

PROGRESS REPORT ON SEED PRODUCTION RESEARCH

prepared by

N.J. Ehlke and D.J. Vellekson
Department of Agronomy and Plant Genetics
University of Minnesota
St. Paul, Minnesota 55108

for

PRESENTATION AT THE GRASS-LEGUME SEED INSTITUTE Baudette, Minnesota

April 4, 2000

Weather:

Table 1. Monthly precipitation at Roseau, MN 1967-1999.

Variety Performance Trials:

- Table 2. Kentucky bluegrass seeded in 1996.
- Table 3. Kentucky bluegrass seeded in 1997.
- Table 4. Reed canarygrass seeded in 1995.
- Table 5. Timothy seeded in 1998.
- Table 6. Birdsfoot trefoil seeded in 1998.
- Table 7. Kura clover seeded in 1998.
- Table 8. Cicer milkvetch seeded in 1998.
- Table 9. Quackgrass seeded in 1996.
- Table 10. Perennial ryegrass seeded in 1998.
- Table 11. Perennial ryegrass winter hardiness trial seeded in 1998.

Other Trials:

- Table 12. Effect of herbicide timing and renovation on 'Park' Kentucky bluegrass.
- Table 13. Effect of herbicides applied to 'Park' Kentucky bluegrass.
- Table 14. Effect of fungicides on 'Park' Kentucky bluegrass.
- Table 15. Effect of fertilizer applied to 'Endura' kura clover.
- Table 16. Legume establishment trial-1998.
- Table 17. 'Roundup' timing on selected birdsfoot trefoil population - 1998-1999.
- Table 18. Summary of Roundup timing on selected birdsfoot trefoil populations.

Kentucky Bluegrass

Kentucky bluegrass seed production fields generally looked good to excellent in much of northern Minnesota in 1999. Extremely wet field conditions again made harvesting difficult in many areas. High winds over the July 4 weekend also shattered large amounts of the crop that had not been cut.

Two herbicide and two fungicide trials were conducted in 1999 on 'Park' Kentucky bluegrass and have data presented in the proceedings. The fungicide trials were conducted in 2 locations in cooperation with Jon Powell, the turf pathologist on the U of MN-St. Paul campus. One trial was on the 'Rice' farm north of Roseau and the other on the Helmstetter farm north of Roosevelt. Quadris (a fungicide used on canola and the same active ingredient as in the turf fungicide Heritage) was used in both trials. This is a broad spectrum fungicide that controls many diseases including powdery mildew in turf. Tilt, which is commonly used to control mildew in seed production fields was also used. Both were applied to test effects of applying each alone and in combination with 2,4-D to test the antagonistic effects between the chemicals. Powdery mildew and other diseases appeared minimal at both locations and none of the treatments significantly effected seed yields in 1999.

The herbicide trials on Cenex and Rice farms netted some interesting results. Fall applications of 2,4-D, Banvel, and Express yielded higher than spring applications at both locations. This is not surprising as we have seen this other years but the trend seems clearer that there is some yield decrease on spring application of these broadleaf herbicides.

Spring vs. fall 'Beacon' applications have data that is less clear. Fall application on the Rice farm produced significantly higher yields than the spring application. The Cenex location had slightly higher yields on spring applications but it was not significant. Applying a related chemical 'Maverick' in the spring, significantly reduced yields. The antagonistic effect of applying 2,4-D+Express+Malathion in the spring reduced seed yields significantly. Data is in tables 12 & 13.

Two Kentucky bluegrass variety trials were harvested in 1999. A trial seeded on the peat in 1997 has data for the first year. Park had some seed loss due to shattering before harvest, but overall yields are good. Abbey and Barmax yielded over 500#/ac. Minnfine does not seem to do nearly as well on the peat. The excess nitrogen seems to be at least part of the problem as stands lodged severely and become sodbound. The 1996 Kentucky bluegrass variety trial on Cenex mineral soil also has yields reported for the first time in table 2.

Birdsfoot trefoil

Management of 'Roundup' treatments on selected birdsfoot trefoil populations has been ongoing for several years. The proper time to apply the treatments is of major importance. Generally speaking, the best time to apply the treatment of 'Roundup' in northern Minnesota, is early June. This is assuming the crop is not under severe stress and the weeds to be controlled are at the proper stage. Summary data of all years of treatments at Roseau and St. Paul are included in table 18. Hi levels of residual nitrogen may explain the higher seed yields of the 2 application system over the checks. Excess nitrogen often times will produce more vegetative material and the stress of another application of 'Roundup' seemed to induce more uniform flowering. Two Roundup applications a year will not normally increase seed yields. A variety trial seeded in 1998 has first year seed yields reported in table 6. No significant yield differences were found between varieties.

Cicer milkvetch

Cicer milkvetch is a vigorous and persistent forage legume that spreads by rhizomes. It is very winter hardy and has good forage nutritive value. It's seedling vigor is low however and sometimes takes 2 years for good establishment and does not tolerate wet, poorly drained soils. Cicer milkvetch is grazed extensively in the western US and has a high livestock carrying capacity. The problem that has sometimes occurred is the presence of an unknown antiquality component that decreases palatability and can cause photosensitization in grazing ruminants. Breeding work was done at St. Paul in an attempt to solve this problem. Utilizing grazing sheep to select plants out of a world collection of cicer milkvetch, the result of this work is the variety 'Hi Pal'. Four varieties of cicer milkvetch were seeded on the Magnusson farm near Roseau in 1998 and seed yields for 1999 are in table 8. Hi Pal had the highest yield in the trial and also performed well in a seed yield trial several years ago on the Baumgartner farm. There is a larger field currently in seed increase and there hopefully will be seed available in several years to allow for more extensive growing of the variety.

Table 1. Monthly precipitation and average Park Kentucky bluegrass seed yields at Roseau, MN from 1967 to 1999.

Year	MONTHLY PRECIPITATION (inches)												TOTAL	DEPARTURE FROM NORMAL	Park Yield lb/A
	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC			
1967	1.13	0.39	0.59	2.89	0.89	2.23	4.95	1.69	0.83	1.11	0.70	1.76	19.16	-1.79	650
1968	0.62	T	1.25	0.63	1.46	6.47	6.13	8.49	2.35	1.26	1.06	0.21	29.98	+9.03	488
1969	3.07	0.11	0.05	1.27	3.31	2.29	3.70	4.28	3.29	1.91	0.30	0.73	24.31	+3.36	673
1970	0.71	0.41	1.38	2.56	5.93	4.07	3.55	0.83	2.77	1.49	1.21	0.37	25.28	+4.33	492
1971	0.54	0.13	0.26	1.50	2.24	2.29	3.58	0.69	3.33	2.97	0.29	0.50	19.02	-1.93	405
1972	0.68	0.76	0.50	0.70	1.66	5.03	1.92	1.53	4.22	1.40	0.38	0.32	19.10	-1.85	422
1973	0.09	0.17	1.18	0.90	2.46	2.21	4.04	2.09	5.67	1.19	0.67	0.75	21.40	+0.45	642
1974	0.88	0.87	0.16	2.72	4.12	1.56	2.56	10.97	0.42	0.66	0.15	1.40	26.47	+5.52	504
1975	1.10	0.29	0.64	1.40	1.52	4.96	2.26	1.75	1.79	1.49	0.20	0.65	18.05	-2.90	146
1976	1.13	0.50	1.05	0.77	0.54	5.82	1.52	3.72	0.34	0.07	T	0.37	15.83	-5.12	140
1977	0.14	0.62	1.02	0.27	2.43	3.71	2.28	1.74	3.83	0.87	2.27	0.26	19.44	-1.51	507
1978	0.36	0.26	0.17	1.00	1.97	1.92	6.25	3.25	3.44	0.23	0.98	0.79	20.62	-0.33	415
1979	0.50	1.01	1.06	2.77	1.89	1.91	3.70	1.59	0.45	1.40	1.02	0.16	17.46	-3.49	62
1980	0.55	0.82	0.35	0.00	0.24	1.75	3.35	5.19	4.12	1.66	0.94	0.18	19.15	-1.80	625
1981	0.27	0.16	0.66	0.56	2.79	6.85	2.63	2.41	3.63	1.75	0.90	0.99	23.60	+2.65	595
1982	1.30	0.45	0.74	0.24	1.38	2.00	5.53	2.71	1.92	2.91	0.46	0.57	20.21	-0.74	605
1983	1.31	1.26	1.17	0.53	2.76	4.03	1.62	3.34	2.91	2.26	0.66	0.10	21.85	+0.90	613
1984	T	0.95	T	0.72	0.72	4.46	3.78	0.99	0.37	4.32	0.10	1.02	17.18	-3.77	525
1985	0.12	0.33	0.06	1.07	4.35	4.62	1.08	8.72	1.60	1.04	1.68	0.38	25.05	+4.10	488
1986	0.30	0.90	0.26	2.96	1.40	2.43	3.59	2.04	2.52	0.65	1.97	0.36	19.38	-1.57	288
1987	0.47	0.30	0.10	0.59	4.37	2.25	4.80	2.22	0.82	0.92	0.73	0.35	17.92	-3.03	152
1988	0.60	0.09	1.75	0.00	1.74	1.34	5.53	1.70	2.24	0.12	0.77	1.05	16.81	-4.14	320
1989	3.27	0.32	2.86	0.10	2.82	5.46	1.60	2.56	1.24	0.41	0.62	0.45	21.71	+0.76	160
1990	0.55	0.20	1.12	1.09	0.46	3.19	2.48	0.62	0.91	0.16	0.18	0.72	11.69	-9.26	210
1991	0.56	0.64	0.58	2.87	3.19	5.94	3.40	1.99	7.42	1.64	1.36	0.70	30.29	+9.34	630
1992	0.61	0.68	0.45	2.27	1.99	2.36	2.72	4.51	2.76	0.12	1.27	0.88	20.62	-0.33	490
1993	0.68	0.05	0.27	1.01	1.63	5.06	5.87	4.69	0.72	0.71	0.45	0.65	21.79	+0.84	230
1994	0.21	0.33	0.47	0.02	0.16	2.54	3.03	3.48	3.94	1.38	2.72	0.32	18.59	-2.20	300
1995	0.57	0.59	1.23	0.61	2.50	2.13	4.59	3.59	1.81	1.33	1.54	1.46	21.95	+1.16	250
1996	0.94	0.48	0.22	1.65	4.62	1.64	7.34	1.78	1.77	1.75	2.73	1.07	25.99	+5.20	350
1997	1.06	0.14	1.02	0.84	2.02	3.36	4.02	1.31	4.01	2.45	0.19	0.25	20.67	-0.12	275
1998	0.69	1.05	0.21	0.77	4.55	5.39	3.01	2.20	0.31	4.42	1.39	0.95	24.94	+4.39	400
1999	0.15	0.77	0.23	1.31	4.09	6.97	3.46	1.38	3.16	0.43	0.38	0.56	22.89	+2.34	

* Seed yield estimates of Park Kentucky bluegrass on 2-4 year old stands at Roseau test plots with 100 lbs/A of nitrogen.

Table 2. Lodging, height, harvest date and seed yield for 8 Kentucky bluegrass varieties seeded on the Cenex farm near Roseau, MN 1996. 1999 data.

Variety	msp #	Lodging at harvest	Harvest height (in)	Harvest date	Seed yield lbs/A
Abbey	2606	1.0	24	08-Jul	607
Trenton	3047	1.8	31	08-Jul	386
Blacksburg	3094	1.8	21	07-Jul	107
Midnight	3020	1.0	24	08-Jul	352
Minnfine	2794	8.0	31	07-Jul	399
Optigreen	3096	1.0	27	08-Jul	504
Park	3021	6.0	33	07-Jul	323
Rugby	3038	3.0	31	08-Jul	299
LSD@5%		2.0	2		161

Lodging: 1=no lodging, 9=severe lodging.
 Experimental design: RCB/ 4reps.

Table 3. Lodging, height, harvest date and seed yield for 12 Kentucky bluegrass varieties seeded on the Higgins farm north of Roseau on organic soil, 1997. 1999 data.

Variety	msp #	Lodging at harvest	Harvest height (in)	Harvest date	Seed yield lbs/A
Abbey	2606	1.3	19	08-Jul	531
Trenton	3047	2.8	26	11-Jul	243
Blacksburg	3094	1.0	19	12-Jul	85
Midnight	3153	1.5	20	12-Jul	272
Minnfine	2794	7.5	24	07-Jul	156
Optigreen	3156	1.3	20	12-Jul	283
Park	3021	3.8	29	07-Jul	225
Lato	2918	4.0	31	07-Jul	301
CAS-JC91	3164	1.8	23	12-Jul	308
Park	2552	4.2	29	07-Jul	232
Unique	2859	1.0	18	12-Jul	250
Barmax	2861	2.0	19	07-Jul	529
LSD@5%		1.6	2	2	89

Lodging: 1=no lodging, 9=severe lodging.
 Experimental design: RCB/4reps.

Table 4. Harvest height, percent heading and seed yield for 8 reed canarygrass strains seeded 7/26/95 on Cenex Farm.

Variety	msp#	% Heading		Harvest height (in.)	Seed yield(lbs/A)				4 yr. Ave.
		6-17	6-24		1996	1997	1998	1999	
Fu Sr 8702	3010	70	80	67	214	638	372	462	421
Fu Sr 8703	3011	48	60	66	129	589	190	343	313
LQ Sr 9102	3012	33	55	70	143	453	274	477	337
LQ Sr 9104	3013	18	43	66	138	466	138	446	297
Mn-76	2408	65	78	70	76	299	96	201	168
Palaton	2983	38	58	71	243	769	230	513	439
Venture	2661	55	68	66	274	609	210	631	431
Vantage	2925	93	58	70	187	645	239	401	368
LSD at 5% level		19	15	3	77	220	116	136	85

Experimental design: RCB with 4 reps.

Table 5. Heading, lodging, height, harvest date and seed yield for 8 timothy varieties seeded 8/11/98 on the Magnusson farm, Roseau, MN. 1999 data.

Variety	msp#	Heading (%) 6/20/99	Height (in) 8/3/99	Lodging 8/3/99	Harvest date	Seed yield (lbs/A)
Climax	3171	30	47	1.0	8/3/99	551
Colt	3246	55	45	1.5	8/3/99	457
Comtal	3245	20	44	4.0	8/3/99	486
Grindstad	3109	50	42	5.3	8/3/99	479
Heidemij	2715	0	43	6.5	8/17/99	417
PP1	3124	60	43	3.5	8/3/99	468
PPA	3125	50	43	4.5	8/3/99	454
Timfor	2876	38	45	2.3	8/3/99	488
LSD @ 5% level		8	2	2.6		92

*lodging, 1=no lodging; 9=severe lodging.

Experimental design: RCB/ 4 reps.

Table 6. Seed yield for 6 birdsfoot trefoil varieties planted in 1998 on the Magnusson farm, Roseau, MN. 1999 data.

Variety	msp#	Seed yield
		lbs/A
Dawn	3142	602
Leo	2951	459
Norcen	3173	644
Nueltin	3213	531
Roseau	3214	520
Viking	2949	459

LSD @ 5% level NS

Experimental design: RCB/ 4reps.

Table 7. Seed yield for 4 kura clover strains seeded on the Magnusson farm- 6/2/98. 1999 data.

Strain	msp#	Seed yield
		lbs/A
Endura	3210	169
Erect bunch	3206	85
Prostrate spreader	3145	67
Rhizo	3086	62

LSD @ 5% level 62

Experimental design: RCB /4 reps
(only 2 reps harvested).

Table 8. Seed yield on 4 cicer milkvetch varieties seeded in 1998 on the Magnusson farm, Roseau, MN. 1999 data.

Variety	msp#	Seed yield
		lbs/A
Hi pal	3187	372
Lutana	3215	210
Monarch	3216	263
Windsor	3231	181

LSD@5% level 116

Experimental design: RCB/ 4reps.

Table 9. Percent heading, height, and seed yield for 5 quackgrass lines seeded on the Cenex farm in 1995. 1996-99 data.*

Strain	msp#	% heading			Harvest height (in.) 8/11	Seed yield (lbs/A)*		3 yr. ave.	
		06/24/1999	06/28/1999	07/06/1999		1996	1997		1999
Everett(hi rhizome/shoot)	2975	30	45	50	85	161	428	134	241
Hi forage	2976	35	48	60	90	308	341	118	256
1994 Roseau ecotype	3015	40	63	78	98	254	397	180	278
1994 Roseau common	3014	35	48	63	90	297	308	120	242
1993 common	3016	45	50	63	90	342	363	169	292
LSD@ 5% level		9	11	10		108	93	54	NS

Experimental design: RCB/4 reps.

*Standing water problems in 1998 & 1999.

Table 10. Winter injury, % heading, harvest date, and seed yield for 7 perennial ryegrass varieties seeded under spring wheat on 5/31/98 on the Magnusson farm near Roseau, MN. 1999 data.

Variety	mssp #	winter injury 5/28/99	%heading 6/18/99	Harvest date	Seed yield (lbs/A)
Delray	3105	3.3	78	7/23/99	923
P1	3106	3.5	63	7/23/99	1360
Tophat	3029	2.3	73	7/24/99	1346
Brightstar*	3092	3.0	40	7/27/99	1232
NK-200*	3009	2.3	0	8/9/99	1204
PST-2m3*	3093	2.3	25	7/28/99	1217
Chaparal*	3174	2.3	20	7/28/99	1128
LSD at 5%		1.5			231

Experimental design; RCB w 4 reps.

Winter injury: 1= no injury; 10=dead.

*Seed yields on these varieties have been adjusted because of harvest problems.

Table 11. Perennial ryegrass winter hardiness variety trial seeded 8/19/98 at Rosemount and 8/11/98 at Roseau on the Magnusson farm.

Variety	MSP#	ROSEMOUNT		ROSEAU	
		WI 4/26/99	WI 4/28/99	WI 4/30/99	WI 5/28/99
Affinity	3030	3.5	3.3	4.0	2.7
Barspectra annual	3175	9.5	9.8	10.0	10.0
Brightstar	3159	4.8	4.0	3.3	1.3
Chaparal	3174	4.8	4.3	5.0	2.7
Charger II	3224	3.8	3.0	5.0	2.7
Delray	3105	4.5	3.0	4.7	2.3
K9 Bulk	3101	2.5	2.0	3.0	1.7
K9 c2	3244	2.3	2.0	2.2	1.3
NK-200	3179	2.3	2.0	2.3	1.0
NK-200	3009	3.3	2.8	2.7	1.7
p1	3018	5.5	4.8	5.7	4.0
p1 Baumgartner 97	3181	5.5	5.3	5.2	3.3
p1 Helmstetter 96	3106	5.5	5.0	5.5	4.7
Panther	3082	4.8	4.3	2.5	1.0
syn. 210 early	3242	3.0	2.8	3.5	2.7
syn. 210 medium	3243	4.5	3.8	4.5	2.3
T.Q. xSpread syn.2	3102	2.8	2.0	3.3	2.0
Tophat	3029	3.3	3.3	4.0	1.7
winter hardy select	3103	2.5	2.0	3.0	1.7
winter hardy x t.q. 96	3104	3.0	2.0	2.3	1.7
LSD@5%		2.0	2.1	1.9	1.5

Winter injury rating. 1=no injury ,10=dead.

Experimental design: RCB/ 4reps.

Table 12. 'Park' Kentucky Bluegrass Renovation - Weed Control Study.¹ Cenex farm - Roseau, MN. 1997-99 data.

Treatment ²	Timing ⁷	Harvest		Weed infestation (%)			Seed Yield (lbs/A)		
		Ht. (in.)	Lodging ³	Quackgrass	Thistle	1997	1998	1999	3 yr. Ave. ⁶
1. 3/4 pt./Ac. Banvel+ 3/4 pt./Ac. 2,4-D Amine	Fall 9/16/98	34	4.8	17	1	460	341	324	375
2. 3/4 pt./Ac. Banvel+ 3/4 pt./Ac. 2,4-D Amine	Spring 5/29/98	33	5.0	9	1	391	250	275	305
3. 0.25#/Ac. Beacon+ 0.25% nonionic surfactant	Fall 9/10/97	34	6.3	9	4	381	197	270	283
4. 0.025#/Ac. Beacon+ .25% nonionic surfactant	Spring 5/20/98	34	4.8	1	11	509	283	382	391
5. Banvel+ 2,4-D+ ⁴ Roundup strip	Fall 9/16/98 Fall 8/23/96	34	5.0	9	1	392	389	341	374
6. Beacon+ ⁴ Roundup strip	Fall 9/10/97	36	6.8	1	30	336	207	317	287
7. 3/4 pt. Banvel + 3/4 pt. 2,4-D ⁵ Roundup strip	'9/16/98	34	6.0	6	8	---	381	342	362
8. No treatment	-----	33	4.3	14	17	402	385	303	363
LSD at 5% level		1	2.0	14	18	122	99	114	93

Experimental design - RCB w/4 reps.

¹Field seeded in 1990.

²3/4 pt./Ac. Banvel = .375#; Dicamba.

3/4 pt./Ac. 2,4-D = .375# A; 2,4-D.

.025#/Ac. Beacon = .02# A; Primisulfuron.

³1=no lodging, 9=severe lodging.

⁴3"=Roundup strip applied every 10" at 1/2 pt./Ac after burning 8/23/96.

⁵3"=Roundup strip applied every 10" at 1/2 pt./Ac before burning 7/30/97.

⁶2 year Ave. on Treatment 7.

⁷Timing of last treatment date.

Table 13. 1998-99 herbicide trial on 'Park' Kentucky bluegrass - Rice farms north of Roseau

Experimental design:

plot size-10'x70'
 spring treatment-5/26/99 9:30pm.wind NNW at 0-5 mph, 65 F wet ground
 fall treatment -9/16/98 4:00pm. Sunny wind ENE 0-7mph, dry ground
 CO2 bicycle sprayer-8003 12.5gpa

treatment	product applied/ac.	adjuvant	timing	Harvest height (in)	Lodging	Seed yield lbs/A
Beacon	0.4 ounces	0.25% non-ionic	spring	31	4.5	347
Beacon	0.4 ounces	0.25% non-ionic	fall	31	5.0	440
Beacon	0.2+0.2 ounces	0.25% non-ionic	fall+spring	32	3.3	263
Weedar 64 +Banvel	0.75 pints+0.75 pints	none	fall	31	6.5	415
Weedar 64 +Banvel	0.75 pints+0.75 pints	none	spring	32	6.0	344
Weedar 64 + Express	0.25 ounces+0.75 pints	none	fall	31	6.3	395
Weedar 64 + Express	0.25 ounces+0.75 pints	none	spring	30	5.8	352
Maverick	0.67 ounces	.5% non-ionic	spring	23	1.0	219
Weedar 64+Express+Malathion	0.25 oz+0.75pt.+1 pt.	none	spring	29	1.5	223
no treatment	none	none		31	6.3	333
		LSD @ 5% level		8	1.7	94

Treatment formulations

- Beacon 75% DF
- Weedar 64 3.8#/ gal.
- Banvel 4#/ gal.
- Express 75% DF
- Maverick 75% DG
- Malathion 5#/gal

Lodging: 1=no lodging; 9=severe lodging
 Plots harvested 7/6/99. Approximately 30-40% shattering except treatments 8 & 9 which had little shattering because of herbicide injury and delayed maturity.

Table 14. 1999 Fungicide x herbicide trial on 'Park' Kentucky bluegrass

Locations:

Helmstetter farm north of Roosevelt
 Rice farm north of Roseau

Harvest date: 7/1/99

Treatment	Helmstetter			Rice			
	Harvest ht.(in.)	Lodging	Seed yield lbs/A	Harvest ht.(in.)	Lodging	Seed yield lbs/A	Bushel weight lbs/bu
Tilt	30	3.8	649	33	7	826	26.7
2,4D	31	4.5	572	31	8	741	27.2
Quadris +2,4D	31	4.5	605	33	7.8	782	26.5
Tilt + 2,4D	31	5.5	600	33	7.5	774	26.9
Quadris	31	4.5	624	31	7.8	826	27.1
no treatment	33	7.3	662	32	8.8	801	26.9
LSD AT 5%	NS	NS	NS	NS	1.2	NS	0.5

Lodging, 1=no lodging, 9=severe lodging
 Bushel weights corrected to 6% moisture.

Plot size-10'x50'

C02 bicycle sprayer at 12.5 gpa

Application dates: 5/25/99 - Helmstetter Farm and 5/26/99 at Rice Farm

Rates:

Tilt- 1/4 pt./ac

Quadris-13 oz./ac.

Weedar 64- 1 pt./ac

Table 15. Fertility trial on 'Endura' Kura Clover. Cenex farm - 1997-1999 data.

Fertility level	Seed Yield (lbs/A)			3 yr. ave.	Soil Test lbs/A (10/10/98)		
	1997	1998	1999		P ₂ O ₅	K ₂ O	SO ₄
0	578	566	210	451	6	170	10
50+0+0	526	537	187	417	6	160	10
0+0+80	640	526	140	436	4	174	70
0+0+240	580	600	205	462	6	276	26
0+40+80+10 sulfur	575	580	123	426	14	240	28
50+40+80+10 sulfur	584	473	158	405	8	194	134
1996 Soil test (prior to fertility treatments)					22	300	10

LSD at 5% level

NS

NS

70

NS

Experimental Design: RCB w/4 reps.

Fertilizer applied 4/30/99.

Table 16. Herbicides were applied to 6 legumes as an aid to establishment in 1998. Each species was seeded in a randomized complete block design with 3 reps, in 5 feet X 10 feet plots, with 1 foot between the rows, on the Magnusson farm on 6/3/98. Treflan and Eptam were applied pre-plant incorporate. All other treatments were applied 7/22/98 with a bicycle sprayer at 12 GPA and 28 PSI. Weeds were 2"-4" high. All treatments except the no treatment control plots were clipped on 8/20/98.

Treatment	Trade name	Chemical name	Application rate	lbs active ingredient	Timing of application	Additives
1	Treflan	Trifluralin	1.5pt	0.75	PPI	
2	Eptam	EPTC	4 pt.	3.5	PPI	
3	Ally	Metsulfuron	0.13 oz.	0.0067	Post	1/4 pt Preference
4	Roundup Ultra	Glyphosate	1pt.	0.375	Post	
5	Pursuit	Imazethapyr	3 oz.	0.047	Post	1pt. Prefer 28
6	Raptor	Imazamox	4 oz.	0.03	Post	1pt. Prefer 28
7	Gramoxone extra	Paraquat	1pt.	0.31	Post	1/4pt Preference
8	Clip					
9	No treatment					

Species	Variety	Herbicide Treatment								
		1	2	3	4	5	6	7	8	9
Nueltin	birdsfoot trefoil	1.7	2.3	9.0	4.7	1.7	2.7	7.7		
Norcen	birdsfoot trefoil	2.3	1.7	9.3	8.7	1.7	2.7	9.0		
Marathon	red clover	2.3	2.3	10.0	7.0	2.7	3.0	7.0		
GH 766	alfalfa	2.3	2.0	9.3	7.0	2.3	2.3	8.0		
Endura	kura clover	2.3	2.3	10.0	7.3	1.7	2.7	7.0		
Lutana	cicer milkvetch	2.0	2.7	9.3	8.0	2.0	4.0	10.0		
All Species	Stand/vigor 7/22/99	6.7	6.0	1.0	3.3	9.7	7.0	2.2	4.1	3.3

¹Injury rating. 1=none; 10=dead. We were not able to rate the clip and no treatment plots because of weeds.

²Stand/vigor. 1=no stand, 10=best. For all species, stand/vigor was a mean visual rating.

Table 17. The effect of timing of 'Roundup' applications on selected birdfoot trefoil populations seeded in St. Paul 7/30/97. 1998-99 data. Treatments all 2 pt./AC 'Roundup Ultra' at 12 GPA.

Treatment #	Roundup treatment	Population	% Thistle infestation		% Total weeds infestation		Seed yield lbs/A		
			98	99	98	99	98	99	2 yr. Ave.
1	5/5/98 5/14/99	Norcen	1	1	3	51	214	190	202
		Roseau(NC3M)	0	0	1	11	213	212	212
		Leo	4	5	5	54	168	178	173
		Nueltin(LC6F)	1	3	1	21	264	421	343
2	5/21/98 6/3/99	Norcen	0	0	24	13	354	310	332
		Roseau(NC3M)	0	0	2	0	262	413	337
		Leo	0	0	16	13	303	254	279
		Nueltin(LC6F)	0	0	3	3	422	415	418
3	6/10/98 6/15/99	Norcen	1	1	5	5	241	285	263
		Roseau(NC3M)	0	0	0	0	259	350	304
		Leo	0	0	6	3	182	216	199
		Nueltin(LC6F)	0	0	0	0	251	326	288
1 + 3	5/5/98+ 5/14/99+ 6/10/98 6/15/99	Norcen	1	0	75	90	0	4	2
		Roseau(NC3M)	0	0	1	6	388	239	314
		Leo	0	0	78	90	0	11	6
		Nueltin(LC6F)	0	0	2	14	424	413	418
5	no treatment no treatment no treatment no treatment	Norcen	13	18	20	20	238	259	249
		Roseau(NC3M)	14	19	21	20	204	203	204
		Leo	13	28	20	28	216	194	205
		Nueltin(LC6F)	18	38	26	40	257	154	206
6	no treatment no thistles planted	Norcen	4	16	13	21	177	252	215
		Roseau(NC3M)	6	9	10	15	180	236	208
		Leo	6	10	11	13	279	223	251
		Nueltin(LC6F)	11	20	18	26	186	274	230
			6	11	9	15	134	133	106

% thistle and % weeds = % of total biomass.
 Roundup Ultra applied at 2 pts/ac. on each treatment date.
 Thistles transplanted into all plots except treatment 6 - August 15, 1997.

Table 18. The effect of timing of Roundup applications on selected birdsfoot trefoil populations. Summaries of thistle infestations and seed yields in 4 trials seeded between 1994 and 1997.

Treatment #	Roundup treatment	Population	% thistle infestation				seed yield (lbs/A)				
			F8 1994	F8 1995	F8 1996	F1a 1996	F8 1994	F8 1995-6	Brandt 1994	F1a 1995	X24 1997
1	early	Roseau(NC3M)	53	70	85	85	0	266	153	408	212
	early	Norcen	63	70	85	85	1	148	85	183	202
	early	Nueltin(LC6F)	47	70	85	85	1	255	90	289	343
	early	Leo	65	70	85	85	4	127	3	194	173
2	intermediate	Roseau(NC3M)	17	5	5	5	0	343	98	430	337
	intermediate	Norcen	36	5	5	5	0	154	7	169	332
	intermediate	Nueltin(LC6F)	18	5	5	5	0	282	96	579	418
	intermediate	Leo	46	5	5	5	0	115	31	243	279
3	late	Roseau(NC3M)	0	3	6	6	0	314	323	304	
	late	Norcen	0	3	6	6	1	244	361	263	
	late	Nueltin(LC6F)	0	3	6	6	0	318	426	288	
	late	Leo	0	3	6	6	0	234	468	199	
4	early+late	Roseau(NC3M)	0	4	10	10	0	371	453	314	
	early+late	Norcen	9	4	10	10	1	73	303	2	
	early+late	Nueltin(LC6F)	0	4	10	10	0	379	379	418	
	early+late	Leo	0	4	10	10	0	53	292	6	
5	no treatment	Roseau(NC3M)	80	100	100	100	19	77	359	204	
	no treatment	Norcen	78	100	100	100	18	107	262	249	
	no treatment	Nueltin(LC6F)	89	100	100	100	38	63	353	206	
	no treatment	Leo	91	100	100	100	28	64	378	205	
6	no thistles planted	Roseau(NC3M)	80	100	100	100	9	210	339	208	
	no treatment	Norcen	78	100	100	100	16	258	261	215	
	no treatment	Nueltin(LC6F)	89	100	100	100	20	232	274	230	
	no treatment	Leo	91	100	100	100	10	331	290	251	
LSD at 5%											
12 NS 166 106											

Roundup Ultra applied at 2pts/ac, each treatment date.
 Thistles transplanted into all plots except treatment 6.
 LOCATION= F8 & F1a Baumgartner farm
 Brandt- Craig Brandt farm south of Roseau
 X24 -St. Paul campus

Roundup timing:
 early- mid-May
 intermediate-early June
 late- mid-late June