

# 10 years of reduced versus enhanced rates of N and P fertilizer



Adam Gurr<sup>1</sup>, Stephen Vajdik<sup>1</sup>, J Heard<sup>2</sup>, D Flaten<sup>3</sup> and J Breker<sup>4</sup>

<sup>1</sup> Agritruth Research, <sup>2</sup> Manitoba Agriculture, <sup>3</sup> University of Manitoba (Emeritus), <sup>4</sup> AgVise Laboratories



## BACKGROUND AND METHODS

- An on-farm-test trial was initiated in spring 2013 to evaluate the long term impact of normal fertilization rates of nitrogen (N) and phosphorus (P) (Medium), versus a 30% reduced rate (Low) and a 30% increased rate (High) of N and P.
- The Medium fertilizer rates were 95-120 lb N/ac for wheat, 120-130 lb N/ac for canola, 35 lb P<sub>2</sub>O<sub>5</sub>/ac for all crops and 15 lb sulphur (S)/ac for canola.
- These rates have been applied in a randomized complete block design with 4 replicates running the full length of the field (1/2 mile), with the individual treatments applied to the same strips each year.
- All fertilizer was side-banded at planting with a zero till Seed Hawk air drill on 12" spacing (Figure 1).
- Strips were combined and weighed with a grain cart (Figure 2)
- 10 years after initiation, individual strips were soil sampled (Figure 3).
- Since initiation 4 wheat crops, 4 canola crops and one soybean crop were grown. Wet conditions prevented seeding and fertilization of the 2014 crop.



Figure 1, 2 and 3. Seeding/fertilization operations. Combine harvesting. Soil sampling after 10 years in November 2022.

- Data was analysed using ANOVA.
- Yield and wheat protein is displayed in Figure 4.
- Return to fertilizer, is the resulting crop value less the fertilizer cost. This was calculated with prevailing fertilizer costs and crop prices (adjusted for protein). (Figure 5 and Table 1).
- N and P nutrient balance was calculated from actual fertilizer applied less that removed in the grain crop using Manitoba developed removal values<sup>1</sup> below. (Figures 6-7).
- wheat = 1.5 lb N, 0.5 lb P<sub>2</sub>O<sub>5</sub>, 0.23 lb K<sub>2</sub>O/bu
- canola = 2.1 lb N, 0.7 lb P<sub>2</sub>O<sub>5</sub>, 0.4 lb K<sub>2</sub>O/bu
- soybeans = 2.9 lb N, 0.65 lb P<sub>2</sub>O<sub>5</sub>, 1.06 lb K<sub>2</sub>O/bu
- Soil test values after 10 years are reported in Table 2.

## AGRONOMICS – YIELD AND PROTEIN

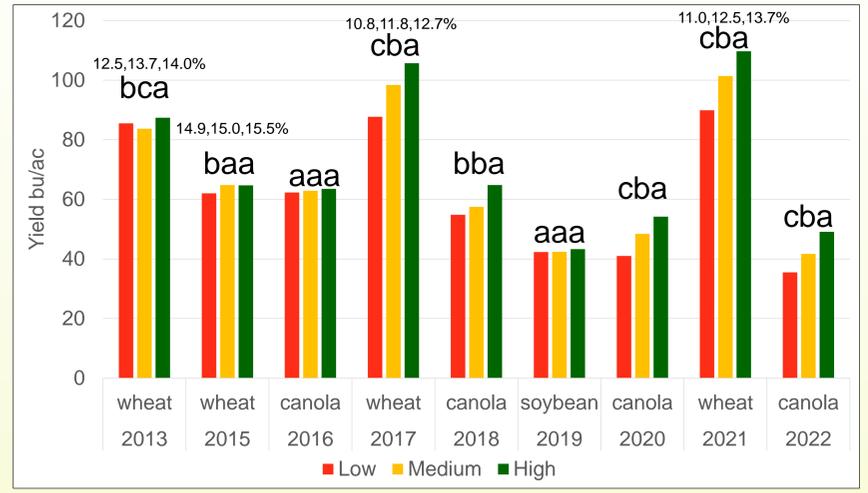


Figure 4. Yield and wheat protein response to fertilization strategy. Letters over the columns indicate significant differences at the 10% probability level. Numbers over columns indicate wheat protein.

- For the first 3 crops harvested there was minimal yield impact.
- Fertilizer rate had a significant impact on yield and protein in 5/6 subsequent crops. Soybeans did not respond to applied P fertilizer.

## ECONOMICS – RETURN TO FERTILIZER

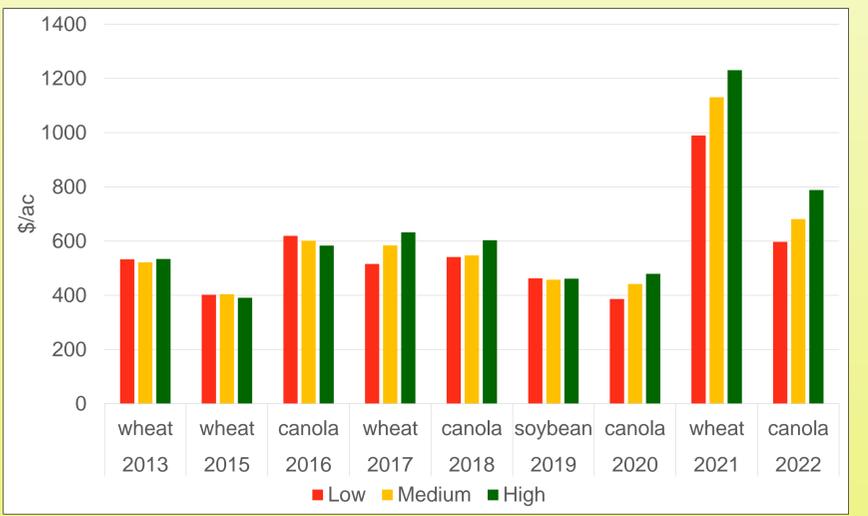


Figure 5. Return to fertilizer economics.

- For the first 3 crops there was a slight economic advantage to the Low rate.
- For the last 5/6 years the High rate has been most profitable. The exception is the soybean crop.
- In the most recent 6 years the annual return after fertilizer has averaged \$582, \$621 and \$699, for the Low, Medium and High fertilization strategies respectively.

Table 1. Total fertilizer applied, fertilizer cost and revenue after 10 years.

	Low	Medium	High
Total N applied	653	929	1216
Total P <sub>2</sub> O <sub>5</sub> applied	225	315	405
Total S applied	40	60	80
Total fertilizer cost	\$ 438	\$ 630	\$ 821
Total revenue	\$ 5,485	\$ 6,001	\$ 6,525
Net revenue	\$ 5,047	\$ 5,371	\$ 5,704

- Total net revenue was greatest for the High fertilization rate.

## NUTRIENT BALANCE AND SOIL TEST VALUES

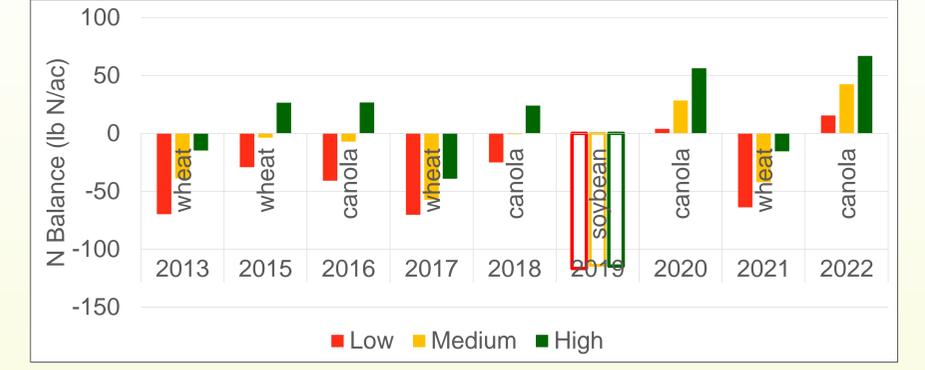


Figure 6. Nitrogen balance (the large negative balance in soybeans is partially offset by biological N fixation).

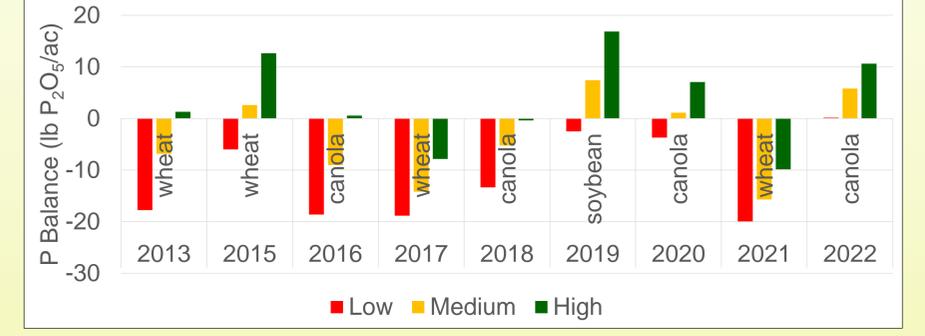


Figure 7. Phosphorus balance.

- In general the Low and Medium rates are not meeting the removal values of crops.
- Overall N budget was -400, -200 and +16 lb N/ac for Low, Medium and High fertility, respectively.
- Overall P budget was -101, -34 and +31 lb P<sub>2</sub>O<sub>5</sub>/ac for Low, Medium and High fertility, respectively.
- The high yielding wheat crops had frequent N and P deficits.
- The only significant differences in soil test values (Table 2) were for phosphorus, closely reflecting the P balance, and a buffering capacity requiring +/- 30 lb P<sub>2</sub>O<sub>5</sub> fertilizer to change soil test 1 ppm (as previously observed for Newdale clay loam soil).
- The differences in N balance were not reflected in soil nitrate or total N levels, or soil pH.

Table 2. Soil test results after 10 years of cropping. Letters following values indicate significant differences at the 10% probability level

	pH *	OM % *	Nitrate-N lb/ac**	Olsen P ppm*	K ppm*	S lb/ac**	EC**	Total Org C%*	Total N %*
Low	7.8	6.5	39	6.8 c	300	222	0.71	4.6	0.34
Medium	7.9	6.3	35	8.5 b	298	219	0.51	4.3	0.31
High	7.8	6.5	47	10.8 a	313	148	0.53	4.5	0.33

\* 0-6" sample depth, \*\* 0-24" sample depth

## SUMMARY

- Short term yield and economic results were the opposite of the long term impact.
- Short term studies of fertilization may lead to misleading conclusions about reducing fertilizer rates.

## References

<sup>1</sup>Heard, J. Updating Values of Prairie Crop Nutrient Uptake and Removal. Part 1.