

**"SPECIAL CROPS" METERING OF LUPINS
THROUGH A PNEUMATIC SEEDER**

RL0392

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ALBERTA FARM MACHINERY RESEARCH CENTRE

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SUMMARY

Tests were conducted by the Alberta Farm Machinery Research Centre (AFMRC) to determine if pneumatic seeders could be used to seed lupins. Seed number per unit mass and seed density were determined. Metering distribution uniformity and seed damage using a Case IH 8500 air drill was measured for Primorski and Ultra lupins. Uniformity of distribution across the width of the machine ranged from 5.63 to 7.60 per cent. Varying the metering rate from 84.1 to 174.2 kg/ha (75.0 to 155.2 lb/ac) had no significant effect on distribution uniformity. Reducing fan speed from 4000 to 2800 rpm did not effect distribution uniformity. No seed damage occurred because of the fluted roller metering systems. Average crackage was found to be 0.463 and 2.549 per cent for the Primorski and Ultra lupins for the air delivery system, respectively. Crackage results for the Primorski lupins indicated less seed damage in the air delivery system than the Ultra lupins.

INTRODUCTION

The AFMRC in conjunction with the Alberta Agriculture Region One Special Crops Group initiated a project to determine metering rates and seed damage caused by an pneumatic seeder when seeding Primorski and Ultra lupins. All testing was completed on a Case IH 8500 air drill.

Tests were conducted using standard AFMRC test procedures for pneumatic seeders.

SEED COUNTS

Seed counts were determined for the Primorski and Ultra lupins. Results indicated that the Primorski and Ultra lupins have an average seed count of 3410 and 2808 seeds/kg (1546 and 1270 seeds/lb), respectively.

SEED DENSITY

Seed density was determined using a 0.5 litre volume container and scale. Results indicated the Primorski and Ultra lupins have an average density of 730.31 and 748.92 g/L (58.55 and 60.05 lb/bu), respectively.

METERING

Lupin metering rate calibration for the Case IH 8500 air drill was completed. Seed metering rate tables for lupins were not available from the manufacturer. Tests were done by weighing Ultra lupins metered over a measured time out of the Case IH 8500 metering system. The Case IH 8500 air drill was equipped with a ground driven fluted roller meter. The Case IH 8500 metered seed out of a tank into a venturi feed housing and then into primary air lines which carried the seed to seven distribution headers. Seed was then separated into 11 secondary lines and delivered to ground openers. Metering rate was adjusted by a hand lever which increased or decreased the amount of meter exposed to the seed. Top, middle and bottom settings for metering gates were also available and set depending on the size of the seed metered. For the lupins, the top metering gate setting was used. Calibration with Primorski lupins was not completed. Sample tests indicated that metering rates for Primorski lupins were within 2 per cent of the Ultra lupins metering rates. Calibration results for the Ultra lupins are illustrated in FIGURE 1. Appendix I contains the metering test results.

Air Drill Calibration Lupins (Ultra)

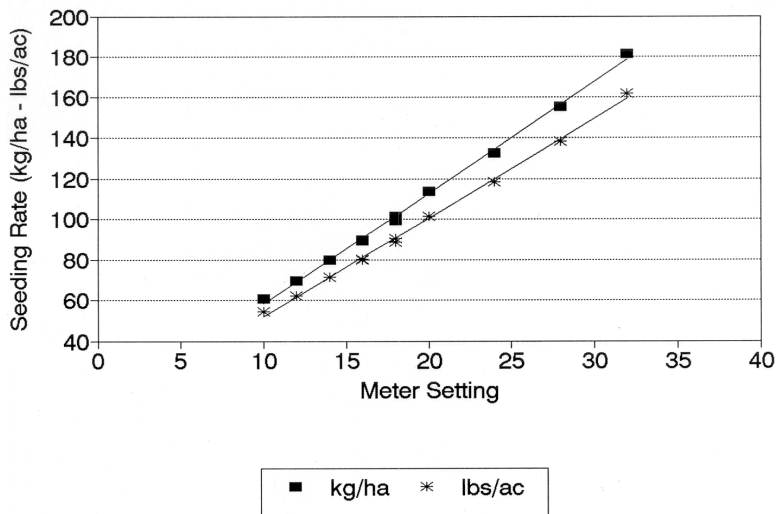


FIGURE 1. Ultra Lupin Metering Calibration For Case IH 8500 Air Drill.

Comparing lupin metering rates and manufacturers seed charts indicated that lupin metering rates were similar to wheat and soybean metering charts for the fluted roller metering system used on the Case IH 8500 air drill. The results are illustrated in FIGURE 2.

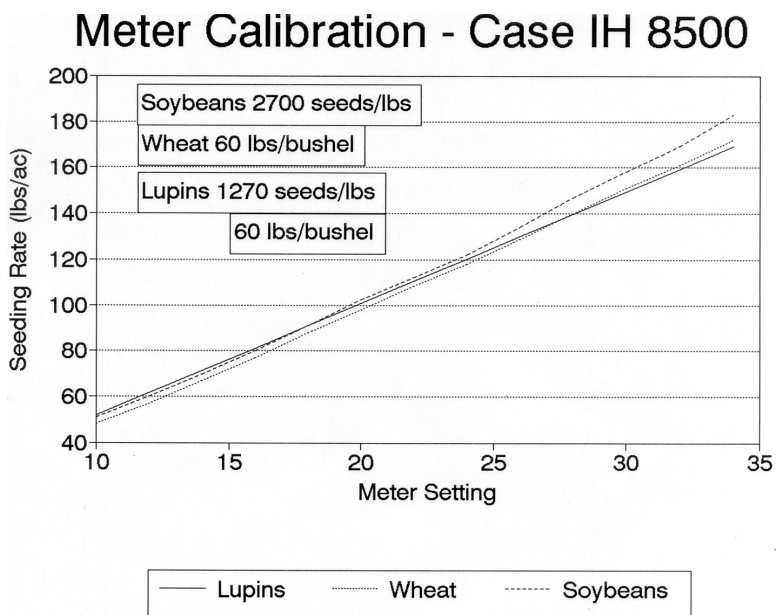


FIGURE 2. Lupins vs. Case IH 8500 Air Metering Charts.

UNIFORMITY OF DISTRIBUTION

Tests to determine the uniformity of seed distribution across the width of the air drill were completed. Tests were completed to determine if fan speed and metering rate affected distribution uniformity. Uniformity was measured at different air flows (fan speeds) and metering rates. Complete uniformity of distribution test results are located in Appendix II.

The coefficient of variation (CV) was used to rate uniformity distribution. The CV is the standard deviation of application rates from individual outlets expressed as a per cent of the average application rate. A low CV represents uniform application whereas a high CV indicates non-uniform application. An acceptable variation for seeding grain or applying fertilizer is a CV value not greater than 15 per cent. CV's of 5 per cent are typical for most seeding equipment presently marketed. Previous testing done on the Case IH 8500 using Laura wheat indicated CV's ranging from 6.50 to 7.00 per cent. Tests on Tobin canola resulted in CV's ranging from 6.90 to 7.50 per cent. CV's for tests on Radley peas ranged from 8.45 to 10.55 per cent.

EFFECT OF FAN SPEED AND METERING RATE ON UNIFORMITY

Fan speeds of 2800 and 4000 rpm were used. The manufacturer suggested a fan speed of 2800 rpm be used for lentils and canola. A fan speed of 4000 rpm was recommended for all other crops listed by the manufacturer. The manufacturer's seed chart which lists recommended fan speeds is located in Appendix III. Fan speeds had little effect on the uniformity of distribution of the lupins, see TABLE 1. For example, at fan speeds of 2800 and 4000 rpm, the CV's at a distribution metering rate of 98.1 kg/ha (87.5 lb/ac) were 6.85 and 7.04 per cent, respectively.

The metering rate did not significantly affect the uniformity of distribution across the machine width. Seeding rates of 84.1 to 174.2 kg/ha (75.0 to 155.2 lb/ac) were used. Increasing the seeding rate from 84.1 to 174.2 kg/ha (75.0 to 155.2 lb/ac) slightly decreases the CV of distribution from 7.60 to 5.63 per cent. TABLE 1 outlines the CV's at different metering settings and air flows (fan speeds).

TABLE 1. Uniformity of Distribution CV's.

METER SETTING	VARIETY	SEEDING RATE kg/ha (lb/ac)	FAN SPEED rpm	CV per cent
14	Primorski	84.1 (75.0)	2800	7.60
14	Ultra	80.5 (71.8)	2800	6.58
18	Ultra	101.8 (90.8)	2800	6.63
18	Primorski	98.1 (87.5)	2800	6.85
22	Primorski	115.3 (102.9)	2800	7.05
22	Ultra	121.0 (108.0)	2800	6.31
32	Ultra	174.2 (155.4)	2800	5.63
18	Primorski	98.6 (87.9)	4000	7.04
18	Primorski	99.2 (88.5)	4000	7.58
18	Ultra	104.1 (92.9)	4000	7.03

SEED CRACKAGE

Crackage samples were taken at the fluted roller meter. Crackage samples were also done once the seed was delivered through the air delivery system at the openers.

For metering crackage samples, seeds were metered at 101 kg/ha (91 lb/ac). Samples of seed taken after the metering system indicated no visible damage to the seed. Crackage analysis of seed run through the metering system indicated an average crackage of 0.36 and 0.31 per cent less than the control samples taken for the Primorski and Ultra lupins, respectively.

Samples were taken at the opener of four hoses of the air delivery system for the Primorski and Ultra lupins at a meter setting of 18 or seeding rate of 101 kg/ha (91 lb/ac). Average crackage was found to be 0.463 and 2.549 per cent for the Primorski and Ultra lupins, respectively. Crackage results for the Primorski lupins indicated less seed damage in the air delivery system than the Ultra lupins.

TABLE 2. Crackage Test Results.

SEEDING RATE kg/ha (lb/ac)	GATE SET	TYPE	FAN SPEED rpm	CONTROL CRACKAGE %	AVERAGE % SAMPLE CRACKAGE	AVERAGE % DIFFERENCE FROM CONTROL
101 (91)	Middle	Ultra	Meter	5.85	6.57	0.715
114 (102)	Top	Ultra	Meter	5.41	4.08	-1.335
101 (91)	Top	Primorski	Meter	4.76	4.40	-0.360
101 (91)	Top	Ultra	2800	2.98	5.04	2.695
101 (91)	Top	Ultra	4000	2.64	2.70	2.403
101 (91)	Top	Primorski	2800	3.40	3.16	-0.243
101 (91)	Top	Primorski	4000	2.62	3.30	0.683

A single test was completed to determine the effect of gate setting on crackage. Ultra lupins were metered at 101 kg/ha (90 lb/ac) using the middle gate setting. Crackage was measured to be 0.715 per cent higher than the control when the middle gate setting was used. Crackage tests with the meter gate set at the top indicated a crackage of -0.360 per cent of the control. Using the middle gate setting caused a 0.715 per cent higher crackage than the top gate setting.

CONCLUSIONS

From the tests on the Case IH 8500 air drill the following conclusions can be drawn:

1. The fluted roller metering system of the Case IH 8500 air drill caused little or no damage to the Primorski or Ultra lupins.
2. The air delivery system of the Case IH 85 air drill caused a maximum of 2.7 per cent crackage to the seed at a metering rate of 101 kg/ha (91 lb/ac).
3. The uniformity of distribution of the lupin seed by the Case IH 8500 air drill ranged from 5.63 to 7.60 per cent and was considered acceptable.
4. Fan speed and metering rate did not affect uniformity of seed distribution.
5. Metering rate testing of lupins indicated that manufacturers metering calibration charts were similar for wheat and soybeans (density = 2700 seeds/lb).
6. Metering of the Ultra lupins using the middle gate setting rather than the top gate setting caused a 0.715 per cent higher average crackage.

APPENDIX I

Metering Test Results

Air Drill Calibration Tests

Date : 10 February 1992

Project : Special Crops

Material : Lupins (Ultra)

Density : 60 lbs/bushel

Meter Setting : #10

Drive Wheel RPM : 40

Ground Speed : 5 mph

Tank: F

Miscellaneous : Gate Setting Top

Conversion : 5.469 min/ha

Run Number :	Material Metered (grams)		
	1	2	3
Time of Run (min)	0.5	0.528	
1	805.9	842	
2	775.9	824.6	
3	789.79	827.05	
4	783.52	839.08	
5	784.3	849.73	
6	810.4	850.26	
7	815.39	837.1	
Rate (kg/ha)	60.87216	60.79933	
(lbs/ac)	54.30892	54.24395	
Mean X	795.0286	838.5457	
Standard Dev. S	14.19231	9.283278	
CV	1.785132	1.107069	
Average Rate (kg/ha)		60.83574	
(lbs/ac)		54.27643	

Air Drill Calibration Tests

Date : 10 February 1992

Project : Special Crops

Material : Lupins (Ultra)

Density : 60 lbs/bushel

Meter Setting : #12

Drive Wheel RPM : 40

Ground Speed : 5 mph

Tank : F

Miscellaneous : Gate Setting Top

Conversion : 5.469 min/ha

Run Number :	Material Metered (grams)		
	1	2	3
Time of Run (min)	0.517	0.501	
1	933.4	920.1	
2	945.1	884.5	
3	925.49	891.7	
4	944.2	903.3	
5	955.15	912.34	
6	974.5	936.15	
7	947.05	892.17	
Rate (kg/ha)	70.08032	69.21134	
(lbs/ac)	62.52426	61.74897	
Mean X	946.4129	905.7514	
Standard Dev. S	14.5374	16.95749	
CV	1.536053	1.872201	
Average Rate (kg/ha)		69.64583	
(lbs/ac)		62.13662	

Air Drill Calibration Tests

Date : 10 February 1992

Project: Special Crops

Material : Lupins (Ultra)

Density : 60 lbs/bushel

Meter Setting : #14

Drive Wheel RPM : 40

Ground Speed : 5 mph

Tank : F

Miscellaneous : Gate Setting Top

Conversion : 5.469 min/ha

	Material Metered (grams)		
Run Number :	1	2	3
Time of Run (min)	0.402	0.352	0.805
1	833.8	721.6	1635.69
2	846	718.7	1641.4
3	837.2	720.25	1678.9
4	845.94	738.91	1660.2
5	853.9	748.8	1693.2
6	865.7	757.6	1709.5
7	832.7	741.55	1697.7
Rate (kg/ha)	80.47375	79.97496	79.60004
(lbs/ac)	71.79707	71.35206	71.01756
Mean X	845.0343	735.3443	1673.799
Standard Dev. S	11.00094	14.24968	26.55227
CV	1.301834	1.937824	1.586348
Average Rate (kg/ha)	80.01625		
(lbs/ac)	71.3889		

Air Drill Calibration Tests

Date : 10 February 1992

Project : Special Crops

Material : Lupins (Ultra)

Density : 60 lbs/bushel

Meter Setting : #16

Drive Wheel RPM : 40

Ground Speed : 5 mph

Tank : F

Miscellaneous: Gate Setting Top

Conversion : 5.469 min/ha

Run Number :	Material Metered (grams)		
	1	2	3
Time of Run (min)	0.396	0.404	
1	919.9	928.4	
2	915.7	922	
3	921.12	948.84	
4	946.16	943.84	
5	924.62	943.67	
6	921.9	952.8	
7	929.45	951.73	
Rate (kg/ha)	89.47685	89.22701	
(lbs/ac)	79.82945	79.60655	
Mean X	925.55	941.6114	
Standard Dev. S	9.279312	11.00763	
CV	1.002573	1.169021	
Average Rate (kg/ha)		89.35193	
(lbs/ac)		79.718	

Air Drill Calibration Tests

Date : 10 February 1992

Project : Special Crops

Material : Lupins (Ultra)

Density : 60 lbs/bushel

Meter Setting : #16

Drive Wheel RPM : 40

Ground Speed : 5 mph

Tank : F

Miscellaneous : Gate Setting Top

Conversion : 5.469 min/ha

Run Number :	Material Metered (grams)		
	1	2	3
Time of Run (min)	0.399	0.403	
1	928.5	956.2	
2	930.9	953.2	
3	930.6	943.6	
4	957.8	924.6	
5	907	926	
6	938.7	963.2	
7	952.7	954.7	
Rate (kg/ha)	89.72724	89.85852	
(lbs/ac)	80.05285	80.16997	
Mean X	935.1714	945.9286	
Standard Dev. S	15.62523	14.09708	
CV	1.670841	1.49029	
Average Rate (kg/ha)		89.79288	
(lbs/ac)		80.11141	

Air Drill Calibration Tests

Date : 10 February 1992

Project : Special Crops

Material : Lupins (Ultra)

Density : 60 lbs/bushel

Meter Setting : #18

Drive Wheel RPM : 40

Ground Speed : 5 mph

Tank : F

Miscellaneous : Gate Setting Top

Conversion : 5.469 min/ha

	Material Metered (grams)		
Run Number :	1	2	3
Time of Run (min)	0.301	0.305	
1	797	798.8	
2	799.8	792.2	
3	811.51	792.98	
4	811.27	805.01	
5	802.4	790.83	
6	828.4	802.8	
7	816.64	811.36	
Rate (kg/ha)	102.9666	100.3065	
(lbs/ac)	91.8647	89.49144	
Mean X	809.5743	799.14	
Standard Dev. S	10.11416	7.095892	
CV	1.249319	0.887941	
Average Rate (kg/ha)		101.6365	
(lbs/ac)		90.67807	

Air Drill Calibration Tests

Date : 10 February 1992

Project : Special Crops

Material : Lupins (Ultra)

Density : 60 lbs/bushel

Meter Setting : #18

Drive Wheel RPM : 40

Ground Speed : 5 mph

Tank : F

Miscellaneous : Gate Setting Top

Conversion : 5.469 min/ha

	Material Metered (grams)		
Run Number :	1	2	3
Time of Run (min)	0.403		
1	1031.1		
2	1033		
3	1047.2		
4	1036.71		
5	1054.89		
6	1063.08		
7	1062		
Rate (kg/ha)	99.44596		
(lbs/ac)	88.7237		
Mean X	1046.854		
Standard Dev. S	12.53797		
CV	1.19768		
Average Rate (kg/ha)	99.44596		
(lbs/ac)	88.7237		

Air Drill Calibration Tests

Date : 10 February 1992

Project : Special Crops

Material : Lupins (Ultra)

Density : 60 lbs/bushel

Meter Setting : #20

Drive Wheel RPM : 40

Ground Speed : 5 mph

Tank : F

Miscellaneous : Gate Setting Top

Conversion : 5.469 min/ha

Run Number :	Material Metered (grams)		
	1	2	3
Time of Run (min)	0.154	0.21	0.32
1	471.42	604.3	944.9
2	460.05	640.6	935.8
3	463.34	627.6	948.5
4	458.6	623.4	936.6
5	467.64	625.26	930.6
6	464.41	636.9	969.6
7	459.6	622.68	940.7
Rate (kg/ha)	115.2418	114.087	112.9126
(lbs/ac)	102.8164	101.7861	100.7384
Mean X	463.58	625.82	943.8143
Standard Dev. S	4.339147	10.84648	11.88413
CV	0.936008	1.733163	1.25916
Average Rate (kg/ha)		114.0805	
(lbs/ac)		101.7803	

Air Drill Calibration Tests

Date : 10 February 1992

Project : Special Crops

Material : Lupins (Ultra)

Density : 60 lbs/bushel

Meter Setting : #24

Drive Wheel RPM : 40

Ground Speed: 5 mph

Tank : F

Miscellaneous : Gate Setting Top

Conversion : 5.469 min/ha

Run Number :	Material Metered (grams)		
	1	2	3
Time of Run (min)	0.252	0.301	
1	849	1029	
2	852.8	1061	
3	874.73	1044.7	
4	891.7	1058.7	
5	870.23	1046.4	
6	879	1055.2	
7	881.92	1043.6	
Rate (kg/ha)	132.3711	133.3382	
(lbs/ac)	118.0988	118.9617	
Mean X	871.34	1048.371	
Standard Dev. S	14.34609	10.19926	
CV	1.64644	0.972867	
Average Rate (kg/ha)		132.8546	
(lbs/ac)		118.5303	

Air Drill Calibration Tests

Date : 10 February 1992

Project : Special Crops

Material : Lupins (Ultra)

Density : 60 lbs/bushel

Meter Setting : #28

Drive Wheel RPM : 40

Ground Speed : 5 mph

Tank : F

Miscellaneous : Gate Setting Top

Conversion : 5.469 min/ha

Run Number :	Material Metered (grams)		
	1	2	3
Time of Run (min)	0.204	0.204	
1	817.7	827.4	
2	815.8	808.9	
3	828.5	837.1	
4	822.27	843	
5	825.65	815.7	
6	853.65	835.1	
7	820.49	830.2	
Rate (kg/ha)	155.0638	155.4215	
(lbs/ac)	138.3449	138.6639	
Mean X	826.2943	828.2	
Standard Dev. S	11.8773	11.2074	
CV	1.437418	1.353223	
Average Rate (kg/ha)		155.2427	
(lbs/ac)		138.5044	

Air Drill Calibration Tests

Date : 10 February 1992

Project : Special Crops

Material : Lupins (Ultra)

Density : 60 lbs/bushel

Meter Setting : #32

Drive Wheel RPM : 40

Ground Speed : 5 mph

Tank : F

Miscellaneous : Gate Setting Top

Conversion : 5.469 min/ha

	Material Metered (grams)		
Run Number :	1	2	3
Time of Run (min)	0.151	0.15	0.154
1	726.9	696	734
2	720.2	697.3	747.2
3	723.3	700.24	751.7
4	722.49	712.6	738.7
5	708.98	681.38	729.8
6	709.9	721.7	719.8
7	697.17	712.3	743.5
Rate (kg/ha)	181.4165	179.4386	183.4139
(lbs/ac)	161.8562	160.0915	163.6382
Mean X	715.5629	703.0743	737.8143
Standard Dev. S	9.794909	12.44894	10.12288
CV	1.36884	1.770644	1.372009
Average Rate (kg/ha)	181.423		
(lbs/ac)	161.862		

Regression Output:

Constant	2.945677
Std Err of Y Est	1.709505
R Squared	0.997558
No. of Observations	11
Degrees of Freedom	9
X Coefficient(s)	4.881286
Std Err of Coef.	0.080506

Regression Output:

Constant	3.295355
Std Err of Y Est	1.913916
R Squared	0.997564
No. of Observations	11
Degrees of Freedom	9
X Coefficient(s)	5.471448
Std Err of Coef.	0.090132

APPENDIX II

Uniformity of Distribution Results

Air Drill Distribution Tests

Date : 11 February 1992

Project : Special Crops

Material : Lupins (Primonski)

Density : 60 lbs/bushel

Test Run #1

Meter Setting : #18

Drive Wheel RPM : 39-40

Ground Speed : 5 mph

Tank : F

Miscellaneous : Gate Setting Top

Conversion : 5.469 min/ha

Fan Speed : 3080 - 4050

Meter RPM : 52

Time of Run : 1.752 min

Samples

368.92	388.1	432.02	432.9	404.25
439.52	374.8	452.89	371.64	448.04
471	386.58	432.97	430.55	382.31
462.82	401.4	466.18	425.44	404.92
448.42	405.28	440.06	402.59	398.13
434.49	388.85	412.24	400.77	404.04
379.73	424.24	418.96	388.72	416.49
366.03	401.6	384.77	428.67	413.03
374.38	420.51	378.21	397.7	394.42
345.1	420.8	364.61	420.12	446.73
354.98	416.93	413.25	413.98	438.75
418.5	416	354.59	419.63	395.69
418.3	379.37	425.89	450.63	474.11
418.2	370.63	405.07	430.87	
425.71	420.86	421.15	403.34	
370.09	371.06	458.71	395.59	

Seeding Rate (kg/ha)	98.57567
(lbs/ac)	87.94724

Mean X	410.1145
Standard Dev. S	28.86592
CV	7.038502

Air Drill Distribution Tests
Header Distributions

Date : 11 February 1992
Project : Special Crops

Material : Lupins (Primonski)

Density : 60 lbs/bushel

Test Run #1

Meter Setting : #18

Drive Wheel RPM : 39-40

Ground Speed : 5 mph

Tank : F

Miscellaneous : Gate Setting Top

Conversion : 5.469 min/ha

Fan Speed : 3080 - 4050

Meter RPM : 52

Time of Run : 1.752 min

Header Number						
1	2	3	4	5	6	7
368.92	418.5	424.24	452.89	425.89	428.67	382.31
439.52	418.3	401.6	432.97	405.07	397.7	404.92
471	418.2	420.51	466.18	421.15	420.12	398.13
462.82	425.71	420.8	440.06	458.71	413.98	404.04
448.42	370.09	416.93	412.24	432.9	419.63	416.49
434.49	388.1	416	418.96	371.64	450.63	413.03
379.73	374.8	379.37	384.77	430.55	430.87	394.42
366.03	386.58	370.63	378.21	425.44	403.34	446.73
374.38	401.4	420.86	364.61	402.59	395.59	438.75
345.1	405.28	371.06	413.25	400.77	404.25	395.69
354.98	388.85	432.02	354.59	388.72	448.04	474.11

Header Averages

404.12636 399.6191 406.7291 410.7936 414.8573 419.3473 415.3291

Header Standard Deviations

44.847153 18.27393 21.4775 34.76359 22.89064 18.01067 26.00897

Header Coefficient of Variations

11.097309 4.572838 5.280542 8.462544 5.517714 4.294929 6.262255

Over all Header CV 7.038502

Air Drill Distribution Tests

Date : 11 February 1992

Project : Special Crops

Material : Lupins (Primonski)

Density : 60 lbs/bushel

Test Run #2

Meter Setting : #18

Drive Wheel RPM : 39-40

Ground Speed : 5 mph

Tank : F

Miscellaneous : Gate Setting Top

Conversion : 5.469 min/ha

Fan Speed : 3990 - 4120

Meter RPM : 52

Time of Run : 1.751 min

Samples	Header Number				
	1	2	3	4	5
	383.8	380.3	376.42	441.2	402.79
	445.88	341.33	462.96	373.5	388.91
	496.26	389.22	426.07	430.69	383.21
	466.78	401.64	462.1	416.86	421.06
	451.23	416	436.23	398.91	414.12
	404.69	414.47	412.511	405.68	418.46
	395.07	429.86	409.41	394.49	437.12
	351.01	418.36	396.57	428.75	401.22
	361.22	403.08	370.02	439.34	383.69
	354.12	416	362.18	427.62	443.86
	358.73	444.04	361.56	419.56	445.29
	402.78	420.64	426.8	417.21	403.06
	417.6	406.63	420.38	446.96	436.88
	417.69	377	456.94	421.32	
	440.15	427.26	450.67	386.52	
	370.3	373	463.94	453.02	

Seeding Rate (kg/ha)	99.17349
(lbs/ac)	88.48061

Mean X	412.3662
Standard Dev. S	31.24112
CV	7.576062

Material : Lupins (Primonski)

Density : 60 lbs/bushel

Test Run #2

Meter Setting : #18

Drive Wheel RPM : 39-40

Ground Speed : 5 mph

Tank : F

Miscellaneous : Gate Setting Top

Conversion : 5.469 min/ha

Fan Speed : 3080 - 4050

Meter RPM : 52

Time of Run : 1.751 min

Header Number						
1	2	3	4	5	6	7
383.8	402.78	429.86	462.96	420.38	428.75	383.21
445.88	417.6	418.36	426.07	456.94	439.34	421.06
496.26	417.69	403.08	462.1	450.67	427.62	414.12
466.78	440.15	416	436.23	463.94	419.56	418.46
451.23	370.3	444.04	412.511	441.2	417.21	437.12
404.69	380.3	420.64	409.41	373.5	446.96	401.22
395.07	341.33	406.63	396.57	430.69	421.32	383.69
351.01	389.22	377	370.02	416.86	386.52	443.86
361.22	401.64	427.26	362.18	398.91	453.02	445.29
354.12	416	373	361.56	405.68	402.79	403.06
358.73	414.47	376.42	426.8	394.49	388.91	436.88

Header Averages

406.25364 399.2255 408.39 411.4919 423.0236 421.0909 417.0882

Header Standard Deviations

48.659945 26.16812 22.73662 34.56455 27.25628 20.68407 21.41216

Header Coefficient of Variations

11.977725 6.554722 5.56738 8.399813 6.443204 4.912019 5.133726

Over all Header CV 7.576062

Air Drill Distribution Tests

Date : 13 February 1992

Project : Special Crops

Material : Lupins (Primorski)

Density : 60 lbs/bushel

Meter Setting : #18

Drive Wheel RPM" 39-40

Ground Speed : 5 mph

Tank : F

Miscellaneous : Gate Setting Top

Coverage : 5.469 min/ha

Fan Speed : 2810 - 2840

Meter RPM : 52

Time of Run : 1.755 min

	Header Number				
Samples	1	2	3	4	5
	382.38	386.69	391.09	427.74	392.61
	430.23	356.58	438.32	362.37	412.78
	468.82	385.18	426.04	456.42	392.6
	476.2	405.86	451.96	400.97	407.96
	440.69	415	430.94	400.15	398.51
	407.6	393.94	411	385.66	396.11
	397.74	417.63	400	382.87	412.3
	350.03	416.21	400.24	419.82	406.15
	366.1	404.34	365.3	418.92	388.14
	334.18	408.27	376.22	420.85	444.77
	366.67	435.33	355.64	429.06	438.54
	405.03	418.69	407.17	401.39	378.73
	430.18	420.39	433.76	448.54	464.62
	423.42	372.33	437	439.25	
	420.14	415.84	415.03	403.8	
	392.05	393.02	443.81	412.85	

Seeding Rate (kg/ha)	98.05172
(lbs/ac)	87.47979

Mean X	408.6332
Standard Dev. S	27.99156
CV	6.850044

Air Drill Distribution Tests

Date : 13 February 1992

Project : Special Crops

Material : Lupins (Primorski)

Density : 60 lbs/bushel

Meter Setting : #22

Drive Wheel RPM : 39-40

Ground Speed : 5 mph

Tank : F

Miscellaneous : Gate Setting Top

Coverion : 5.469 min/ha

Fan Speed : 2790 - 2820

Meter RPM : 52

Time of Run : 1.606 min

Samples	1	2	3	4	5
	418	425.1	395.57	447.48	418.99
	465.54	392.22	472.98	388.81	431.16
	516.02	408.26	454.6	467.39	412.52
	520.52	426.47	492.85	425.12	443.49
	481.8	455	461.52	439.6	437.53
	435.32	446.67	437.97	418.46	443.92
	419.35	426.09	431.89	398.09	468.9
	367.9	442.62	425.13	454.08	404.37
	415.52	439.79	392.13	458.43	402.32
	374.19	451.2	385.42	438.2	477.42
	392.69	442.64	402.09	445.58	454.43
	437.9	458.51	457.17	436.33	459.23
	477.5	458	467.05	462.04	487.73
	423.62	407	464.04	469.92	
	460.27	480.93	478.05	417.68	
	427.95	406.53	465.09	460.17	

Seeding Rate (kg/ha)	115.2851
(lbs/ac)	102.8551

Mean X	439.6631
Standard Dev. S	31.01686
CV	7.054688

Air Drill Distribution Tests

Date : 13 February 1992

Project : Special Crops

Material : Lupins (Primorski)

Density : 60 lbs/bushel

Meter Setting : #14

Drive Wheel RPM : 39-40

Ground Speed : 5 mph

Tank : F

Miscellaneous : Gate Setting Top

Coverage : 5.469 min/ha

Fan Speed : 2830

Meter RPM : 52

Time of Run : 1.995 min

Samples	1	2	3	4	5
	317.48	313.11	297.4	370	337.88
	402.33	301.31	370.8	331.2	352.47
	420.07	311.62	367	358	337.96
	409.1	334.75	393.9	330.9	360
	385.18	338.52	372	342.7	343.43
	337.7	359.95	343.8	353	339.07
	329.07	372.95	352	326.6	352.13
	312.73	352.71	339.6	362.53	362.32
	306.79	350	315.99	362.48	313.13
	304.3	358.1	321.6	353.69	390.65
	319.8	367.1	312.9	346.92	387.62
	356.59	360	355.1	360.97	320.66
	397.84	353.4	370.2	376.16	376.61
	347.64	309.6	365.9	383.13	
	385.32	369.2	358.2	338.42	
	323.05	344.6	363.3	363.4	

Seeding Rate (kg/ha)	84.09368
(lbs/ac)	75.0267

Mean X	350.4627
Standard Dev. S	26.64253
CV	7.6021

Air Drill Distribution Tests

Date : 13 February 1992

Project : Special Crops

Material : Lupins (Ultra)

Density : 60 lbs/bushel

Meter Setting : #18

Drive Wheel RPM : 39-40

Ground Speed : 5 mph

Tank : F

Miscellaneous : Gate Setting Top

Coverage : 5.469 min/ha

Fan Speed : 4080 - 3980

Meter RPM : 52

Time of Run : 1.715 min

Samples	1	2	3	4	5
	402.17	402.63	385.78	443.85	393
	457.16	377.87	449.36	368.04	428.52
	482.38	410.82	436.23	463.51	402.56
	470.57	408.64	479.5	416.58	433.79
	462.92	438.63	437.82	436.84	401.17
	450.84	411.22	414.42	403.32	413.2
	414.18	433.94	416.08	402.63	416.2
	369.29	415.31	380	409.37	401
	385.76	425.14	395.5	444	402.5
	385.75	454	386.76	453.7	447.87
	364.19	446.09	367.3	450.2	459.18
	434	427.34	452.28	428.46	408
	457.41	433.54	434.45	469.49	476.24
	428.56	380.41	438.04	459.09	
	413	454.1	444.72	415.82	
	376.2	394.42	452.14	468.85	

Seeding Rate (kg/ha) 104.1369
 (lbs/ac) 92.90886

Mean X 424.1018
 Standard Dev. S 29.82398
 CV 7.032269

Air Drill Distribution Tests

Date : 13 February 1992

Project : Special Crops

Material : Lupins (Ultra)

Density : 60 lbs/bushel

Meter Setting : #14

Ground Speed : 5 mph

Miscellaneous : Gate Setting Top

Coverage : 5.469 min/ha

Fan Speed : 2840 - 2780

Meter RPM : 52

Time of Run : 2.058 min

Drive Wheel RPM : 39-40

Tank : F

Samples

385.27	366.9	356.5	396.84	371.88
434.8	358.1	426.49	376	384.37
465.8	370.1	407.8	408.69	360.44
459.3	374.6	443.66	391.59	383.15
424.3	397.8	397.65	391.03	368.35
400.4	390.19	391.69	398.87	381.76
389.2	403.82	391.3	376.14	393.79
333.89	394.2	369.16	421.81	388.75
354.66	380.4	392	383	429.96
340.44	384.2	375.92	394.49	408.23
332.89	414.11	353.79	398.34	399.48
397.53	399.8	402.4	391	392.3
406.97	402.84	411.47	427.55	396.86
388	354.38	404.36	429.13	
419.8	421.78	403.25	373.3	
360.18	381.2	438.66	405.6	

Seeding Rate (kg/ha)
(lbs/ac)

80.45821
71.78321

Mean X

393.2032

Standard Dev. S

25.86252

CV

6.577392

Air Drill Distribution Tests

Date : 13 February 1992

Project : Special Crops

Material : Lupins (Ultra)

Density : 60 lbs/bushel

Meter Setting : #18

Ground Speed : 5 mph

Miscellaneous: Gate Setting Top

Coverision : 5.469 min/ha

Fan Speed : 2780 - 2830

Meter RPM : 52.2

Time of Run : 1.709 min

Drive Wheel RPM : 39-40

Tank : F

Samples

375.55	395.92	364	418.63	402.26
449.34	367.28	457.51	387.18	403.44
497.35	388.38	426.45	433.06	391.25
454.61	412.39	454.89	397.67	414.4
445.26	415.17	443	405.4	409
420.02	392.58	406	399.88	390.05
401.68	432.73	411.75	409.9	414.95
380.6	426.22	416.67	419.6	405.65
382.01	415.87	393.19	444.77	371.64
340.79	425.76	381.92	423.04	438.99
374	446.15	345.52	419.39	420.49
406.25	409	438.16	443.36	397.91
448.64	421.99	423.75	443.43	464.09
402.52	386.44	415.24	436.46	
426.23	421.73	412.25	392.93	
395.06	388.89	448.16	428.23	

Seeding Rate (kg/ha)	101.801 9
(lbs/ac)	90.82559

Mean X	413.1418
Standard Dev. S	27.37597
CV	6.62629

Air Drill Distribution Tests

Date : 13 February 1992

Project : Special Crops

Material : Lupins (Ultra)

Density : 60 lbs/bushel

Meter Setting : #32

Drive Wheel RPM : 39-40

Ground Speed : 5 mph

Tank : F

Miscellaneous : Gate Setting Top

Coverage : 5.469 min/ha

Fan Speed : 2790 - 2850

Meter RPM : 52.2

Time of Run : 1.502 min

Samples

613.1	593.2	564.3	663.7	573.1
617.2	575.9	604.5	592.7	605.7
544.3	575.4	615.9	643.6	606.5
570.2	609.6	587.2	611.1	638.8
548.6	640.9	587.6	593.8	639.2
571.1	612.5	583	616.5	609.3
603.4	643.4	587.3	595.7	617.1
674.3	630.7	636.1	658.1	591.2
714	626.5	662.3	627.7	564.8
710.1	634.9	593.8	640.5	658.8
654.9	671.4	679.4	615.6	652
613.9	626.6	643.2	629.2	586.5
684.8	622.3	640.3	648.5	667.3
626.7	591.4	628.4	647.9	
649.3	644.6	634.3	588.6	
621.3	583.4	663.7	646.6	

Seeding Rate (kg/ha)
(lbs/ac)

174.1971
155.4152

Mean X
Standard Dev. S
CV

621.31 56
34.9788
5.629796

Air Drill Distribution Tests

Date : 13 February 1992
 Project : Special Crops

Material : Lupins (Ultra)
 Density : 60 lbs/bushel
 Meter Setting : #22
 Ground Speed : 5 mph
 Miscellaneous : Gate Setting Top
 Conversion : 5.469 min/ha
 Fan Speed : 2830
 Meter RPM : 52.2
 Time of Run : 1.507 min

Drive Wheel RPM : 39-40
 Tank : F

Samples

419.14	410	389.77	440.03	417.85
468.55	415.22	490.4	392.69	437.39
485.49	396.76	446.09	430.06	412.73
489.2	430.93	472.24	433.97	432.77
476.1	413.65	465.65	417.73	425.18
429.9	444.58	436.38	431.58	414.12
409.46	420.44	445.28	419.27	453.44
356.8	446.44	410.6	438.73	409.51
402.6	443.6	395	446.14	398.6
374.3	442.55	396.92	458.18	452.1
394.88	456.9	380.05	435.22	441.24
438.61	442.7	439.41	443.33	417
459.04	456.78	439.96	445.49	490.67
442.34	389.71	450.21	458.91	
455.62	462.17	444.5	417.52	
415.42	439.34	466.63	443.62	

Seeding Rate (kg/ha) 121.041 6
 (lbs/ac) 107.9909

Mean X 433.1608
 Standard Dev. S 27.33425
 CV 6.310416

APPENDIX III

**Manufacturers Seed and Fertilizer
Metering Charts
Case IH 8500 Air Drill**

SEED AND FERTILIZER CHARTS

SEED CHART FOR 7 INCH ROWS

NOTE: This chart is in pounds per acre (lbs/A). See pages 47 through 52 for charts in kilograms per hectare kg/ha).

See page 36 for information on how to use this chart.

Grain	Wt lbs/bu	Metering Gate	Shaft Speed	Fan Speed rpm	Seed Adjustment Lever Position																									
					2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52
Alfalfa	60	Bottom	Slow	4000	1	3	4	6	8	10	11	13	15	18	20	21	23	25	27	28	30	32	34	36	38	39	41	43	45	46
Barley	48	Bottom	Fast	4000	8	17	23	29	36	43	51	59	66	73	81	88	95	102	111	119	127	134	142	150	159	168	179	190	190	190
Canola (Rapeseed)	50	Bottom	Slow	2800	1	3	5	7	8	10	11	13	15	17	19	21	22	24	26	28	30	32	34	35	38	41	43	45	46	46
Cotton	46	Top	Slow	4000	1	3	4	6	7	8	10	11	13	15	17	18	20	22	24	25	27	28	30	32	34	35	37	39	40	41
Field Peas	60	Top	Fast	4000	10	20	27	34	43	52	61	70	79	88	97	106	116	126	135	144	156	168	178	188	200	213	220	227	230	234
Flax	56	Bottom	Slow	4000	1	3	5	7	9	11	13	14	16	18	20	21	23	25	27	28	30	32	34	35	36	38	40	42	43	45
Lentils	60	Top	Fast	2800	9	18	25	32	40	48	56	64	74	83	90	98	106	115	123	132	141	150	159	168	177	186	195	203	207	211
Millet (White)	56	Bottom	Slow	4000	1	3	4	6	8	10	11	13	14	15	18	20	21	22	25	27	28	29	32	34	36	38	39	41	42	43
Millet (Japanese)	35	Bottom	Slow	4000	1	1	3	4	5	6	6	7	8	10	11	11	13	14	15	15	17	18	19	20	20	21	22	24	25	25
Milo	56	Bottom	Slow	4000	1	3	4	6	7	8	11	13	14	15	17	18	20	22	24	25	27	29	31	32	34	36	39	41	41	42
Mustard	50	Bottom	Slow	4000	1	3	4	6	7	8	11	13	14	15	17	18	20	22	24	25	27	29	31	32	34	36	39	41	41	42
Oats	32	Bottom	Fast	4000	6	11	15	18	22	27	31	35	40	45	48	52	57	62	65	69	74	78	83	87	92	97	102	108	109	111
Red Clover (Buckwheat)	60	Bottom	Slow	4000	1	3	4	6	8	10	11	13	15	17	18	20	21	22	24	25	27	29	31	32	34	35	36	38	39	41
Rice	45	Bottom	Fast	4000	7	14	20	25	32	38	44	50	57	63	70	77	83	88	95	101	108	115	121	127	136	144	150	155	160	165
Rye	60	Bottom	Fast	4000	9	18	27	35	44	53	62	70	79	88	97	105	114	123	133	143	152	161	170	179	190	202	211	220	225	230
Sorghum	56	Bottom	Fast	4000	9	18	25	32	40	48	55	63	71	80	88	95	104	112	120	129	137	144	153	162	172	181	191	202	204	207
Soybeans (2400 seeds/lb)	60	Middle	Fast	4000	12	24	36	49	58	67	76	85	98	111	121	132	144	155	166	176	188	200	214	228	241	253	259	265	267	269
Soybeans (2700 seeds/lb)	60	Middle	Fast	4000	11	22	32	42	51	60	70	80	91	102	112	122	134	147	158	169	183	196	209	223	239	255	261	267	270	273
Soybeans (3900 seeds/lb)	60	Middle	Fast	4000	11	22	32	42	52	62	72	83	94	105	116	127	139	150	163	176	190	203	218	234	249	263	269	274	279	284
Sunflower (Oiler)	25	Middle	Slow	4000	1	1	2	3	4	4	5	6	7	8	9	10	11	11	12	13	13	14	15	17	18	18	19	20	20	20
Wheat	60	Bottom	Fast	4000	11	21	30	39	48	57	67	77	88	98	108	118	129	140	151	161	172	183	195	207	220	232	249	266	267	267