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Forage Seed Production and Quality Control, Focusing on Weed Control

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Executive Summary

Based on input from provincial Forage Specialists, data was generated to pursue minor use registration of Puma Super in a number of forage grass species grown for seed production. Fourteen studies were conducted at Scott on seedling and established stands of 5 different grass species from 2003-05. In 2004-05, studies were conducted at Melfort on four different species. Results are summarized below:

Seedling Crested wheatgrass – At both Scott and Melfort, crested wheatgrass exhibited good tolerance to Puma Super with no adverse effect on seed yield.

Established Crested wheat grass – Puma Super applied at the 1X and 2X rate to established Crested wheat grass in 2004 resulted in acceptable (< 10%) injury. Despite the lack of observed injury, Puma Super applied at the 2X rate caused a significant reduction in yield compared to Puma Super at the1X rate.

Seedling intermediate wheat grass – Puma Super applied at the 1X and 2X to seedling intermediate wheatgrass did not result in significant plant injury and did not reduce seed yields relative to the industry standard or untreated check.

Established intermediate wheat grass – Visual observations from one study initiated in 2004 indicated that Puma Super applied at the 1X and 2X rate resulted in acceptable (< 10%) injury. No significant seed yield reduction was associated with Puma Super even at the 2X rate. Germination tests showed no evidence that Puma Super reduced germination rates of the seed relative to the untreated check or the industry standard (Achieve 80 DG).
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Meadow brome grass - No significant crop injury or yield reduction resulted from Puma Super application in two studies conducted at Scott and one study conducted at Melfort.

Smooth Brome grass seedlings – Smooth brome grass was tolerant to seedling applied Puma Super under the growing conditions that existed at Scott in 2004 and 2005 (two experiments).

Tall fescue – Visual observations indicated acceptable levels of injury (stunting) for Puma Super. Yields were not reduced from Puma Super application in any of the three studies conducted.

Herbicide treatments mentioned in this report are not registered for use and their use is not recommended by the researchers involved. Use of these products is entirely at the risk of the producer or company involved.

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1.0 ABSTRACT

Data was generated to pursue minor use registration of Puma Super in a number of forage grass species grown for seed production. Fourteen studies were conducted at Scott on seedling and established stands of 5 different grass species from 2003-05. Studies were also conducted at Melfort on four different grass species in 2004-05. Seedling crested wheatgrass exhibited good tolerance to Puma Super with no adverse effect on seed yield. Puma Super applied in established crested wheat grass at the 1X and 2X rate resulted in acceptable (< 10%) injury. Despite the lack of observed injury, Puma Super applied at the 2X rate caused a significant reduction in yield compared to Puma Super at the1X rate**.** Seedling and established intermediate wheatgrass, meadow bromegrass, smooth bromegrass and tall fescue exhibited acceptable tolerance with no reduction in seed yields when Puma Super was applied at both 1X and 2X rates.

2.0 OBJECTIVE

To evaluate the tolerance of a number of forage grass species grown for seed production to the graminicide Puma Super (fenoxyprop-p-ethyl). Puma Super is a herbicide which effectively controls grass weeds such as wild oat and green foxtail, which are problematic for forage seed producers.

3.0 INTRODUCTION

Evaluation of tolerance of forage grasses for seed production requires an initial year of establishment followed by yield measurements in the second year. Registration of pesticides is based on timing with applications occurring at either the seedling or established stage of growth.

This project was initially intended to conduct research on the tolerance of forage grass species to Avadex Mico-Active (triallate). However, the manufacturer (Monsanto) withdrew the herbicide from the market in 2003. Therefore, the project objectives were changed in 2003 to those listed above. In addition, the Saskatchewan Forage Council suspended their field research program in 2003 and transferred the project to scientists at Scott in the spring of 2004.

Since the efficacy of Puma Super on the control of grassy weed species is well documented in a number of other cereal crops, there was no need to repeat weed control efficacy trials. In addition, the end use is seed production, and since there is no consumption of the seed or fodder by humans or livestock, there is no need to conduct pesticide residue trials. To satisfy PMRA registration requirements, the forage grasses must be shown to be tolerant to Puma Super. Tolerance is determined by visual injury ratings and by seed yield. In order for registration to occur on both seedling (year of establishment) and established forage species, tolerance trials must be conducted in separate seedling and established forage stands.

Consultations with provincial forage specialists identified a number of species for which additional seedling and established tolerance trials to Puma Super were required. The number of species evaluated was based on available resources.

Fourteen trials conducted at the Scott Research Farm and four trials conducted at Melfort are reported. Tolerance trials were conducted on the following species: tall fescue; intermediate wheat grass, crested wheat grass, meadow brome grass and smooth brome grass. Guardian was seeded at 5 kg/ha, Chief and Paddock were seeded at 7 kg/ha, Parkland at 4.5 kg/ha, and Magna at 8 kg/ha. Only certified seed was used.

In order to demonstrate crop tolerance, the herbicide must be applied to the crop at both the 1X label rate and two

times the label rate.

The following materials and methods were consistent across all trials conducted at Scott and Melfort.

Soil Description at Scott:
Texture: Loam **% OM:** 4 **% Sand:** 31 **% Silt:** 42 **% Clay:** 27
pH: 6 **Soil Association:** Scott **Fertility Level:** Good

Soil Description at Melfort:
Texture: Silty Clay Loam **% OM:** 10.6 **pH:** 5.6
Soil Association: Melfort **Fertility Level:** Excellent

At Scott, all plots were seeded at a row spacing of 45.7 cm using a hoe-drill equipped with on-row packing. All experiments employed Randomized Complete Block experimental design with 4 replicates. Plot size was 2 X 5 meters.

At Scott, herbicide applications were made with a Rogers shrouded sprayer equipped with 80015 flat fan nozzles and calibrated to apply a carrier volume of 100 l/ha at an operating pressure of 275 kpa. Carbon dioxide was used as the propellant.

At Melfort, seeding was done with a double disc press drill at a seeding depth of 1 cm and 30 cm row spacing. The plot size was 5 feet wide by 20 feet long. The test area had been seeded to wheat for ground cover and sprayed out with glyphosate prior to heading in 2003. In 2002 it was seeded to barley, sprayed with Puma and Buctril M and harvested for seed. In 2001 it was summerfallowed. Fertility levels were adequate to establish a grass seed crop. Spraying was done with an air assist self-propelled plot sprayer that applied 110 l/ha of product using an operating pressure of 275 kpa.

For data collection, the rating scale that was used was % visual injury. Ratings and their significance are based on guidelines found in the paper 'Guidelines for the conduct of chemical weed control trials in forage grass grown for seed' (Darwent, A.L. et al.). The document describes phytotoxicity from 0-9% as 'acceptable', 10-20% where slight discoloration and/or stunting occurs as 'just acceptable', 21-30% as 'not acceptable', and >30% as severe which accounts for the ability of grasses to recover from injury (Darwent, A.L. et al.).

For statistical analysis to increase the degrees of freedom and improve the precision of the analyses other pesticides under investigation were retained in the analyses. However only results from the applications of Puma Super, the untreated check, and Puma 92 Super (old formulation) are discussed here.

Environmental data from both locations are reported in the APPENDIX. Equivalent rates of herbicides expressed in liters/acre are presented in Table 17 in the APPENDIX.

4.0 TOLERANCE OF CRESTED WHEATGRASS TO PUMA SUPER

4.1 SEEDLING CRESTED WHEATGRASS

4.1.a Introduction

Crested wheatgrass is a widely adapted grass species that been used for both hay production and pasture production purposes. As with many grass seed crops, weed control is one of the most challenging and potentially limiting factors to successful seed production. A number of trials have been conducted using various herbicides for weed control in crested wheatgrass. There have been several areas identified that need additional data. Therefore, to support minor use registration, trials were conducted to determine the effect of Puma Super on seed yield of crested wheatgrass. Other herbicide treatments are included in the trial to satisfy data requirements for other Minor Use studies; however the focus of this project involved Puma Super and only the results from the application of this herbicide are discussed.

4.1.b Materials and Methods

Scott Seedling Trial

This trial was fall dormant seeded directly into wheat stubble on October 28, 2003 and emerged on April 28, 2004. The cultivar Parkland was seeded at a rate of 4.5 kg/ha with a hoe-drill using a 45.7 cm row space. Plots were harvested with a Wintersteiger plot combine on August 5, 2005. Seed was dried, cleaned and weighed.

In the week preceding application 29.8 mm of rain fell with 2.2 mm falling within 10 days after application. The first significant rainfall after application occurred on July 1 when 11.8 mm of precipitation was recorded. The year 2004 was characterized by near normal precipitation through out the growing season but below normal temperatures in May, June, and August, with mean monthly temperatures averaging 1.1, 1.4, and 1.9 degrees Celsius below normal respectively. September precipitation (14.8 mm) was 17.2 mm below the long term average despite extended periods of damp cloudy weather.

The year 2005 was characterized by above normal precipitation throughout the growing season and below normal temperatures in June, July and August, with mean monthly temperatures averaging 0.7, 0.8, and 2.4 degrees Celsius below normal respectively. Precipitation overthe course of the growing season May- August averaged 53% more then the long term average (312 mm vs. 203.7 mm). The wettest months June (95.8 mm) and August (99.9 mm) contributed an additional 35 mm and 54.5 mm respectively above the long term monthly average. A hail storm on July 13th resulted in minimal damage in the form of broken stems. Damage was consistent across the trial with no other impact than a slight reduction in seed yield.

Maintenance weed control consisted of a combination of hand weeding and mowing in 2004. Weed growth on the seed rows which consisted primarily of volunteer wheat and some wild oats was kept in check by cutting just above the crop with a tractor powered 3 point hitch mower with wheels running between the rows. In 2005 broadleaf weed seedlings were controlled with a early spring application of 2, 4-D Amine followed by hand weeding.

Melfort Seedling Trial

A test area at the Melfort Research Farm was seeded to Kirk crested wheatgrass June 24, 2004 @ 9 kg/ha.

Treatment application was done on August 1, 2004 in a randomized complete block design with the crested wheatgrass plants at anywhere from the 2 to 6 leaf stage. Environmental conditions at and near the time of application are presented in Table 16 (APPENDIX). Visual ratings on % injury were done at 14 days after treatment (DATt). Injury ratings at 28 DAT and 42 DAT were not done due to an encroachment and unplanned grazing of the test area by cattle. However, it is unlikely that the grazing had any effect on the final seed yield. The test area was fertilized April 26, 2005, with 89 kg/ha N in the form of ammonium nitrate.

Fall precipitation in 2004 was about 115% of the long term average and provided ideal moisture conditions for going into winter. Precipitation from January 1 to August 30, 2005 was nearly 170% of normal. Grass establishment was good with considerable amounts of biomass production.

The test was swathed with a self propelled plot swather August 22, 2005. The swaths were allowed to dry enough in the field to be combined. Combining was done with a Wintersteiger plot combine on August 30, 2005. The seed harvested from each plot was then dried in a forced air drier and subsequently cleaned with a Clipper table top seed cleaner to determine clean seed yields.

4.1.c Results and Discussion

Scott Seedling Trial

Results are summarized in Table 1. In 2004 visual observations indicated no evidence of crested wheat grass injury to Puma Super with the exception of 41 days after application when evidence of slight stunting (<5%)was observed. Crop injury in 2005, in the form of stunting remained below 5% with no significant reduction in seed yield (P=0.05) relative to the untreated check or industry standard. Seed yield across the trial averaged 734 kg/ha.

Melfort Trial:

Results are presented in Table 2. There were no significant differences in the reduction of seed yield from treatment application. Significant differences were seen in the visual injury assessments done at 14DAT. However, tolerance to the herbicides tested was within the acceptable range (< 20%).

Table 1: Visual injury and seed yield from application of Puma Super and other herbicides to a seedling crested wheatgrass stand – Scott 2004-05.

Trt. No.	TREATMENT	Rate	Crested Wheatgrass Visual Injury Percent 25-Jun-04	Crested Wheatgrass Visual Injury Percent 9-Jul-04	Crested Wheatgrass Visual Injury Percent 27-Jul-04	Crested Wheatgrass Visual Injury Percent 14-Jun-05	Crested Wheatgrass Visual Injury Percent 11-Jul-05	Crested Wheatgrass Seed Yield kg/ha 5-Aug-05
1	WEED FREE CHECK		0 a	0 a	0 a	0 a	3 ab	1046 a
2	PUMA SUPER	92 g ai/ha	0 a	0 a	4 a	0 a	3 ab	1039 a
3	PUMA SUPER	184 g ai/ha	0 a	0 a	2 a	0 a	2 ab	915 a
4	PRESTIGE		0 a	0 a	1 a	0 a	0 b	982 a
	FLUROXYPYR	142 g ai/ha						
	CURTAIL M	660 g ai/ha						
5	PRESTIGE		0 a	0 a	0 a	0 a	1 ab	937 a
	FLUROXYPYR	284 g ai/ha						
	CURTAIL M	1320 g ai/ha						
6	ATTAIN	g ai/ha	0 a	0 a	7 a	0 a	3 ab	812 a
	FLUROXYPYR	105 g ai/ha						
	2, 4-DLV ESTER	560 g ai/ha						
7	ATTAIN	g ai/ha	0 a	0 a	2 a	0 a	5 a	788 a
	FLUROXYPYR	210 g ai/ha						
	2, 4-DLV ESTER	1120 g ai/ha						
8	BANVEL II	140 g ai/ha	0 a	0 a	0 a	0 a	3 ab	974 a
9	ACHIEVE	198 g ai/ha	0 a	0 a	0 a	0 a	0 b	1078 a
	TURBOCHARGE	0.5 % v/v						
10	SPECTRUM		0 a	0 a	0 a	0 a	3 ab	1052 a
	FLORASULAM	5 g ai/ha						
	CURTAIL M	490 g ai/ha						
11	SPECTRUM		0 a	0 a	0 a	0 a	0 b	983 a
	FLORASULAM	10 g ai/ha						
	CURTAIL M	980 g ai/ha						
12	PUMA 92 SUPER	92 g ai/ha	0 a	0 a	0 a	0 a	1 ab	966 a
Tukey's HSD (P=.05)			0	0	4.9	0	4.7	280.3
Standard Deviation			0	0	3.4	0	1.9	194.1
CV			0	0	253.95	0	106.17	20.13
Treatment Prob(F)			1	1	0.1367	1	0.0258	0.5666

Means followed by same letter do not significantly differ (P=.05, Tukey's HSD)

Mean comparisons performed only when AOV Treatment P(F) is significant at mean comparison OSL.

Table 2. Visual injury and seed yield from application of Puma Super and other herbicides to a seedling crested wheatgrass stand – Melfort 2004-05.

Treatment	Rate	Crested Wheatgrass Injury Percent 14 DAT	Crested Wheatgrass Seed yield kg/ha
UNTREATED CHECK		0b	944ab
PUMA SUPER	92 gai/ha	0b	947ab
PUMA SUPER	184 g ai/ha	0b	869bc
PRESTIGE FLUROXYPYR CURTAIL M	 142 g ai/ha 660 g ai/ha	0b	962ab
PRESTIGE FLUROXYPYR CURTAIL M	 284 g ai/ha 1320 g ai/ha	0b	887bc
ATTAIN FLUROXYPYR 2,4-D LV ESTER	 105 g ai/ha 560 g ai/ha	0b	890bc
ATTAIN FLUROXYPYR 2,4-D LV ESTER	 210 g ai/ha 1120 g ai/ha	0b	793c
BANVEL II	140 g ai/ha	0b	1019a
ACHIEVE 80 DG TURBOCHARGE	198 g ai/ha 0.5% v/v	0b	925ab
SPECTRUM FLORASULAM CURTAIL-M	 5 g ai/ha 490 g ai/ha	0b	863bc
SPECTRUM FLORASULAM CURTAIL-M	 10 g ai/ha 980 g ai/ha	0b	887bc
PUMA 92 SUPER	92 g ai/ha	6.25a	967ab
MEAN		0.52	912.4
CV		138.5	9.8
LSD alpha= .05		1.04	128.9
Pr>F		<.0001	ns .0961

Means followed by same letter do not significantly differ (P=.05, Tukey's HSD)
Mean comparisons performed only when AOV Treatment P(F) is significant at mean comparison OSL.

4.2 ESTABLISHED CRESTED WHEATGRASS

4.2.a Materials and Methods

There was one trial conducted on established crested wheatgrass at Scott, SK.

Parkland crested wheatgrass was seeded at a rate 4.5 kg/ha on June 10, 2003. Plots were harvested on August 4, 2004.

Maintenance weed control consisted of a combination of maintenance herbicides, hand weeding and mowing. Weed growth on the seed rows which consisted primarily of volunteer wheat and some wild oats was kept in check by cutting just above the crop with a tractor powered 3 point hitch mower with wheels running between rows.

Herbicide treatments were applied on May 17, 2004. In the week preceding application 4.8 mm of rain fell with 2.0 mm falling within 10 days after application. The first significant rainfall after application occurred on May 29 when 15.2 mm of precipitation was recorded. In 2003 precipitation was below normal in May (20.3 mm vs long term average of 36 mm) and in June (31.3 mm vs long term average of 60.0 mm) but near normal for the remainder of the growing season. Temperatures in July and August of 2003 were above normal averaging 1.2 and 1.9 degrees above normal respectively. The year 2004 was characterized by near normal precipitation through out the growing season but below normal temperatures in May, June, and August, with mean monthly temperatures averaging 1.1, 1.4, and 1.9 degrees Celsius below normal respectively

4.2.b Results and Discussion

Crop establishment was uniform and very competitive with weeds kept in check by crop competition in 2004. Results are presented in Table 3.

Tolerance of established Crested Wheat grass to Puma Super applied at the 1X and 2X rate was classed as acceptable (< 10% injury) with very low levels of injury observed. Despite the lack of observed injury Puma Super applied at the 2X rate caused a significant reduction in yield of 351 kg/ha compared to Puma Super 1X (1327 kg/ha), 479 kg/ha less then the weed free check (1455 kg/ha) and 601 kg/ha less than the industry standard Achieve 80 DG (1577 kg/ha). This data indicates Crested Wheat grass was not tolerant to Puma Super applied to established Crested wheat grass at the 2X rate under the growing conditions experienced at Scott, Saskatchewan in 2004.

Percent germination tests conducted on 100 seeds/plot between March and April of 2005 showed no evidence that Puma Super reduced germination rates of the seed relative to the untreated check or industry standard Achieve 80 DG.

4.3 CONCLUSIONS

These two studies indicate seedling crested wheat grass grown for seed production tolerated Puma Super under the environmental conditions experienced at Scott and Melfort, SK in 2004 and 2005. Puma 92 Super which was

included to create a bridged data set with Puma Super also showed little evidence of visual injury and no reductions in seed yield.

Although this is only one study, there was indication that established crested wheatgrass did not tolerate Puma Super since its yield declined significantly when Puma Super was applied at the 2X rate.

Table 3: Visual injury and seed yield from application of Puma Super and other herbicides to an established crested wheatgrass stand – Scott 2003-04.

Trt. No.	TREATMENT	Rate	Crested Wheatgrass Visual Injury Percent 27-May-04	Crested Wheatgrass Visual Injury Percent 14-Jun-04	Crested Wheatgrass Visual Injury Percent 25-Jun-04	Crested Wheatgrass Visual Injury Percent 22-Jul-04	Crested Wheatgrass Yield kg/ha 4-Aug-04	Crested Wheatgrass Seed Germination Percent 5-Aug-05
1	WEED FREE CHECK		0 a	0 a	0 b	0 b	1454.7 ab	47 ab
2	PUMA SUPER	92 g ai/ha	1 a	0 a	0 b	0 b	1327.4 abc	44 ab
3	PUMA SUPER	184 g ai/ha	3 a	0 a	0 b	0 b	976 c	49 ab
4	PRESTIGE		0 a	0 a	0 b	0 b	1237.2 abc	37 ab
	FLUROXYPYR	142 g ai/ha						
	CURTAIL M	660 g ai/ha						
5	PRESTIGE		0 a	0 a	0 b	0 b	896 cd	26 bc
	FLUROXYPYR	284 g ai/ha						
	CURTAIL M	1320 g ai/ha						
6	ATTAIN	g ai/ha	1 a	0 a	0 b	1 ab	1425.5 ab	52 ab
	FLUROXYPYR	105 g ai/ha						
	2, 4-DLV ESTER	560 g ai/ha						
7	ATTAIN	g ai/ha	0 a	0 a	0 b	0 b	1224.4 abc	49 ab
	FLUROXYPYR	210 g ai/ha						
	2, 4-DLV ESTER	1120 g ai/ha						
8	BANVEL II	140 g ai/ha	1 a	0 a	5 a	4 a	458 d	3 c
9	ACHIEVE	198 g ai/ha	0 a	0 a	0 b	0 b	1577.4 a	48 ab
	TURBOCHARGE	0.5 % v/v						
10	SPECTRUM		1 a	0 a	0 b	0 b	1341.9 abc	48 ab
	FLORASULAM	5 g ai/ha						
	CURTAIL M	490 g ai/ha						
11	SPECTRUM		3 a	0 a	0 b	0 b	1007.5 bc	35 ab
	FLORASULAM	10 g ai/ha						
	CURTAIL M	980 g ai/ha						
12	PUMA 92 SUPER	92 g ai/ha	1 a	0 a	0 b	0 b	1548.2 a	56 a
Tukey's HSD (P=.05)			3.3	0	2.9	3.6	449.1	28.6
Standard Deviation			2.3	0	1.2	1.5	180.73	11.5
CV			246	0	282.84	391.38	14.98	27.98
Treatment Prob(F)			0.7578	1	0.0001	0.041	0.0001	0.0001

Means followed by same letter do not significantly differ (P=.05, Tukey's HSD)
Mean comparisons performed only when AOV Treatment P(F) is significant at mean comparison OSL.

5.0 TOLERANCE OF INTERMEDIATE WHEAT GRASS TO PUMA SUPER

5.1. SEEDLING INTERMEDIATE WHEAT GRASS

5.1.a Introduction

Intermediate wheatgrass is a widely adapted grass species that has been used primarily for hay production with secondary uses as well. As with many grass seed crops, weed control is one of the most challenging and potentially limiting factors to successful seed production. A number of trials have been conducted using various herbicides for weed control in intermediate wheatgrass. There have been several areas identified that need additional data. Therefore, to support minor use registration, trials were conducted to determine the effect of Puma Super on seed yield of intermediate wheatgrass. Other herbicide treatments are included in the trial to satisfy data requirements for other Minor Use studies; however the focus of this project involved Puma Super and only the results from the application of this herbicide are discussed.

5.1.b Materials and Methods

Scott Seedling Trial

This trial was fall dormant seeded directly into wheat stubble on October 28, 2003 and emerged on April 28, 2004. Chief intermediate wheatgrass was seeded at a rate of 7 kg/ha. Plots on were harvested on August 10, 2005.

Maintenance weed control consisted of a combination of hand weeding and mowing in 2004. Weed growth on the seed rows which consisted primarily of volunteer wheat and some wild oats was kept in check by cutting just above the crop with a tractor powered 3 point hitch mower with wheels running between the rows. In 2005 broadleaf weed seedlings were controlled with a combination of early spring application of 2, 4-D Amine followed by hand weeding.

Treatments were applied on June 16, 2004. In the week preceding application 29.8 mm of rain fell with 2.2 mm falling within 10 days after application. The first significant rainfall after application occurred on July 1 when 11.8 mm of precipitation was recorded. The year 2004 was characterized by near normal precipitation through out the growing season but below normal temperatures in May, June, and August, with mean monthly temperatures averaging 1.1, 1.4, and 1.9 degrees Celsius below normal respectively. September precipitation (14.8 mm) was 17.2 mm below the long term average despite extended periods of damp cloudy weather.

The year 2005 was characterized by above normal precipitation throughout the growing season and below normal temperatures in June, July and August, with mean monthly temperatures averaging 0.7, 0.8, and 2.4 degrees Celsius below normal respectively. Precipitation over the course of the growing season May- August averaged 53% more then the long term average (312 mm vs. 203.7 mm). The wettest months June (95.8 mm) and August (99.9 mm) contributed an additional 35 mm and 54.5 mm respectively above the long term monthly average. A hail storm on July 13th resulted in broken stems. Damage however was consistent across the trial with no other impact than a general reduction in seed yield. Plots were harvested on August 10, 2005.

Melfort Seedling Trial

A test area at the Melfort Research Farm was seeded to Chief intermediate wheatgrass June 24, 2004 @ 9 kg/ha.

Fall precipitation in 2004 was about 115% of the long term average and provided ideal moisture conditions for going into winter. Precipitation from January 1 to August 30, 2005 was nearly 170% of normal. Grass establishment was good with considerable amounts of biomass production.

Treatment application was done on August 1, 2004 in a randomized complete block design with the intermediate wheatgrass plants at anywhere from the 3 to 5 leaf stage. Environmental conditions at and near the time of application are presented in Table 16 (APPENDIX). Visual ratings on % injury were done at 14 days after treatment (DAT). Injury ratings at 28 DAT and 42 DAT were not done due to an encroachment and unplanned grazing of the test area by cattle. However, it is unlikely that the grazing had any effect on the final seed yield. The test area was fertilized April 26, 2005, with 89 kg/ha N in the form of ammonium nitrate.

The test was swathed with a self propelled plot swather August 22, 2005. The swaths were allowed to dry enough in the field to be combined. Combining was done with a Wintersteiger plot combine on August 30, 2005. The seed harvested from each plot was then dried in a forced air drier and subsequently cleaned with a Clipper table top seed cleaner to determine clean seed yields.

5.1.c Results and Discussion

Scott Seedling Trial

Results are presented in Table 4. Visual observations in 2004 indicated no evidence of injury either at 9, 23 or 41 days after application with Puma Super regardless of rate or formulation at the 1Xrate. In 2005 injury associated with seedling applied Puma Super remained below 3% with no reductions in seed yield relative to the untreated check or industry standard. Seed yield across the trial averaged 363 kg/ha or approximately 50% less than seed yields obtained from trials harvested in 2004 due primarily to hail damage incurred on July 13th, 2005.

Melfort Seedling Trial

Data is summarized in Table 5. There were no significant reductions of seed yield from treatment application. Significant differences were seen in the visual injury assessments done at 14DAT. However, tolerance to the herbicides tested was within the acceptable range (< 20%).

Table 4: Visual injury and seed yield from application of Puma Super and other herbicides to a seedling intermediate wheatgrass stand – Scott 2004-05.

Trt. No.	TREATMENT	Rate	Intermediate Wheatgrass Visual Injury Percent 25-Jun-04	Intermediate Wheatgrass Visual Injury Percent 9-Jul-04	Intermediate Wheatgrass Visual Injury Percent 27-Jul-04	Intermediate Wheatgrass Visual Injury Percent 14-Jun-05	Intermediate Wheatgrass Visual Injury Percent 11-Jul-05	Intermediate Wheatgrass Seed Yield kg/ha 10-Aug-05
1	WEED FREE CHECK		0 a	0 a	0 a	0 a	1 a	420 a
2	PUMA SUPER	92 g ai/ha	0 a	0 a	0 a	0 a	0 a	471 a
3	PUMA SUPER	184 g ai/ha	0 a	0 a	0 a	0 a	2 a	388 a
4	PRESTIGE FLUROXYPYR CURTAIL M	 142 g ai/ha 660 g ai/ha	0 a	0 a	2 a	0 a	0 a	487 a
5	PRESTIGE FLUROXYPYR CURTAIL M	 284 g ai/ha 1320 g ai/ha	0 a	0 a	1 a	0 a	0 a	485 a
6	ATTAIN FLUROXYPYR 2, 4-DLV ESTER	g ai/ha 105 g ai/ha 560 g ai/ha	0 a	0 a	0 a	0 a	0 a	496 a
7	ATTAIN FLUROXYPYR 2, 4-DLV ESTER	 210 g ai/ha 1120 g ai/ha	0 a	0 a	0 a	0 a	1 a	490 a
8	BANVEL II	140 g ai/ha	0 a	0 a	1 a	0 a	0 a	510 a
9	ACHIEVE TURBOCHARGE	198 g ai/ha 0.5 % v/v	0 a	0 a	0 a	0 a	0 a	501 a
10	SPECTRUM FLORASULAM CURTAIL M	 5 g ai/ha 490 g ai/ha	0 a	1 a	0 a	0 a	0 a	478 a
11	SPECTRUM FLORASULAM CURTAIL M	 10 g ai/ha 980 g ai/ha	0 a	0 a	0 a	0 a	2 a	532 a
12	PUMA 92 SUPER	92 g ai/ha	0 a	0 a	0 a	0 a	0 a	471 a
Tukey's HSD (P=.05)			0	1	2.1	0	2.3	94.4
Standard Deviation			0	0.7	1.4	0	1.6	65.4
CV			0	692.82	431.17	0	340.59	13.69
Treatment Prob(F)			1	0.4671	0.6001	1	0.5735	0.2131

Means followed by same letter do not significantly differ (P=.05, Tukey's HSD)

Mean comparisons performed only when AOV Treatment P(F) is significant at mean comparison OSL.

Table 5.:Visual injury and seed yield from application of Puma Super and other herbicides to a seedling intermediate wheatgrass stand – Melfort 2004-05.

Treatment	Rate	Intermediate Wheatgrass Injury Percent 14 DAT	Intermediate Wheatgrass Seed yield kg/ha
UNTREATED CHECK		0b	1206a
PUMA SUPER	92 gai/ha	0b	1153ab
PUMA SUPER	184 g ai/ha	0b	1181a
PRESTIGE FLUROXYPYR CURTAIL M	 142 g ai/ha 660 g ai/ha	0b	1064b
PRESTIGE FLUROXYPYR CURTAIL M	 284 g ai/ha 1320 g ai/ha	0b	1191a
ATTAIN FLUROXYPYR 2,4-D LV ESTER	 105 g ai/ha 560 g ai/ha	0b	1142ab
ATTAIN FLUROXYPYR 2,4-D LV ESTER	 210 g ai/ha 1120 g ai/ha	0b	1146ab
BANVEL II	140 g ai/ha	0b	1151ab
ACHIEVE 80 DG TURBOCHARGE	198 g ai/ha 0.5% v/v	0b	1122ab
SPECTRUM FLORASULAM CURTAIL-M	 5 g ai/ha 490 g ai/ha	0b	1121ab
SPECTRUM FLORASULAM CURTAIL-M	 10 g ai/ha 980 g ai/ha	0b	1057b
PUMA 92 SUPER	92 g ai/ha	8.75a	1183a
MEAN		0.73	1143
CV		99	7
LSD alpha= .05		1.04	115
Pr>F		<.0001	ns 0.2324

Means followed by same letter do not significantly differ (P=.05, Tukey's HSD)
Mean comparisons performed only when AOV Treatment P(F) is significant at mean comparison OSL.

5.2 ESTABLISHED INTERMEDIATE WHEAT GRASS

5.2.a Materials and Methods

This trial was seeded on June 10, 2003 and harvested on August 12, 2004. Chief Intermediate wheat grass was seeded at a rate of 7 kg/ha.

Herbicide treatments were applied on May 17, 2004. In the week preceding application 4.8 mm of rain fell with 2.0 mm falling within 10 days after application. The first significant rainfall after application occurred on May 29 when 15.2 mm of precipitation was recorded. In 2003 precipitation was below normal in May (20.3 mm vs long term average of 36 mm) and in June (31.3 mm vs long term average of 60.0 mm) but near normal for the remainder of the growing season. Temperatures in July and August of 2003 were above normal averaging 1.2 and 1.9 degrees above normal respectively. The year 2004 was characterized by near normal precipitation through out the growing season but below normal temperatures in May, June, and August, with mean monthly temperatures averaging 1.1 , 1.4, and 1.9 degrees Celsius below normal respectively

5.2.b Results and Discussion

Crop establishment was uniform and very competitive with weeds kept in check by crop competition in 2004. Results are presented in Table 6. Tolerance of established Intermediate wheat grass to Puma Super applied at the 1X and 2X rate was rated as acceptable (< 10% injury) with only slight injury in the form of stunted growth at 10 days after application. No significant seed yield reduction was associated with Puma Super even at the 2X rate. Seed yields from plots treated with Puma Super at the 1X and 2X rates yielded 888 kg/ha and 806 kg/ha, respectively compared to 935 kg/ha for the weed free check and 881 kg/ha for the industry standard Achieve 80 DG.

5.2.c Conclusion

This data suggests Intermediate Wheat grass was tolerant to Puma Super applied even at the 2X rate under the growing conditions experienced at Scott, Saskatchewan in 2003 and 2004. Percent germination tests conducted on 100 seeds/plot between March and April of 2005 showed no evidence that Puma Super reduced germination rates of the seed relative to the untreated check or industry standard Achieve 80DG.

5.3 CONCLUSIONS

Results indicate that both seedling and established intermediate wheat grass tolerated both 1X and 2X rates of Puma Super under the environmental conditions experienced at Scott and Melfort from 2003 to 2005.

Table 6: Visual injury and seed yield from application of Puma Super and other herbicides to an established intermediate wheatgrass stand – Scott 2003-04.

Trt. No.	TREATMENT	Rate	Intermediate Wheatgrass Visual Injury Percent 27-May-04	Intermediate Wheatgrass Visual Injury Percent 14-Jun-04	Intermediate Wheatgrass Visual Injury Percent 25-Jun-04	Intermediate Wheatgrass Visual Injury Percent 22-Jul-04	Intermediate Wheatgrass Seed Yield kg/ha 4-Aug-04	Intermediate Wheatgrass Seed Germination Percent
1	WEED FREE CHECK		0 b	0 a	0 b	0 b	934.7 a	22 a
2	PUMA SUPER	92 g ai/ha	0 b	0 a	0 b	0 b	888.1 a	21 a
3	PUMA SUPER	184 g ai/ha	4 ab	0 a	0 b	0 b	806.1 a	22 a
4	PRESTIGE		0 b	0 a	0 b	0 b	942.3 a	21 a
	FLUROXYPYR	142 g ai/ha						
	CURTAIL M	660 g ai/ha						
5	PRESTIGE		4 ab	0 a	0 b	0 b	901.6 a	18 a
	FLUROXYPYR	284 g ai/ha						
	CURTAIL M	1320 g ai/ha						
6	ATTAIN	g ai/ha	0 b	0 a	0 b	0 b	779.9 a	18 a
	FLUROXYPYR	105 g ai/ha						
	2, 4-DLV ESTER	560 g ai/ha						
7	ATTAIN	g ai/ha	6 a	0 a	0 b	0 b	925.2 a	20 a
	FLUROXYPYR	210 g ai/ha						
	2, 4-DLV ESTER	1120 g ai/ha						
8	BANVEL II	140 g ai/ha	0 b	0 a	9 a	8 a	734.9 a	15 a
9	ACHIEVE	198 g ai/ha	0 b	0 a	0 b	0 b	880.6 a	26 a
	TURBOCHARGE	0.5 % v/v						
10	SPECTRUM		0 b	0 a	0 b	0 b	907.5 a	24 a
	FLORASULAM	5 g ai/ha						
	CURTAIL M	490 g ai/ha						
11	SPECTRUM		4 ab	0 a	0 b	0 b	992.1 a	29 a
	FLORASULAM	10 g ai/ha						
	CURTAIL M	980 g ai/ha						
12	PUMA 92 SUPER	92 g ai/ha	0 b	0 a	0 b	0 b	873.4 a	27 a
Tukey's HSD (P=.05)			5.5	0	5.4	4.5	181.46	9.4
Standard Deviation			2.2	0	2.2	1.8	125.68	6.5
CV			153.14	0	296.92	261.94	14.27	29.66
Treatment Prob(F)			0.0008	1	0.0001	0.0001	0.2344	0.1616

Means followed by same letter do not significantly differ (P=.05, Tukey's HSD)

Mean comparisons performed only when AOV Treatment P(F) is significant at mean comparison OSL.

6.0 TOLERANCE OF SEEDLING MEADOW BROME GRASS TO PUMA SUPER

6.0.a Introduction

Meadow bromegrass is a widely adapted grass species that has been used primarily for pasture production. As with many grass seed crops, weed control is one of the most challenging and potentially limiting factors to successful seed production. A number of trials have been conducted using various herbicides for weed control in meadow bromegrass. There have been several areas identified that need additional data. Therefore, to support minor use registration, trials were conducted to determine the effect of Puma Super on seed yield of meadow brome grass. Other herbicide treatments are included in the trial to satisfy data requirements for other Minor Use studies; however the focus of this project involved Puma Super and only the results from the application of this herbicide are discussed.

6.0.b Materials and Methods

Scott Seedling Trial 1
This trial was fall dormant seeded directly into wheat stubble on October 28, 2003 and emerged on April 28, 2004. The cultivar was Paddock and seeding rate was 7 kg/ha.

Maintenance weed control consisted of a combination of hand weeding and mowing in 2004. Weed growth on the seed rows which consisted primarily of volunteer wheat and some wild oats was kept in check by cutting just above the crop with a tractor powered 3 point hitch mower with wheels running between the rows. In 2005 broadleaf weed seedlings were controlled with a early spring application of 2, 4-D Amine followed by hand weeding.

Herbicide treatments were applied on June 16, 2004. In the week preceding application 29.8 mm of rain fell with 2.2 mm falling within 10 days after application. The first significant rainfall after application occurred on July 1 when 11.8 mm of precipitation was recorded

Scott Seedling Trial 2
This trial was seeded directly into wheat stubble on June 9, 2004. Paddock meadow brome grass was seeded at a rate of 7.5 kg/ha.

Maintenance weed control was the same as Scott Seedling Trial 1. Herbicide treatments were applied on July 13, 2004. In the week preceding application 14 mm of rain fell with 11.8 mm falling within 10 days after application. The first significant rainfall after application occurred on July 20 when 6.4 mm of precipitation was recorded.

At Scott, the year 2004 was characterized by near normal precipitation through out the growing season but below normal temperatures in May, June, and August, with mean monthly temperatures averaging 1.1, 1.4, and 1.9 degrees Celsius below normal respectively. September precipitation (14.8 mm) was 17.2 mm below the long term average despite extended periods of damp cloudy weather.

At Scott, 2005 was characterized by above normal precipitation throughout the growing season and below normal temperatures in June, July and August, with mean monthly temperatures averaging 0.7, 0.8, and 2.4 degrees

Celsius below normal respectively. Precipitation over the course of the growing season May- August averaged 53% more then the long term average (312 mm vs. 203.7 mm). The wettest months June (95.8 mm) and August (99.9 mm) contributed an additional 35 mm and 54.5 mm respectively above the long term monthly average. A hail storm on July 13th resulted in minimal damage in the form of broken stems. Damage was consistent across the trial with no other impact than a slight reduction in seed yield. Plots were harvested on July 25, 2005.

Melfort Seedling Trial

A test area at the Melfort Research Farm was seeded to Fleet meadow bromegrass June 24, 2004 @ 9 kg/ha.

Fall precipitation in 2004 was about 115% of the long term average and provided ideal moisture conditions for going into winter. Precipitation from January 1 to August 30, 2005 was nearly 170% of normal. Grass establishment was good with considerable amounts of biomass production.

Treatment application was done on August 1, 2004 in a randomized complete block design with the meadow bromegrass plants at anywhere from the 3 to 6 leaf stage. Environmental conditions at and near the time of application are presented in Table 16 (APPENDIX).

Visual ratings on % injury were done at 14 days after treatment (DAT). Injury ratings at 28 DAT and 42 DAT were not done due to an encroachment and unplanned grazing of the test area by cattle. However, it is unlikely that the grazing had any effect on the final seed yield. The test area was fertilized April 26, 2005, with 89 kg/ha N in the form of ammonium nitrate.

The test was swathed with a self propelled plot swather August 4, 2005. The swaths were allowed to dry enough in the field to be combined. Combining was done with a Wintersteiger plot combine on August 22, 2005. The seed harvested from each plot was then dried in a forced air drier and subsequently cleaned with a Clipper table top seed cleaner to determine clean seed yields.

6.0.c Results and Discussion

Scott Seedling Trial 1

Results are presented in Table 7. In 2004, visual observations indicated little evidence of Meadow Brome grass injury to Puma Super with the exception of 41 days after application when evidence of slight stunting was observed at the 2X rate. In 2005 injury remained very low (<2%) and no significant differences in seed yield between treatments were observed (P=0.05). Seed yield across the trial averaged 536 kg/ha or approximately 30% less than yields obtained from meadow brome grass trials harvested in 2004. Reduction in yield was a function of hail damage but also a thinner plant stand. This reduction in crop establishment made the crop more susceptible to weed infestation. Although plots were thoroughly hand weeded on June 10th variable weed competition across the trial may have already impacted on seed yield and contributed to the high seed yield coefficient of variation (37%). Despite the variability and subsequent reduction in ability to detect yield differences there was no observed trend toward reduced seed yields where Puma Super was applied.

Scott Seedling Trial 2

Results are presented in Table 8. In 2004 visual observations indicated little evidence of meadow brome grass injury to Puma Super even at the 2 X rate. In 2005 there were no symptoms of injury to Puma Super and no significant differences in seed yield between treatments were observed (P=0.05). Seed yield across the trial averaged 617 kg/ha or approximately 15% less than yields obtained from meadow brome grass trials harvested in 2004. Reduction in yield was primarily a function of hail damage.

Melfort Seedling Trial

Results are presented in Table 9. There were no significant differences in the reduction of seed yield from treatment application. No injury was detected as seen in the visual injury assessments done at 14 DAT.

6.1 CONCLUSIONS

These results suggest that Meadow Brome grass seedlings were tolerant to applications of Puma Super under the conditions experienced at Scott and Melfort in 2004 and 2005. Puma 92 Super which was included to create bridged data with Puma Super showed similar levels of injury at the same rate with no observed reductions in yield.

Table 7: Visual injury and seed yield from application of Puma Super and other herbicides to a seedling meadow brome grass stand – Scott 2004-05.

Trt. No.	TREATMENT	Rate	Meadow Brome grass Visual Injury Percent 25-Jun-04	Meadow Brome grass Visual Injury Percent 9-Jul-04	Meadow Brome grass Visual Injury Percent 27-Jul-04	Meadow Brome grass Visual Injury Percent 14-Jun-05	Meadow Brome grass Visual Injury Percent 11-Jul-05	Meadow Brome grass Seed Yield kg/ha 25-Jul-05
1	WEED FREE CHECK		0 a	0 a	0 a	0 a	0 a	599 a
2	PUMA SUPER	92 g ai/ha	0 a	0 a	0 a	0 a	0 a	866 a
3	PUMA SUPER	184 g ai/ha	0 a	0 a	1 a	0 a	1 a	745 a
4	PRESTIGE FLUROXYPYR CURTAIL M	 142 g ai/ha 660 g ai/ha	0 a	0 a	0 a	0 a	0 a	743 a
5	PRESTIGE FLUROXYPYR CURTAIL M	 284 g ai/ha 1320 g ai/ha	0 a	0 a	0 a	0 a	0 a	461 a
6	ATTAIN FLUROXYPYR 2, 4-DLV ESTER	g ai/ha 105 g ai/ha 560 g ai/ha	0 a	0 a	1 a	0 a	0 a	797 a
7	ATTAIN FLUROXYPYR 2, 4-DLV ESTER	g ai/ha 210 g ai/ha 1120 g ai/ha	0 a	1 a	3 a	0 a	1 a	685 a
8	BANVEL II	140 g ai/ha	0 a	0 a	0 a	0 a	0 a	703 a
9	ACHIEVE TURBOCHARGE	198 g ai/ha 0.5 % v/v	0 a	0 a	2 a	0 a	0 a	714 a
10	SPECTRUM FLORASULAM CURTAIL M	 5 g ai/ha 490 g ai/ha	0 a	0 a	0 a	0 a	0 a	495 a
11	SPECTRUM FLORASULAM CURTAIL M	 10 g ai/ha 980 g ai/ha	0 a	1 a	0 a	0 a	0 a	721 a
12	PUMA 92 SUPER	92 g ai/ha	0 a	0 a	2 a	0 a	1 a	922 a
Tukey's HSD (P=.05)			0	1.4	3.2	0	1.3	381.2
Standard Deviation			0	1	2.2	0	0.9	264
CV			0	467.1	275.78	0	406.85	37.49
Treatment Prob(F)			1	0.4671	0.4695	1	0.5849	0.4338

Means followed by same letter do not significantly differ (P=.05, Tukey's HSD)

Mean comparisons performed only when AOV Treatment P(F) is significant at mean comparison OSL.

Table 8: Visual injury and seed yield from application of Puma Super and other herbicides to a seedling meadow brome grass stand – Scott 2004-05.

Trt. No.	TREATMENT	Rate	Meadow Brome grass Visual Injury Percent 25-Jun-04	Meadow Brome grass Visual Injury Percent 9-Jul-04	Meadow Brome grass Visual Injury Percent 27-Jul-04	Meadow Brome grass Visual Injury Percent 14-Jun-05	Meadow Brome grass Visual Injury Percent 11-Jul-05	Meadow Brome grass Seed Yield kg/ha 25-Jul-05
1	WEED FREE CHECK		0 a	0 a	0 a	0 a	0 a	649 a
2	PUMA SUPER	92 g ai/ha	0 a	0 a	0 a	0 a	0 a	694 a
3	PUMA SUPER	184 g ai/ha	2 a	1 a	2 a	0 a	0 a	792 a
4	PRESTIGE FLUROXYPYR CURTAIL M	 142 g ai/ha 660 g ai/ha	2 a	0 a	0 a	0 a	0 a	701 a
5	PRESTIGE FLUROXYPYR CURTAIL M	 284 g ai/ha 1320 g ai/ha	1 a	1 a	3 a	0 a	0 a	763 a
6	ATTAIN FLUROXYPYR 2, 4-DLV ESTER	g ai/ha 105 g ai/ha 560 g ai/ha	4 a	1 a	3 a	0 a	1 a	818 a
7	ATTAIN FLUROXYPYR 2, 4-DLV ESTER	g ai/ha 210 g ai/ha 1120 g ai/ha	0 a	1 a	3 a	0 a	0 a	748 a
8	BANVEL II	140 g ai/ha	0 a	0 a	0 a	0 a	0 a	833 a
9	ACHIEVE TURBOCHARGE	198 g ai/ha 0.5 % v/v	0 a	0 a	0 a	0 a	0 a	920 a
10	SPECTRUM FLORASULAM CURTAIL M	 5 g ai/ha 490 g ai/ha	0 a	0 a	0 a	0 a	0 a	907 a
11	SPECTRUM FLORASULAM CURTAIL M	 10 g ai/ha 980 g ai/ha	1 a	0 a	0 a	0 a	0 a	820 a
12	PUMA 92 SUPER	92 g ai/ha	0 a	0 a	0 a	0 a	0 a	1076 a
Tukey's HSD (P=.05)			3.4	2	2.9	0	1	271.6
Standard Deviation			2.4	1.4	2	0	0.7	188.1
CV			278.08	360.32	254.14	0	692.82	23.22
Treatment Prob(F)			0.4214	0.7208	0.2337	1	0.4671	0.1613

Means followed by same letter do not significantly differ (P=.05, Tukey's HSD)

Mean comparisons performed only when AOV Treatment P(F) is significant at mean comparison OSL.

Table 9: Visual injury and seed yield from application of Puma Super and other herbicides to a seedling meadow brome grass stand – Melfort 2004-05.

Treatment	Rate	Meadow Brome grass Injury Percent 14 DAT	Meadow Brome grass Seed yield kg/ha
UNTREATED CHECK		0a	498ab
PUMA SUPER	92 gai/ha	0a	398b
PUMA SUPER	184 g ai/ha	0a	539a
PRESTIGE FLUROXYPYR CURTAIL M	 142 g ai/ha 660 g ai/ha	0a	437ab
PRESTIGE FLUROXYPYR CURTAIL M	 284 g ai/ha 1320 g ai/ha	0a	527a
ATTAIN FLUROXYPYR 2,4-D LV ESTER	 105 g ai/ha 560 g ai/ha	0a	464ab
ATTAIN FLUROXYPYR 2,4-D LV ESTER	 210 g ai/ha 1120 g ai/ha	0a	496ab
BANVEL II	140 g ai/ha	0a	500ab
ACHIEVE 80 DG TURBOCHARGE	198 g ai/ha 0.5% v/v	0a	500ab
SPECTRUM FLORASULAM CURTAIL-M	 5 g ai/ha 490 g ai/ha	0a	482ab
SPECTRUM FLORASULAM CURTAIL-M	 10 g ai/ha 980 g ai/ha	0a	474ab
PUMA 92 SUPER	92 g ai/ha	0a	533a
MEAN		0	487.5
CV		.	14.7
LSD alpha= .05		0	103
Pr>F		.	ns 0.2799

Means followed by same letter do not significantly differ (P=.05, Tukey's HSD)
Mean comparisons performed only when AOV Treatment P(F) is significant at mean comparison OSL.

7.0 TOLERANCE OF SMOOTH BROME TO PUMA SUPER

7.0.a Introduction

Smooth bromegrass is a widely adapted grass species that has been used primarily for hay and pasture production. As with many grass seed crops, weed control is one of the most challenging and potentially limiting factors to successful seed production. A number of trials have been conducted using various herbicides for weed control in smooth bromegrass. There have been several areas identified that need additional data. Therefore, to support minor use registration, trials were conducted to determine the effect of Puma Super on seed yield of smooth brome grass. Other herbicide treatments are included in the trial to satisfy data requirements for other Minor Use studies; however the focus of this project involved Puma Super and only the results from the application of this herbicide are discussed.

7.0.b Materials and Methods

Scott Seedling Trial 1

This trial was fall dormant seeded directly into wheat stubble on October 28, 2003 and emerged on April 28, 2004. The cultivar was Magna which was seeded at a rate of 8 kg/ha. Plots were harvested on July 25, 2005.

Herbicide treatments were applied on June 16, 2004. In the week preceding application 29.8 mm of rain fell with 2.2 mm falling within 10 days after application. The first significant rainfall after application occurred on July 1 when 11.8 mm of precipitation was recorded.

Scott Seedling Trial 2

Magna smooth brome grass was seeded at a rate of 8 kg/ha directly into wheat stubble on June 9, 2004. Plots were harvested on July 25, 2005.

Herbicide treatments were applied on July 13, 2004. In the week preceding application 14 mm of rain fell with 11.8 mm falling within 10 days after application. The first significant rainfall after application occurred on July 20 when 6.4 mm of precipitation was recorded.

In both studies at Scott, maintenance weed control consisted of a combination of hand weeding and mowing in 2004. Weed growth on the seed rows which consisted primarily of volunteer wheat and some wild oats was kept in check by cutting just above the crop with a tractor powered 3 point hitch mower with wheels running between the rows. In 2005 broadleaf weed seedlings were controlled with a combination of 2, 4-D Amine applied early in the spring followed by hand weeding.

The year 2004 was characterized by near normal precipitation through out the growing season but below normal temperatures in May, June, and August, with mean monthly temperatures averaging 1.1, 1.4, and 1.9 degrees Celsius below normal respectively. September precipitation (14.8 mm) was 17.2 mm below the long term average despite extended periods of damp cloudy weather. The year 2005 was characterized by above normal precipitation throughout the growing season and below normal temperatures in June, July and August, with mean monthly temperatures averaging 0.7, 0.8, and 2.4 degrees Celsius below normal respectively. Precipitation over the course of the growing season May-August averaged 53% more then the long term average (312 mm vs. 203.7 mm). The wettest months June (95.8 mm) and August (99.9 mm) contributed an additional 35 mm and 54.5 mm respectively above the long term monthly average. A hail storm on July 13th resulted in minimal damage in the form of broken stems. Damage was consistent across the trial with no other impact than a slight reduction in seed yield.

7.0.c Results and Discussion

Scott Seedling Trial 1

Results are presented in Table 10. In 2004 visual observations indicated little evidence of Smooth Brome grass injury to Puma Super even at the 2 X rate. Crop injury to Puma Super took the form of stunting. Injury symptoms from Puma Super remained low in 2005 (<2%) with no evidence of seed yield loss relative to the untreated check or industry standard. Seed yield across the trial averaged 542 kg/ha.

Table10: Visual injury and seed yield from application of Puma Super and other herbicides to a seedling smooth brome grass stand – Scott 2004-05.

Trt. No.	TREATMENT	Rate	Smooth Brome grass Visual Injury Percent 25-Jun-04	Smooth Brome grass Visual Injury Percent 9-Jul-04	Smooth Brome grass Visual Injury Percent 27-Jul-04	Smooth Brome grass Visual Injury Percent 14-Jun-05	Smooth Brome grass Visual Injury Percent 11-Jul-05	Smooth Brome grass Seed Yield kg/ha 25-Jul-05
1	WEED FREE CHECK		0 a	0 a	1 a	0 a	0 a	788 a
2	PUMA SUPER	92 g ai/ha	0 a	0 a	0 a	0 a	1 a	633 a
3	PUMA SUPER	184 g ai/ha	0 a	1 a	0 a	0 a	1 a	605 a
4	PRESTIGE FLUROXYPYR CURTAIL M	 142 g ai/ha 660 g ai/ha	0 a	0 a	3 a	0 a	1 a	780 a
5	PRESTIGE FLUROXYPYR CURTAIL M	 284 g ai/ha 1320 g ai/ha	0 a	1 a	1 a	0 a	0 a	780 a
6	ATTAIN FLUROXYPYR 2, 4-DLV ESTER	 105 g ai/ha 560 g ai/ha	0 a	1 a	4 a	0 a	1 a	719 a
7	ATTAIN FLUROXYPYR 2, 4-DLV ESTER	g ai/ha 210 g ai/ha 1120 g ai/ha	0 a	3 a	1 a	0 a	1 a	600 a
8	BANVEL II	140 g ai/ha	0 a	3 a	0 a	0 a	1 a	731 a
9	ACHIEVE TURBOCHARGE	198 g ai/ha 0.5 % v/v	0 a	0 a	0 a	0 a	2 a	693 a
10	SPECTRUM FLORASULAM CURTAIL M	 5 g ai/ha 490 g ai/ha	0 a	1 a	2 a	0 a	3 a	707 a
11	SPECTRUM FLORASULAM CURTAIL M	 10 g ai/ha 980 g ai/ha	0 a	3 a	0 a	0 a	1 a	755 a
12	PUMA 92 SUPER	92 g ai/ha	0 a	1 a	0 a	0 a	0 a	748 a
Tukey's HSD (P=.05)			0	3.3	3.9	0	2.1	163.3
Standard Deviation			0	2.3	2.7	0	1.4	113.1
CV			0	201.27	267.71	0	168.9	15.89
Treatment Prob(F)			1	0.6944	0.5832	1	0.4729	0.2189

Means followed by same letter do not significantly differ (P=.05, Tukey's HSD)
Mean comparisons performed only when AOV Treatment P(F) is significant at mean comparison OSL.

Scott Seedling Trial 2

Results are presented in Table 11. In 2004 visual observations indicated no evidence of Smooth Brome grass injury to Puma Super even at the 2 X rate. In 2005 no injury symptoms from Puma Super at the 2X rate were observed and no reductions in seed yield relative to the untreated check or industry standard detected (P=0.05). Seed yield averaged 672 kg/ha across the trial.

Table11: Visual injury and seed yield from application of Puma Super and other herbicides to a seedling smooth brome grass stand – Scott 2004-05.

Trt. No.	TREATMENT	Rate	Smooth Brome grass Visual Injury Percent 23-Jul-04	Smooth Brome grass Visual Injury Percent 6-Aug-04	Smooth Brome grass Visual Injury Percent 20-Aug-04	Smooth Brome grass Visual Injury Percent 14-Jun-05	Smooth Brome grass Visual Injury Percent 11-Jul-05	Smooth Brome grass Seed Yield kg/ha 25-Jul-05
1	WEED FREE CHECK		0 a	2 a	0 b	0 a	0 a	850 a
2	PUMA SUPER	92 g ai/ha	0 a	0 a	0 b	0 a	0 a	902 a
3	PUMA SUPER	184 g ai/ha	0 a	0 a	0 b	0 a	0 a	815 a
4	PRESTIGE		1 a	1 a	1 b	0 a	1 a	868 a
	FLUROXYPYR	142 g ai/ha						
	CURTAIL M	660 g ai/ha						
5	PRESTIGE		1 a	0 a	0 b	0 a	1 a	847 a
	FLUROXYPYR	284 g ai/ha						
	CURTAIL M	1320 g ai/ha						
6	ATTAIN		2 a	1 a	1 b	0 a	0 a	941 a
	FLUROXYPYR	105 g ai/ha						
	2, 4-DLV ESTER	560 g ai/ha						
7	ATTAIN	g ai/ha	5 a	4 a	10 a	0 a	1 a	951 a
	FLUROXYPYR	210 g ai/ha						
	2, 4-DLV ESTER	1120 g ai/ha						
8	BANVEL II	140 g ai/ha	1 a	1 a	0 b	0 a	0 a	916 a
9	ACHIEVE	198 g ai/ha	0 a	0 a	0 b	0 a	0 a	713 a
	TURBOCHARGE	0.5 % v/v						
10	SPECTRUM		0 a	0 a	0 b	0 a	0 a	897 a
	FLORASULAM	5 g ai/ha						
	CURTAIL M	490 g ai/ha						
11	SPECTRUM		1 a	0 a	0 b	0 a	0 a	920 a
	FLORASULAM	10 g ai/ha						
	CURTAIL M	980 g ai/ha						
12	PUMA 92 SUPER	92 g ai/ha	1 a	0 a	0 b	0 a	0 a	964 a
Tukey's HSD (P=.05)			3	2.5	3.6	0	1.1	142.4
Standard Deviation			2.1	1.7	1.5	0	0.7	98.6
CV			197.64	228.99	151.34	0	395.94	11.18
Treatment Prob(F)			0.1687	0.0849	0.0001	1	0.6077	0.0611

Means followed by same letter do not significantly differ (P=.05, Tukey's HSD)
Mean comparisons performed only when AOV Treatment P(F) is significant at mean comparison OSL.

7.1 CONCLUSIONS

The results from the two studies conducted at Scott indicate that smooth brome grass was tolerant to seedling applied Puma Super under the growing conditions that existed at Scott in 2004 and 2005. Puma 92 Super which was included to generate bridging data with Puma Super showed similar levels of injury to Puma Super at the same 1X rate.

8.0 TOLERANCE OF SEEDLING TALL FESCUE TO PUMA SUPER

8.0.a Introduction

Tall Fescue is an introduced grass species that has been used for both grazing and hay production purposes. It is well adapted to acidic soils but also produces well in neutral soils. As with many grass seed crops, weed control is one of the most challenging and potentially limiting factors to successful seed production. A number of trials have been conducted using various herbicides for weed control in tall fescue. There have been several areas identified that need additional data. Therefore, to support minor use registration, trials were conducted to determine the effect of Puma Super on seed yield of tall fescue. Other herbicide treatments are included in the trial to satisfy data requirements for other Minor Use studies; however the focus of this project involved Puma Super and only the results from the application of this herbicide are discussed.

8.0.b Materials and Methods

Scott Seedling Trial 1

A burn-off with glyphosate was conducted on May 26th in preparation to seed. The test area was tilled with spring tooth harrows to 6 cm depth followed by diamond harrows, and packed on May 27th.This trial was seeded on May 28, 2004 to replace a study initiated in 2003 that failed due to poor crop establishment. The cultivar Guardian was seeded at a rate of 5 kg/ha. The crop emerged on June 13, 2004. Seed was harvested on July 26th.

Herbicide treatments were applied on June 28, 2004. In the week preceding application 0.3 mm of rain fell with 45.8 mm falling within 10 days after application in addition to 10 mm of irrigated water on June 30th. The first significant precipitation after application occurred on June 30 when 10 mm of irrigated water was applied.

Scott Seedling Trial 2

A burn-off with glyphosate was conducted on May 26th in preparation to seed. The test area was tilled with spring tooth harrows to 6 cm depth followed by diamond harrows, and packed on May 27th. Guardian tall fescue was seeded at a rate of 5 kg/ha on June 9, 2004. The crop emerged on June 24, 2004. Seed was harvested on July 26th.

In both Scott studies, maintenance weed control consisted of a combination of maintenance herbicides, hand weeding and mowing. Weed growth on the seed rows which consisted primarily of volunteer wheat and some wild oats was kept in check by cutting just above the crop with a tractor powered 3 point hitch mower with wheels running between the rows in 2004. Registered herbicides were used in 2004 and 2005 to control broadleaf weeds.

At Scott, the year 2004 was characterized by near normal precipitation through out the growing season but below normal temperatures in May, June, and August, with mean monthly temperatures averaging 1.1, 1.4, and 1.9 degrees Celsius below normal respectively. September precipitation (14.8 mm) was 17.2 mm below the long term average despite extended periods of damp cloudy weather. The year 2005 was characterized by above normal precipitation throughout the growing season and below normal temperatures in June, July and August, with mean monthly temperatures averaging 0.7, 0.8, and 2.4 degrees Celsius below normal respectively. Precipitation over the course of the growing season May- August averaged 53% more then the long term average (312 mm vs. 203.7 mm). The wettest months June (95.8 mm) and August (99.9 mm) contributed an additional 35 mm and 54.5 mm respectively above the long term monthly average. A hail storm on July 13th resulted in minimal crop damage in the form of broken stems. Observed damage was consistent across the trial.

Melfort Seedling Trial

A test area at the Melfort Research Farm was seeded to Courtenay tall fescue June 24, 2004 @ 9 kg/ha. Fertility levels were adequate to establish a grass seed crop.

Fall precipitation in 2004 was about 115% of the long term average and provided ideal moisture conditions for going into winter. Precipitation from January 1 to August 30, 2005 was nearly 170% of normal. Grass establishment was good with considerable amounts of biomass production.

Herbicide treatment application was done on August 1, 2004 in a randomized complete block design with the tall fescue plants at anywhere from the 2 to 4 leaf stage. Environmental conditions at and near the time of application are presented in Table 16 (APPENDIX). Visual ratings on % injury were done at 14 days after treatment (DAT). Injury ratings at 28 DAT and 42 DAT were not done due to an encroachment and unplanned grazing of the test area by cattle. However, it is unlikely that the grazing had any effect on the final seed yield. The test area was fertilized April 26, 2005, with 89 kg/ha N in the form of ammonium nitrate.

The test was swathed with a self propelled plot swather July 27, 2005. The swaths were allowed to dry enough in the field to be combined. Combining was done with a Wintersteiger plot combine on August 10, 2005. The seed harvested from each plot was then dried in a forced air drier and subsequently cleaned with a Clipper table top seed cleaner to determine clean seed yields.

8.0.c Results and Discussion

Scott Seedling Trial 1

Results are presented in Table 12. In 2004 visual observations indicated acceptable levels of injury (stunting) for Puma Super at the 1X rate with slightly higher injury at the 2 X rate leading to a just acceptable level of injury 25 days after application. Puma 92 Super which was included to create bridging data between the new and old formulation showed similarly low levels of injury to Puma Super at the 1X rate. Average seed yields across the study of 592 kg/ha were at the low end of the range (560-1350 kg/ha) generally anticipated for Tall Fescue.

Scott Seedling Trial 2

Results are presented in Table 13. In 2004 visual observations indicated acceptable levels of injury (stunting) for Puma Super at the 1X rate with slightly higher injury at the 2 X rate leading to a just acceptable level of injury 24 days after application. Puma 92 Super which was included to create bridging data between the new and old formulation showed similarly low levels of injury to Puma Super at the 1X rate. Average seed yields across the study of 552 kg/ha were at the low end of the range (560-1350 kg/ha) generally anticipated for Tall Fescue.

Table12: Visual injury and seed yield from application of Puma Super and other herbicides to a seedling tall fescue grass stand – Scott 2004-05.

Trt. No.	TREATMENT	Rate	Tall Fescue Visual Injury Percent 6-Jul-04	Tall Fescue Visual Injury Percent 23-Jul-04	Tall Fescue Visual Injury Percent 6-Aug-04	Tall Fescue Visual Injury Percent 14-Jun-05	Tall Fescue Visual Injury Percent 11-Jul-05	Tall Fescue Seed Yield kg/ha 26-Jul-05
1	WEED FREE CHECK		0 c	0 d	0 c	0 a	0 a	613 a
2	PUMA SUPER	92 g ai/ha	4 b	5 bc	4 abc	0 a	0 a	619 a
3	PUMA SUPER	184 g ai/ha	9 a	10 a	7 a	0 a	0 a	493 a
4	PUMA 92 SUPER	92 g ai/ha	6 b	7 ab	5 ab	0 a	0 a	566 a
5	SPECTRUM FLORASULAM CURTAIL M	 5 g ai/ha 490 g ai/ha	0 c	1 d	0 c	0 a	0 a	682 a
6	SPECTRUM FLORASULAM CURTAIL M	 10 g ai/ha 980 g ai/ha	0 c	2 cd	1 bc	0 a	0 a	548 a
7	PRESTIGE FLUROXYPYR CURTAIL M	 284 g ai/ha 1320 g ai/ha	0 c	0 d	0 c	0 a	0 a	645 a
8	BANVEL II	140 g ai/ha	0 c	0 d	0 c	0 a	0 a	576 a
Tukey's HSD (P=.05)			2.4	4.4	4.3	0	0	152.6
Standard Deviation			1	1.8	1.8	0	0	103.7
CV			44.77	59.29	91.17	0	0	17.5
Treatment Prob(F)			0.0001	0.0001	0.0001	1	1	0.2907

Means followed by same letter do not significantly differ (P=.05, Tukey's HSD)
Mean comparisons performed only when AOV Treatment P(F) is significant at mean comparison OSL.

Table13: Visual injury and seed yield from application of Puma Super and other herbicides to a seedling tall fescue grass stand – Scott 2004-05.

Trt. No.	TREATMENT	Rate	Tall Fescue Visual Injury Percent 6-Jul-04	Tall Fescue Visual Injury Percent 23-Jul-04	Tall Fescue Visual Injury Percent 6-Aug-04	Tall Fescue Visual Injury Percent 14-Jun-05	Tall Fescue Visual Injury Percent 11-Jul-05	Tall Fescue Seed Yield kg/ha 26-Jul-05
1	WEED FREE CHECK		0 d	1 b	1 b	0 a	0 a	686.3 a
2	PUMA SUPER	92 g ai/ha	5 bc	3 b	2 b	0 a	0 a	702.7 a
3	PUMA SUPER	184 g ai/ha	8 a	10 a	8 a	0 a	0 a	703.1 a
4	PUMA 92 SUPER	92 g ai/ha	6 ab	4 ab	3 b	0 a	0 a	688.5 a
5	SPECTRUM FLORASULAM CURTAIL M	 5 g ai/ha 490 g ai/ha	1 cd	1 b	0 b	0 a	0 a	759.1 a
6	SPECTRUM FLORASULAM CURTAIL M	 10 g ai/ha 980 g ai/ha	0 d	0 b	0 b	0 a	0 a	736.3 a
7	PRESTIGE FLUROXYPYR CURTAIL M	 284 g ai/ha 1320 g ai/ha	1 d	0 b	0 b	0 a	0 a	808.2 a
8	BANVEL II	140 g ai/ha	0 d	0 b	0 b	0 a	0 a	715.2 a
Tukey's HSD (P=.05)			3.6	6.1	3.7	0	0	119.16
Standard Deviation			1.5	2.6	1.6	0	0	81.02
CV			59.53	104.36	90.14	0	0	11.18
Treatment Prob(F)			0.0001	0.0001	0.0001	1	1	0.4253

Means followed by same letter do not significantly differ (P=.05, Tukey's HSD)
Mean comparisons performed only when AOV Treatment P(F) is significant at mean comparison OSL.

Melfort Seedling Trial

Results are presented in Table 14. There were no significant differences in the reduction of seed yield from treatment application. No injury was detected as seen in the visual injury assessments done at 14 DAT.

Table14: Visual injury and seed yield from application of Puma Super and other herbicides to a seedling tall fescue grass stand. Melfort, 2004-05.

Treatment	Rate	Tall Fescue Injury Percent 14 DAT	Tall Fescue Seed yield kg/ha
UNTREATED CHECK		0a	1279abc
PUMA SUPER	92 gai/ha	0a	1287ab
PUMA SUPER	184 g ai/ha	0a	1156c
PRESTIGE FLUROXYPYR CURTAIL M	 142 g ai/ha 660 g ai/ha	0a	1275abc
PRESTIGE FLUROXYPYR CURTAIL M	 284 g ai/ha 1320 g ai/ha	0a	1239abc
ATTAIN FLUROXYPYR 2,4-D LV ESTER	 105 g ai/ha 560 g ai/ha	0a	1301ab
ATTAIN FLUROXYPYR 2,4-D LV ESTER	 210 g ai/ha 1120 g ai/ha	0a	1283abc
BANVEL II	140 g ai/ha	0a	1201bc
ACHIEVE 80 DG TURBOCHARGE	198 g ai/ha 0.5% v/v	0a	1190bc
SPECTRUM FLORASULAM CURTAIL-M	 5 g ai/ha 490 g ai/ha	0a	1351a
SPECTRUM FLORASULAM CURTAIL-M	 10 g ai/ha 980 g ai/ha	0a	1235abc
PUMA 92 SUPER	92 g ai/ha	0a	1222abc
MEAN		0	1252
CV		.	7.2
LSD alpha= .05		0	129
Pr>F		.	ns .01851

Means followed by same letter do not significantly differ (P=.05, Tukey's HSD)
Mean comparisons performed only when AOV Treatment P(F) is significant at mean comparison OSL.

8.2 CONCLUSIONS

This evidence suggests that under the conditions experienced at Scott and Melfort, SK in 2004 and 2005, tall fescue grass seedlings were generally tolerant to applications of Puma Super. At Scott in 2005, observations at heading in both trials indicated that tall fescue plants treated with Puma Super exhibited more and larger seed heads then other treatments in the trial. This resulted in slight lodging but did not translate into higher seed yields.

9.0 EXTENSION ACTIVITIES

The project results were disseminated through extension activities:

Annual Western Applied Research Corporation (WARC) newsletter (2)
Annual Scott Field Days (2)
Poster presented at Canadian Weed Science Society
Annual WARC Research UpDATes, North Battleford (2)

10.0 OVERALL CONCLUSIONS

Most of the forage grass species tested in this study exhibited satisfactory tolerance to Puma Super. The only exception was the established crested wheatgrass study. Data mining will now be conducted to find supporting data. Once this has occurred, Pesticide Minor Use Coordinators in the Prairies will summarize the data for submission to the Pesticide Management Regulatory Agency.

11.0 REFERENCES:

Darwent, A.L., D.E. Cole, H.A. Loeppky and R. Esau. 1998. Guidelines for the conduct of chemical weed control trials in forage grasses grown for seed. Alberta Agriculture, Food and Rural Development. 26 pp.

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12.0 APPENDIX

ENVIRONMENT DATA FOR SCOTT AND MELFORT

Table 15. Monthly summary of environmental data for Scott, SK. (2003-05) and Melfort, SK. (2004-05).

Precipitation (mm)							
	April	May	June	July	August	Sept	Total
Scott							
2003	24	22	34	66	44	43	233
2004	3	35	53	69	44	15	219
2005	27	41	100	77	88	75	408
Scott Long-Term Average	23	36	60	59	45	32	255
Melfort							
2004	21	34	66	56	54	52	283
2005	13	37	166	70	99	97	482
Melfort Long-Term Avg.	25	46	66	76	57	27	297
Mean Monthly Air Temperature (° C)							
	April	May	June	July	August	Sept	Mean
Scott							
2003	4	11	15	18	20	10	13.0
2004	5	8	13	17	14	10	11.2
2005	5	9	13.5	18	13	10	11.4
Scott Long-Term Average	3	10	14	17	16	10	11.8
Melfort							
2004	3	7	13	17	14	11	10.8
2005	6	9	14	17	15	11	11.9
Melfort Long-Term Avg.	3	11	16	18	16	11	12.5

Table 16. Weather information describing conditions around the timing of treatment application of various herbicides on intermediate wheatgrass near Melfort in 2004.

Wind	Temperature	Precipitation				
Speed and direction	at time of application degrees C	week before (mm)	1st week after (mm)	2nd week after (mm)	days to 1st significant rainfall (mm)	amount of 1st significant rainfall (mm)
West @12 km/hr	20	6.8	1.3	7.1	8	6.3

Table 17: Equivalent rates of herbicides used in trials.

Treatment	Rate g ai/ha	Rate liter/acre
PUMA 120 SUPER 1X*	92	0.31
PUMA 120 SUPER 2 X**	184	0.62
PRESTIGE 1X FLUROXYPYR CURTAIL M	 142 660	 0.32 0.8
PRESTIGE 2X FLUROXYPYR CURTAIL M	 284 1320	 0.64 1.6
ATTAIN 1X FLUROXYPYR 2,4-D LV ESTER	 105 560	 0.24 0.40
ATTAIN 2X FLUROXYPYR 2,4-D LV ESTER	 210 1120	 0.48 0.80
BANVEL II 1X	140	0.12
SPECTRUM 1X FLORASULAM CURTAIL-M	 5 490	 0.04 0.60
SPECTRUM 2X FLORASULAM CURTAIL-M	 10 980	 0.08 1.20
PUMA 92 SUPER	92	0.40

*****1X = label rate

**2X = two times the label rate to simulate sprayer overlaps.