Exploring the Effect of High Nitrogen Rates on Oat Production

Westman Agriculture Diversification Organization, Scott Chalmers, Justice Zhanda and Carlie Johnston

INTRODUCTION

Recently, oats have emerged as a major Canadian export crop, with 1.459 million hectares of oats seeded in 2019 and 90% of these hectares in Western Canada (Canadian Grain Commission). As the oat industry grows in Canada, the need for optimized oat production practices grows as well. **This study seeks to asses oat yield, grain quality and crop growth parameters under different nitrogen application rates.** Only one year of data will be summarized here, and therefore results should be used as a reference rather than a recommendation.

MATERIALS AND METHODS

Research was conducted at Melita (Newstead Loam) under dry land no-till conditions in 2020. Plots were arranged in RCBD with eight treatments replicated three times. 'CDC Summit' oats were seeded at 225 plants m^{-2}. Soil tests (AgVise) were conducted to determine basal fertilizer application rates. Plots were seeded May 7th using a dual knife Seed Hawk air seeder at 16 mm depth, with basal fertilizer banded at 10-39-22-9-2 (N-P-K-S-Zn) actual kg ha^{-1}. At seeding, UAN (28-0-0) nitrogen was banded at variable rates from 0 (check) to 142 kg ha^{-1}. Oats were harvested on August 17th. All data were subjected to a two-way analysis of variance (ANOVA) using Minitab 18 and mean separation was done using Fisher's LSD at 5% significance. A Pearson correlation analysis was used to determine the relationship of oat grain yield and protein to NDVI (drone), SPAD (chlorophyll meter) data at flag leaf among other responses. 166 mm of precipitation accumulated from oat seeding to harvest. While the growing season was dry (64% of thirty-year normal precipitation), no significant crop injury was apparent over the growing season.

RESULTS

There were no differences in emergence (P=0.110) or maturity among N application rates used. Even stands among all treatments indicates that risk of fertilizer burn was low with this seeding system. Lodging ratings generally increased with increasing nitrogen level, emphasizing the need to balance nitrogen application rate with crop requirements to reduce issues caused by lodging (Table 1).

Leaf diseases were more prevalent in low nitrogen treatments than in treatments above 114 kg ha^{-1} Nitrogen.

Table 1. Effects of various nitrogen application rates on oat yield and quality parameters at Melita in 2020.

Total N (kg ha^{-1})	Test Weight (kg hL^{-1})	Yield (kg ha^{-1})	Protein (%)	Lodging (1 to 5)	Leaf Disease (1 to 11)
34	50.6a	4019f	8.9c	2c	6ab
54	49.9abc	4301ef	9.1c	2c	6a
62	50.3ab	4551e	9.0c	2c	5abc
92	49.6bcd	5165d	9.7b	3bc	5bc
114	49.3cd	5492cd	10.1b	4a	5abc
136	49.6bdc	6087a	10.8a	3ab	4c
156	49.5bcd	5645bc	10.7a	2c	4c
176	49.1d	5927ab	11.0a	4a	4c
P Value	**0.015**	**<0.001**	**<0.001**	**0.001**	**0.040**
CV	**1**	**4**	**2**	**20**	**13**

Means followed by the same letter are not significantly different.

There were significant differences in grain yield (P<0.001) and test weight (P=0.015) of oats between treatments (Table 1). An increase in nitrogen resulted in a proportional increase in yield of oats from 34 to 136 kg N ha^{-1}, followed by a decrease in yield at 156 and 176 kg N ha^{-1}. Therefore, the optimum total nitrogen level in oats was 136 kg ha^{-1}, beyond which no further gain in yield response was attained (Figure 2). Test weight values indicate that all treatments would be graded as No.3 CW, which requires a minimum weight of 51 kg hL^{-1}. Strong response of grain protein content to high nitrogen levels was observed, as protein content in 136, 156 and 176 kg N ha^{-1} treatments was significantly (P<0.001) higher (10.7 to 11%) than treatments with lower nitrogen levels. Optimum fertilizer level for high protein content here was 136 kg ha^{-1}, as additional fertilizer provided no significant benefit.

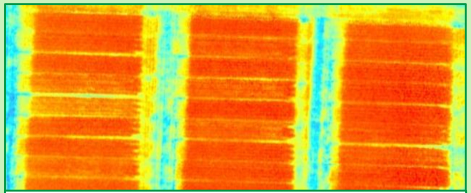

Figure 3. Drone captured NDVI imaging of oat plots grown with various nitrogen levels at Melita in 2020.

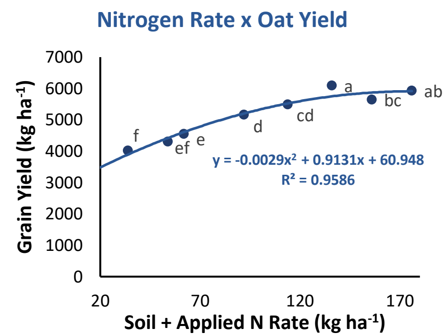

Figure 2. Response of oat grain yield to various levels of soil + applied Nitrogen (kg ha^{-1}) at Melita in 2020. Markers followed by the same letter are not significantly different (P<0.001).

Correlation of grain yield to NDVI and SPAD data revealed significant correlations between NDVI reading and yield (R^2 = 0.58), as well as SPAD reading and yield (R^2 = 0.62). This correlation indicates that NDVI and SPAD readings could be useful for yield prediction in oat crops prior to harvest, though these correlations are on the weaker side given their R-squared values. Significant correlation between NDVI and grain protein content (R^2 = 0.53), as well as SPAD reading and grain protein content (R^2 = 0.60) was also observed. When N application rates are plotted against NDVI and SPAD values, the NDVI response curve is similar to that of the yield response, peaking at 136 kg ha^{-1} nitrogen,

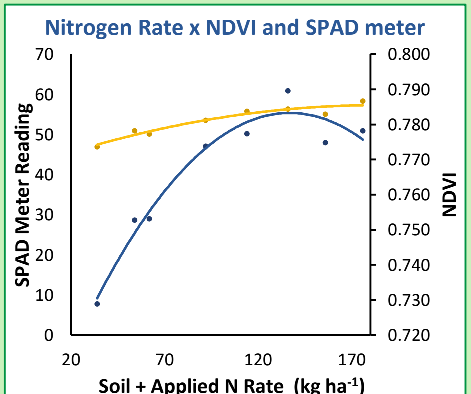

Figure 3. Effect of increasing soil + applied nitrogen levels (kg ha^{-1}) on NDVI (blue) and SPAD meter readings (yellow) in oats at Melita in 2020.

while SPAD meter readings peaked at 176 kg ha^{-1} nitrogen (Figure 3). Visually, NDVI readings illustrate a similar peak response to increasing nitrogen levels as yield, while this peak is less apparent in the SPAD curve. It was also evident in this trial that NDVI (P=0.005) and SPAD meter readings (P=0.003) increased with increase in nitrogen rate.

CONCLUSION

Oat yield and protein content were optimized when grown with 136 kg ha^{-1} total nitrogen, though lodging and test weight may be adversely affected at this nitrogen level. NDVI was demonstrated to be somewhat effective in predicting yield and protein content responses of oats to various nitrogen levels based on similar response peaks. The Prairie Oat Growers Association recommends 109 -131 kg ha^{-1} total nitrogen for optimal oat yield, while Manitoba Agriculture recommends a blanket nitrogen application of 101 kg ha^{-1} when seeding into stubble (Prairie Oat Growers Association, 2020; Manitoba Agriculture). The optimal nitrogen level for oat production demonstrated here under dry conditions is greater than both of these recommendations, and provides more insight into the economic thresholds of oat production in the Canadian prairies and the potential yield advantage of newly available varieties.

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