Annual Ryegrass Seed Production: Fertility and Plant Growth Regulators

For: Saskatchewan Forage Seed Development Commissions

Brianne McInnes BSc., AAg
Research Associate
Northeast Agriculture Research Foundation
Melfort, SK
neag.assistant@gmail.com

Jessica Pratchler MSc., PAg
Technical Advisor
Northeast Agriculture Research Foundation
Melfort, SK
neag.agro@gmail.com

Objective/Rationale: To determine the optimal nitrogen fertilizer rate(s), in combination with a Plant Growth Regulator (PGR), for use in Annual ryegrass for seed production.

Methodology: This small plot research trial was conducted in a randomized complete block design with 4 replicates. Each plot was 2m by 7m with borders on each replicate end. There were 12 treatments based on two factors: plant growth regulator application (Manipulator, Parlay or no PGR) and nitrogen rate (0, 50, 100, and 125 kg of N/ha) (Table 1).

Table 1: Treatments used in Annual Ryegrass Seed Production Fertility and PGR in Melfort, SK 2019.

TRT #	Plant Growth Regulator	N Rate (kg N/ha)
1	Manipulator 1x (730 mL/ac)	0
2		50
3		100
4		125
5	Parlay 1x (715 mL/ac)	0
6		50
7		100
8		125
9	No PGR	0
10		50
11		100
12		125

On May 28th, 2019 an Annual ryegrass (tetraploid - var. unknown) was seeded at an 0.75 inch depth into canola stubble. All plots were seeded using a 6-row Fabro plot seeder on 12-inch row spacing. The targeted seeding rate was 18 lb/ac and was adjusted for a 90 % germination and a 2.6 g TKW. The site was soil sampled prior to seeding to determine residual nutrient levels (Table 2). Nitrogen was applied as 46-0-0 (urea) and was side-banded at the various treatment rates. Phosphorus was also applied to each plot as seed-placed 11-52-0 at 18 lb/ac of P_2O_5. No additional potassium or sulphur fertilizers were required.

Table 2: Residual soil nutrient levels (0-12") found in Annual Ryegrass Seed Production Fertility and PGR in Melfort 2019.

Residual Soil Levels			
Nitrogen (lb/ac)	*Phosphorus (ppm)*	*Potassium (ppm)*	*Sulphur (lb/ac)*
37	10	514	52

The trial received crop protection products as needed, outside of the Plant Growth Regulator treatments. Glyphosate 540 was applied at 0.51 L/ac on May 30th for pre-emergent herbicide control. MCPA (360 mL/ac) was applied on July 5th followed by Assert (0.67 mL/ac) on July 10th as in-crop weed control. No fungicides, insecticides, or desiccants were applied to this trial. The plant growth regulator applications of Parlay (715mL/ac) and Manipulator (730mL/ac) were both done on July 16th. The plant growth regulator was applied via CO2 propelled sprayer, mounted on an ATV. Lastly, all plots were combined on October 4th using a Wintersteiger plot combine, with 5 crop rows collected.

Data collection consisted of base line nutrient levels, crop tolerance, height, lodging, yield, and quality. Base line nutrient levels were determined by taking soil samples at 0-6 and 6-12 inches prior to seeding. Crop tolerance was accounted for by rating crop health/damage from PGR application on a scale of 0-100%, approximately 1 month after application. Crop height was measured by recording the average plant height at the front and back of each plot, near maturity. Lodging was rated using the Belgian lodging scale prior to harvest (area * intensity * 0.2). Yield was determined by cleaning and weighing each harvested sample, while correcting for 11% moisture. Lastly, quality was accounted for by sending composite samples of treatments 2, 6, and 10 away for germination and TKW determination. Statistical analysis was completed with Statistix 10 using Factorial ANOVA.

Results:

Environmental Conditions: May through August were cooler than normal, while September was warmer (Table 3). Both May and August were 1.9°C cooler, while June, July, and September were within 0.4 to 0.6°C of the long-term climate normal for each respective month. May, July, and August received less precipitation than normal, while June and September had more than normal (Table 3). However, both July and September were within 4 mm of the long-term climate normal; while May, June, and August were within 21 to 33 mm of their normal. Due to the cool, dry conditions in May, seedling germination was slow and sporadic. The wet conditions in June, assisted in plant establishment, but also resulted in more seedling germination. This caused for multiple growth stages within a small area, ultimately leading to increased variability within and between plots. This inevitably led to delays in maturity and harvesting. Overall, the growing season was slightly cooler and drier than the long-term climate normal.

Table 3: Mean temperatures and precipitation collect from the Environment Canada Weather Station at Melfort SK., from May to September 2019.

	May	June	July	August	September	Average/Total
			--- Mean Temperature (°C) ---			
2019	8.8	15.3	16.9	14.9	11.2	13.4
Long-Term[x]	10.7	15.9	17.5	16.8	10.8	14.3
			--- Total Precipitation (mm) ---			
2019	18.8	87.4	72.7	30.7	43.0	252.6
Long-Term[x]	42.9	54.3	76.7	52.4	38.7	265.0

[x] Long-term climate normal from Environment Canada Weather Station located at Melfort SK., from 1981-2010

Base Line Nutrient Levels: Soil fertility levels were determined on May 1st, with results previously listed in Table 2. Test results show that residual levels were low for residual nitrogen, moderate for residual phosphorus, and moderate to high for residual potassium and sulphur. Based on these results, it is expected that a response to any rate of side-banded nitrogen will occur.

Crop Tolerance: Crop tolerance was accounted for on August 15th approximately 4 weeks after PGR application. No crop tolerance issues were noted and all plots demonstrated 100% crop tolerance (data not shown). When general trial notes were recorded 2 weeks after application, there also was no evidence of crop damage noted. However, notes were not taken for each individual plot, as it was a whole trial assessment.

Crop Height: Crop height was accounted for on August 23rd. PGR and nitrogen rate did not significantly affect crop height; yet the interaction between the two factors did (Table 4). The significant interaction at $p<0.05$ is likely driven by the significant effect of nitrogen at the $p<0.10$ level. At the 95% confidence level ($p<0.05$), crop height significantly increased by 4 cm over the control when 50 kg/ha of N was applied. When 100 kg N/ha was applied, crop height was shorter than at 50 kg N/ha and was statistically similar to the 0 and 125 kg N/ha treatments. Due to the low levels of residual nitrogen, one may have expected a larger height differences between the 0 kg N/ha and applied nitrogen treatments. While there was statistical difference between treatments, a 1 to 4 cm difference in height between the treatments likely does not have agronomic significance. It was expected that the application of either PGR would result in crop height decreases, however this did not occur in 2019. This is likely due to the dry, and cool growing conditions throughout the 2019 crop year. When examining the interaction, the height stability within the No PGR application treatments reacted as expected. When Manipulator was applied, there was a trend for crop height to decrease over the nitrogen rates tested by a very small range. When Parlay was applied, a significant height increase occurred between 0 and 50 kg N/ha, with height trending downward with increasing nitrogen rate. This large increase is likely a random effect. Overall, due to the cool and dry 2019 growing season, PGR application had little effect on crop height, while increasing nitrogen rate tended to increase crop height slightly.

Lodging: Lodging was accounted for on September 4th using the Belgian Lodging Scale. The amount of lodging was significantly different between the PGR treatments and nitrogen rates, yet the interaction between the two factors was not significant (Table 4). Application of Parlay significantly reduced lodging, while lodging severity in the Manipulator treatments were similar to those found when No PGR was applied. As expected, lodging significantly increased with increasing nitrogen rate. Lodging significantly increased with each additional 50 kg N/ha applied, with the 125 kg N/ha treatment having similar rates of lodging to the 100 kg N/ha treatment. That lack of a significant interaction suggests that the occurrence of lodging in 2019 was too variable to illicit a strong product response. However, it does suggest that nitrogen rate has a stronger effect on lodging than PGR application, with Parlay having only a slightly greater effect than Manipulator. However, it is interesting to note that Parlay + 0 kg N/ha did not display any lodging throughout the four replicates.

Yield: Prior to the harvest of Annual ryegrass for seed there was a significant rainy and windy period, which resulted in some seed losses. Thus, seed yields are presented on the basis of actual combine seed yields, and adjusted yields based on the relative percentage of seed on the ground of each plot. In general, nitrogen rate was the only factor to have a significant effect on actual harvested seed yield and adjusted seed yield (Table 4). As expected, due to low residual nitrogen, any rate of applied nitrogen resulted in a yield increase. The first addition of 50 kg of N/ha resulted in the most significant yield increase in both cases. Yield continued to increased with further additions of 50 and 75 kg N/ha. However, when seed yield was adjusted for losses, yields in the 100 and 125 kg N/ha treatments were similar. In both cases 125 kg of N/ha resulted in the largest average yields of all the treatments in 2019. Furthermore, it was somewhat unexpected that PGR application did not have a significant effect on yield, as there were some lodging reductions that occurred. However, as previously stated, the significant reduction in lodging caused by Parlay may be due to a random effect. Furthermore, it may also be that the reduction in lodging was not strong enough to cause any significant yield responses. Overall, results were similar to those found with

PGR application in other grain cereal crops during 2019, where applied nitrogen had a greater effect than the PGR applied.

Table 4: Statistical analysis of treatment factors for Annual Ryegrass Seed Production Fertility and PGR in Melfort, SK 2019.

Source	Height[z]	Lodging[z]	Yield[z] (lb/ac)	Adj. Yield[z] (lb/ac)
PGR	0.1494	0.0117*	0.2181	0.4023
Nitrogen Rate	0.0509	<0.0001***	<0.0001***	<0.0001***
PGR*NR	0.0290*	0.5045	0.6343	0.4539
Grand Mean	86.6	4.4	923.6	1132.1
CV	4.1	46.3	21.8	23.0
No PGR	87.3a	5.0a	904.0a	1109.7a
Manipulator	87.3a	5.1a	872.3a	1083.2a
Parlay	85.1a	3.1b	994.6a	1203.4a
0 kg N/ha	85.2b	1.5c	594.0c	709.4c
50 kg N/ha	89.0a	4.1b	876.6b	1116.3b
100 kg N/ha	86.6ab	6.0a	1094.4a	1325.5ab
125 kg N/ha	85.5b	5.9a	1129.5a	1377.2a
No PGR kg N/ha	86.4abc	1.9de	574.9ef	718.7cd
No PGR 50 kg N/ha	88.1abc	5.1abc	862.0cde	1072.6bc
No PGR 100 kg N/ha	87.9abc	7.6a	1182.2ab	1477.8a
No PGR 125 kg N/ha	87.0abc	5.3ab	997.0bc	1169.8ab
Manipulator 0 kg N/ha	89.4a	2.4bcde	539.4f	654.2d
Manipulator 50 kg N/ha	89.3ab	5.0abc	836.1cde	1061.4bc
Manipulator 100 kg N/ha	84.3bcd	5.6a	1025.5abc	1195.0ab
Manipulator 125 kg N/ha	86.3abc	7.5a	1088.1abc	1422.5ab
Parlay 0 kg N/ha	79.9d	0.2e	667.7def	755.5cd
Parlay 50 kg N/ha	89.8a	2.2cde	931.8bcd	1215.0ab
Parlay 100 kg N/ha	87.6abc	4.8abcd	1075.4abc	1303.6ab
Parlay 125 kg N/ha	83.3cd	5.1abc	1303.6a	1539.3a

*** highly significant p<0.0001; * significant at p<0.05

[y] letters signify values that are significantly different at p<0.05

Quality: As only 3 composite samples were sent away for quality analysis, statistical analysis was not completed. The composite samples were submitted for each PGR treatment at the 50 kg N/ha rate for consistency. Therefore, any treatment responses that cause numerical differences in TKW and %germination, will be due to PGR application. Manipulator application had greater seed germination than No PGR or Parlay, with Parlay having the least. The reduced germination of the harvested seed found with Parlay is concerning. However, as results are based on composite samples, and not statistically analyzed, it is hard to develop any definitive conclusions. Lastly, it does not appear that PGR application has a negative or positive effect on the thousand kernel weight of the harvest seeds.

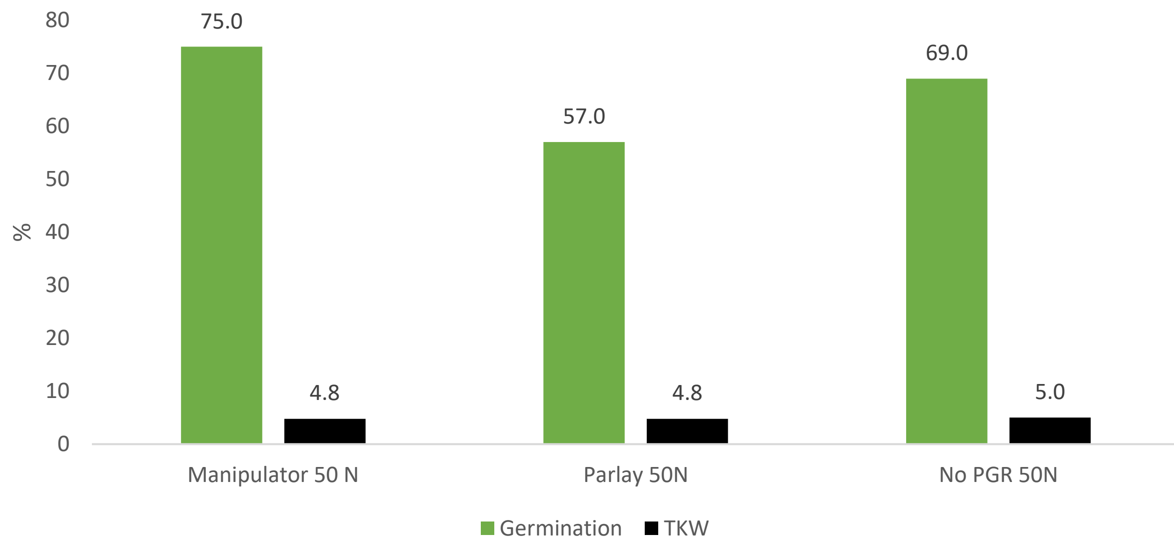

Figure 1: Germination (%) and TKW (grams) found in Annual Ryegrass Seed Production Fertility and PGR in Melfort, SK 2019.

Conclusion: In 2019, PGR application demonstrated less agronomic benefit towards Annual ryegrass for seed production than expected. Manipulator application resulted in little to no effect on height, lodging, or yield and effects were statistically similar to when no PGR was applied. Application of Parlay did result in some reductions to lodging, while height and yield were unaffected. It also appears that Parlay may have negative consequences on the germination of the harvested seed. As expected, nitrogen application had the strongest effect on plant height, degree of lodging, and yield in 2019. Yield was maximized in this experiment, when 125 kg N/ha was applied; yet, was also associated with the highest degree of lodging. The results of this experiment illustrate that applied nitrogen rate has a stronger agronomic effect on height, lodging, and yield than PGR application. Furthermore, the application of a PGR was unable to offset the effects of higher nitrogen rates in 2019. Overall, it is suggested that this trial being completed again as dry and cool seeding conditions as well as seed losses caused variability within the trial, thus making it harder to detect any true significant effects. It is also suggested that individual plots be sent away for quality analysis, to determine if Parlay is causing any true negative effects towards germination of the harvest seeds.