	4	3	Apr 28	10	4	nill
	Regina	Sept 8/86	h. clay	2	96	Oct 22	5	3	May 6	30	5	nill
	Scott	Aug 20/86	clay loam	4	139	Oct 10	10	4	Apr 28	24	4	nill
	Saskatoon	Sept 8/86	loam			Oct 14	5	3	May 7	23	3	nill
									May 25	20	5 (1.)	nill

1.data for experiments containing chlorsulfuron and clopyralid.

TABLE 2. HERBICIDE RATES AND FORMULATIONS

HERBICIDE	RECOMMENDED/ REGISTERED RATE RANGE g/ha	DOUBLE RATE	FORMULATION USED
2,4-D	625 - 850 [1.]	1700	amine
MCPA	625 - 850 [1.]	1700	amine
DICAMBA	110 - 140 [1.]	280	solution
DICAMBA+ 2,4-D	110 + 425 140 + 425 [1.]	280 + 850	solution+ amine
BROMOXYNIL	280 - 338 [1.]	676	emulsifiable concentrate
BROMOXYNIL+ MCPA	280 + 280 [2.]	560 + 560	emulsifiable concentrate
clopyralid	100 - 300 [3.]	600	emulsifiable concentrate
chlorsulfuron	11.25 - 22.50 [4.]	45.00	dry flowable

1. registered for spring application in winter wheat
2. registered for fall and spring application in winter wheat
3. recommended test range in cereal crops
4. registered in spring wheat

Table 3: The effect of 2,4-D on winter wheat yield

Location	Rate g/ha	Yield g/m			
		1986		1987	
		fall	spring	fall	spring
		1.			
Indian Head	0	474.0a	474.0 ns	528.8ab	528.8 ns
	625	473.7a	484.9	552.9a	560.4
	850	468.8a	473.7	560.7a	559.2
	1700	405.8b	487.8	505.6b	547.2
	means	455.5	480.1 *	537.0 ns	548.9
Scott	0	429.8 ns	425.5 ns	398.2 ns	386.7 ns
	625	424.8	419.1	404.5	354.0
	850	414.1	407.5	412.5	381.9
	1700	381.1	402.2	404.3	377.3
	means	412.4 ns	413.6	404.8 *	374.9
Saskatoon	0	220.2a	204.7 ns	131.2b	169.5 ns
	625	207.5a	207.0	174.5a	173.0
	850	199.8a	202.3	181.2a	147.2
	1700	164.2b	193.8	166.0a	133.0
	means	197.9 ns	201.9	163.2 ns	155.6
Regina	0	329.5 ns	329.5 ns	621.7 ns	621.7 ns
	625	350.4	367.5	500.1	513.0
	850	325.0	350.4	504.1	534.9
	1700	294.8	328.5	500.8	535.6
	means	324.9	343.9 *	531.6 ns	551.3
Melfort	0	111.6 ns	111.6 ns		
	625	175.3	155.5		
	850	236.1	158.9		
	1700	180.4	185.5		
	means	175.8 ns	152.9		

1. Means followed by the same letter within evaluation groups are not significantly different at the 5% level according to the L.S.D. test.
ns = not significant.
* = significant.

	Time*Rate	
	1986	1987
Indian Head	*	ns
Scott	*	ns
Saskatoon	ns	ns
Regina	ns	ns
Melfort	ns	

Table 4: The effect of MCPA on winter wheat yield

Location	Rate g/ha	Yield g/m			
		1986		1987	
		fall	spring	fall	spring
		1.			
Indian Head	0	474.0 ns	474.0 ns	528.8 ns	528.8 ns
	625	477.4	474.3	556.5	530.4
	850	473.7	495.1	538.4	525.1
	1700	487.6	480.7	536.1	540.9
	means	487.2 ns	481.0	539.9 ns	531.3
Scott	0	364.8 ns	412.0 ns	394.7 ns	400.2a
	625	413.6	443.3	365.6	371.2b
	850	417.7	424.1	367.7	387.4ab
	1700	423.3	425.5	348.1	366.9b
	means	404.8 ns	426.1	369.0 ns	381.4
Saskatoon	0	210.8a	218.2a	184.7 ns	186.0 ns
	625	209.5a	199.7b	162.2	169.7
	850	206.4a	204.5ab	157.2	135.0
	1700	184.4b	191.1b	191.2	162.2
	means	202.8 ns	203.4	173.8 ns	163.2
Regina	0	329.5 ns	329.5 ns	621.7 ns	621.7 ns
	625	318.9	340.7	469.4	486.1
	850	309.3	330.5	512.0	481.2
	1700	306.7	350.3	485.4	491.3
	means	316.1	337.7 *	522.1 ns	520.0
Melfort	0	111.6 ns	111.6 ns		
	625	160.8	141.6		
	850	148.7	161.9		
	1700	148.0	162.4		
	means	142.3 ns	144.3		

1. Means followed by the same letter within evaluation groups are not significantly different at the 5% level according to the L.S.D. test.
ns = not significant.
* = significant.

	Time*Rate	
	1986	1987
Indian Head	ns	ns
Scott	ns	ns
Saskatoon	*	ns
Regina	ns	ns
Melfort	ns	

Table 5: The effect of dicamba on winter wheat

Location	Rate*	Yield g/m			
		1986		1987	
		fall	spring	fall	spring
		1.			
Indian Head	0	428.3 ns	428.3 ns	567.1 ns	567.1 ns
	110	429.9	454.0	586.8	543.1
	140	596.3	459.8	600.9	558.4
	280	461.9	452.6	558.4	574.2
	means	479.1 ns	448.6	578.3 ns	560.7
Scott	0	442.3 ns	419.1 ns	347.9 ns	354.6 ns
	110	440.5	431.2	371.2	367.5
	140	422.0	420.4	350.4	328.0
	280	435.4	419.1	350.8	359.0
	means	435.1 ns	422.4	355.0 ns	352.2
Saskatoon	0	207.0 ns	200.7ab		
	110	200.2	209.5a		
	140	209.0	--		
	280	198.7	203.5a		
	means	203.7 ns	201.1		
Regina	0	391.7 ns	391.7 ns	548.1 ns	548.1 ns
	110	384.7	384.8	528.9	556.9
	140	373.8	370.7	533.8	541.8
	280	375.6	377.3	570.9	556.9
	means	381.4 ns	376.1	545.4 ns	550.9

1. Means followed by the same letter within evaluation groups are not significantly different at the 5% level according to the L.S.D. test.
ns = not significant.
* = significant.

	Time*Rate	
	1986	1987
Indian Head	ns	ns
Scott	ns	ns
Saskatoon	*	
Regina	ns	ns

Table 6: The effect of dicamba + 2,4-D on winter wheat

Location	Rate*	Yield g/m			
		1986		1987	
		fall	spring	fall	spring
		1.			
Indian Head	0 + 0	428.3 ns	428.3 ns	567.1 ns	567.1 ns
	110+425	457.8	462.5	559.6	559.6
	140+425	444.3	457.4	553.7	558.3
	280+850	392.4	463.9	518.5	560.3
	means	430.7 ns	453.0	549.7 ns	561.3
Scott	0 + 0	430.0 ns	440.9 ns	336.1 ns	343.0 ns
	110+425	447.8	432.5	361.9	349.0
	140+425	453.6	454.2	357.8	327.1
	280+850	450.1	452.0	365.9	340.2
	means	445.3 ns	352.2	355.4 ns	339.8
Saskatoon	0 + 0	214.5 ns	212.2 ns		
	110+425	198.2	203.5		
	140+425	204.2	208.0		
	280+850	184.2	185.0		
	means	200.3 ns	202.1		
Regina	0 + 0	391.7 ns	391.7 ns	548.1 ns	548.1 ns
	110+425	359.3	383.4	525.4	517.5
	140+425	391.3	377.1	517.1	551.6
	280+850	354.9	362.5	523.3	529.6
	means	374.3 ns	378.6	528.4 ns	536.7

1. Means followed by the same letter within evaluation groups are not significantly different at the 5% level according to the L.S.D. test.
ns = not significant.
* = significant.

	Time*Rate	
	1986	1987
Indian Head	ns	ns
Scott	ns	ns
Regina	ns	ns
Saskatoon	ns	

Table 7: The effect of bromoxynil on winter wheat

Location	Rate g/ha	Yield g/m			
		1986		1987	
		fall	spring	fall	spring
		1.			
Indian Head	0	398.1 ns	398.1 ns	597.8 ns	447.8 ns
	280	397.6	379.5	603.2	605.9
	338	392.4	421.9	606.6	607.2
	676	382.4	402.9	596.1	617.4
	means	392.6 ns	400.6	600.9 ns	607.1
Scott	0	415.1ab	357.9 ns	386.2 ns	365.1 ns
	280	421.7a	360.0	370.6	393.9
	338	436.4a	372.5	397.1	365.7
	676	388.1b	392.7	358.0	401.6
	means	415.3 *	370.7	377.9 ns	381.6
Saskatoon	0	175.0 ns	192.5 ns	176.7 ns	176.2 ns
	280	171.2	190.2	158.0	152.2
	338	196.0	184.0	152.2	151.2
	676	171.5	180.2	168.5	186.7
	means	178.4	186.7 *	163.8 ns	166.5
Regina	0	288.5 ns	288.5 ns	529.6 ns	529.6 ns
	280	304.3	294.7	510.7	524.1
	338	286.3	310.7	533.9	520.2
	676	265.5	296.7	520.0	525.8
	means	286.1 ns	297.6	523.5 ns	524.9

1. Means followed by the same letter within evaluation groups are not significantly different at the 5% level according to the L.S.D. test.
ns = not significant.
* = significant.

	Time*Rate	
	1986	1987
Indian Head	ns	ns
Scott	ns	ns
Saskatoon	ns	ns
Regina	ns	ns

Table 8: The effect of bromoxynil plus MCPA on winter wheat yield

Location	Rate g/ha	Yield g/m			
		1986		1987	
		fall	spring	fall	spring
		1.			
Indian Head	0 + 0	398.1 ns	391.8 ns	597.8 ns	597.8 ns
	280+280	408.9	410.0	601.3	605.6
	560+560	386.9	397.7	595.9	610.3
	means	398.1 ns	401.9	598.3 ns	604.5
Saskatoon	0 + 0	147.2 ns	158.0 ns	180.5 ns	177.0 ns
	280+280	178.5	174.2	163.7	195.2
	560+560	159.0	155.0	174.0	231.7
	means	161.5 ns	162.4	172.7 ns	201.3
Regina	0 + 0	288.5a	288.5 ns	529.6 ns	529.6 ns
	280+280	300.4a	280.7	535.3	519.0
	560+560	241.9b	285.9	538.2	513.5
	means	276.9 ns	285.0	534.3 ns	520.7
Scott	0 + 0	409.9 ns	402.0 ns	351.3 ns	391.1 ns
	280+280	399.2	426.1	350.4	382.8
	560+560	398.1	409.6	388.2	368.5
	means	402.4 ns	412.5	363.3 ns	380.8

1. Means followed by the same letter within evaluation groups are not significantly different at the 5% level according to the L.S.D. test.
ns = not significant.
* = significant.

	Time*Rate	
	1986	1987
Indian Head	ns	ns
Scott	ns	ns
Saskatoon	ns	ns
Regina	*	ns

Table 9: The effect of chlorsulfuron on winter wheat yield

Location	Rate g/ha	Yield g/m			
		1986		1987	
		fall	spring	fall	spring
		1.			
Indian Head	0.00	406.8 ns	406.8 ns	319.2 ns	319.2 ns
	11.25	397.9	395.9	342.4	332.1
	22.50	433.0	397.4	330.2	318.5
	45.00	405.3	399.9	312.5	300.6
	means	410.7 ns	400.0	326.1 ns	317.6
Scott	0.00	367.4 ns	361.5 ns	334.6 ns	320.1 ns
	11.25	366.0	378.9	310.7	310.7
	22.50	354.9	342.8	311.4	312.2
	45.00	322.4	374.5	307.8	333.6
	means	352.6 ns	364.4	316.1 ns	319.1
Saskatoon	0.00	195.7 ns	171.7 ns	118.0 ns	147.7 ns
	11.25	169.7	176.2	186.7	180.2
	22.50	165.5	176.5	154.0	165.2
	45.00	176.0	171.5	178.5	156.5
	means	176.7 ns	173.9	159.3 ns	162.4
Melfort	0.00	180.8 ns	180.8 ns		
	11.25	178.6	223.7		
	22.50	213.9	222.0		
	45.00	242.9	242.5		
	means	204.1 ns	217.2		

1. Means followed by the same letter within evaluation groups are not significantly different at the 5% level according to the L.S.D. test.
ns = not significant.
* = significant.

	Time*Rate	
	1986	1987
Indian Head	ns	ns
Scott	ns	ns
Saskatoon	ns	ns
Melfort	ns	

Table 10: The effect of clopyralid on winter wheat yield

Location	Rate g/ha	Yield g/m			
		1986		1987	
		fall	spring	fall	spring
		1.			
Indian Head	0	406.8 ns	406.8a	319.2 ns	319.2 ns
	100	406.0	377.0b	307.6	317.0
	300	387.7	355.6b	350.3	314.8
	600	380.5	352.5b	309.9	296.8
	means	395.2 *	372.9	321.7 ns	311.7
Scott	0	371.2 ns	337.0a	339.7a	351.0a
	100	347.1	344.2a	338.1a	315.0a
	300	343.2	330.2a	329.2a	316.2a
	600	324.4	289.9b	292.5b	240.7b
	means	346.4 ns	325.3	324.8 ns	305.7
Saskatoon	0	178.2 ns	184.0 ns	124.0 ns	170.2 ns
	100	174.2	181.5	144.0	126.0
	300	169.2	174.2	149.0	149.2
	600	169.0	170.2	160.2	152.5
	means	172.6 ns	177.4	144.3 ns	149.4
Regina	0	331.4 ns	331.4 ns	443.6 ns	443.6 ns
	100	344.2	330.7	472.4	459.1
	300	333.5	334.7	471.8	453.9
	600	318.2	337.2	409.6	403.8
	means	331.8 ns	334.1	449.3 ns	440.1
Melfort	0	180.8 ns	180.8 ns		
	100	206.8	205.5		
	300	257.6	234.6		
	600	237.3	228.8		
	means	220.6 ns	212.5		

1. Means followed by the same letter within evaluation groups are not significantly different at the 5% level according to the L.S.D. test.
ns = not significant.
* = significant.

	Time*Rate	
	1986	1987
Indian Head	ns	ns
Scott	ns	ns
Saskatoon	ns	ns
Regina	ns	ns
Melfort	ns	