

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



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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 P₂O₅/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 values¹ below. (Figures 6-7).
 - wheat = 1.5 lb N, 0.5 lb P₂O₅, 0.23 lb K₂O/bu
 - canola = 2.1 lb N, 0.7 lb P₂O₅, 0.4 lb K₂O/bu
 - soybeans = 2.9 lb N, 0.65 lb P₂O₅, 1.06 lb K₂O/bu
- Soil test values after 10 years are reported in Table 2.

AGRONOMICS – YIELD AND PROTEIN

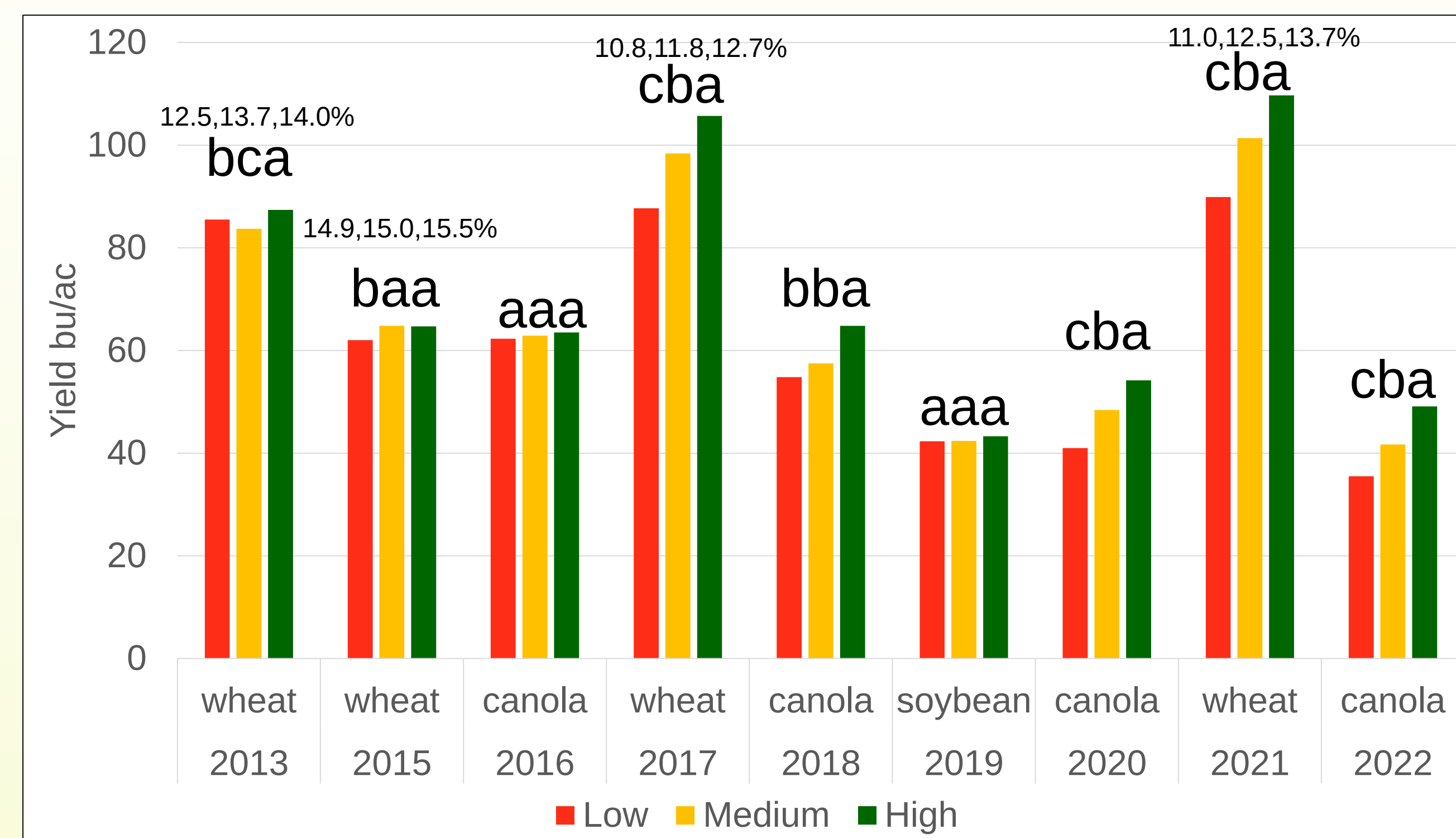


Figure 4. Yield and wheat protein response to fertilization strategy. Letters over the columns indicate significant differences at the 10% probability level. Numbers over columns indicate wheat protein.

- 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

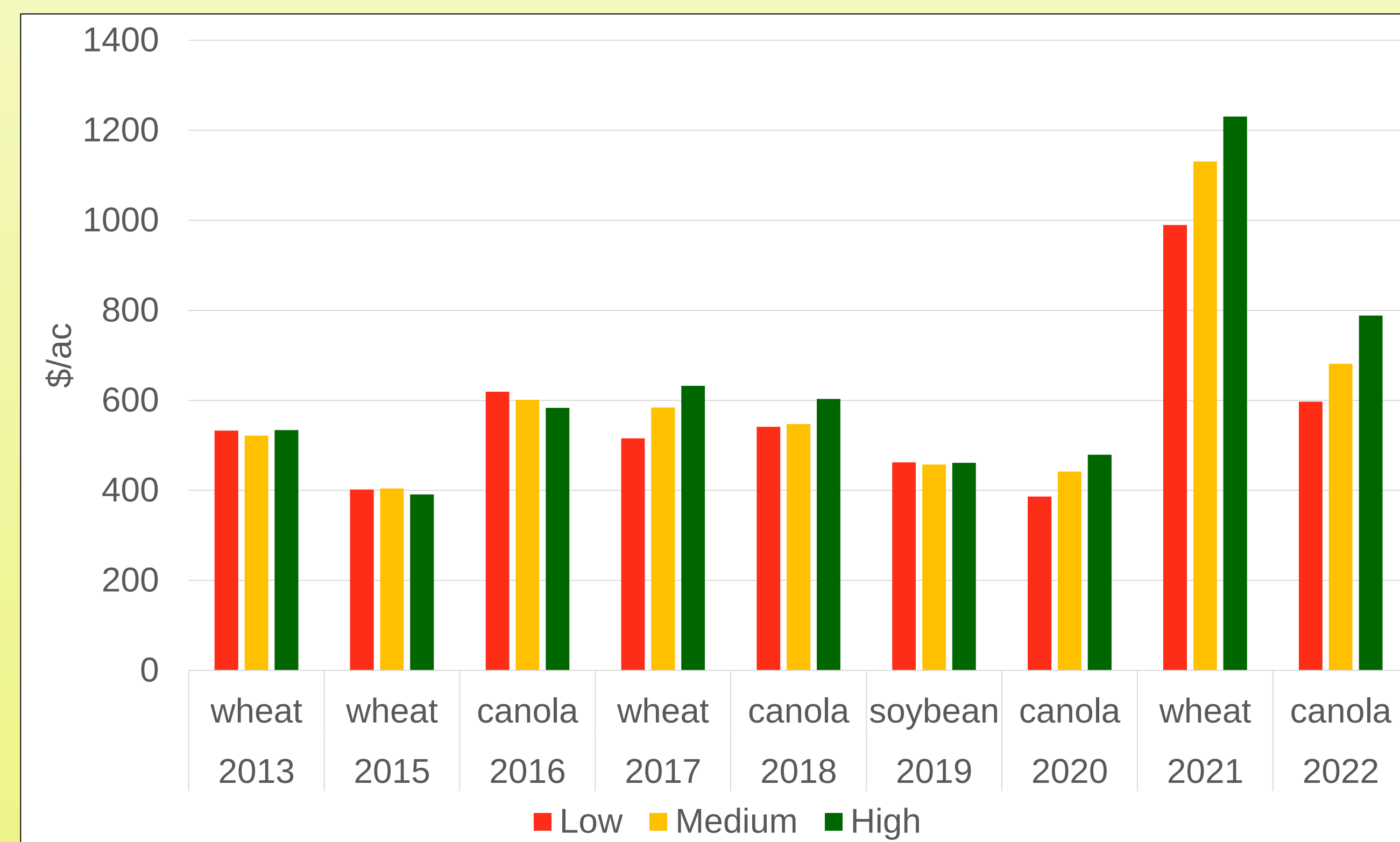


Figure 5. Return to fertilizer economics.

- 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 P2O5 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

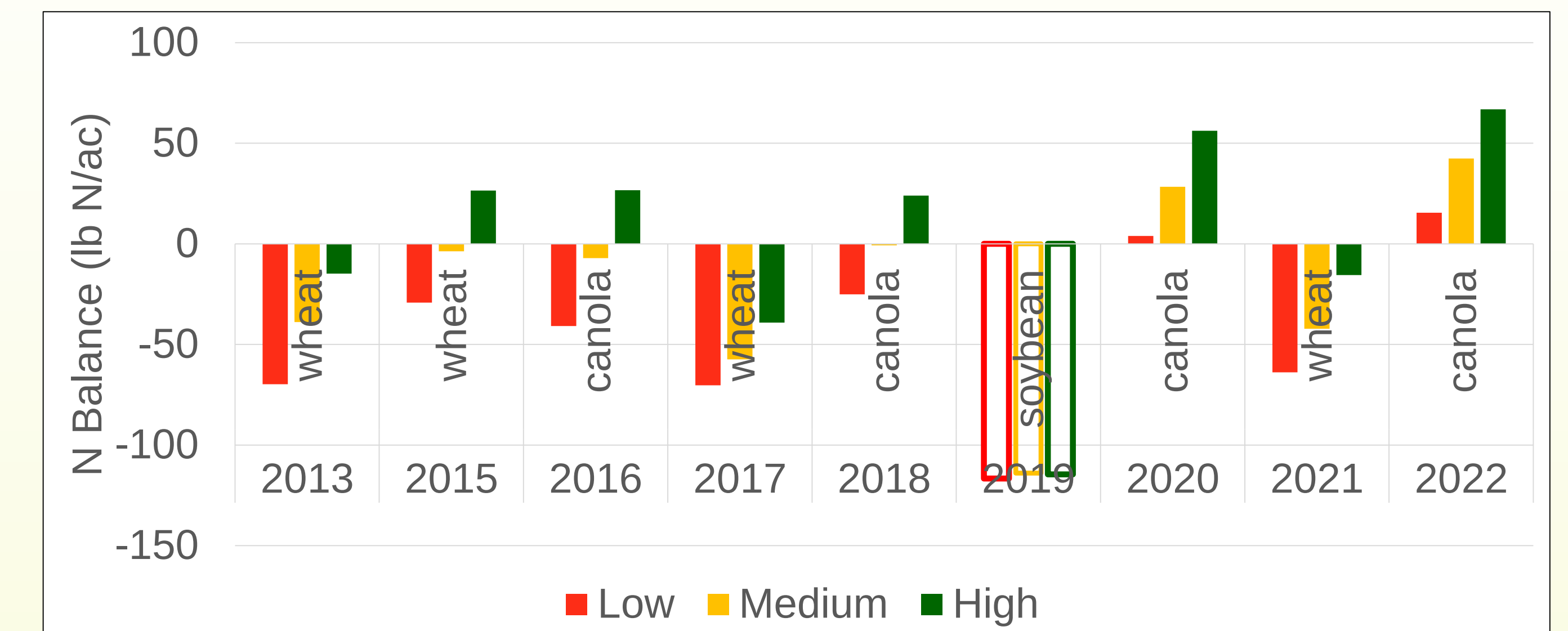


Figure 6. Nitrogen balance (the large negative balance in soybeans is partially offset by biological N fixation).

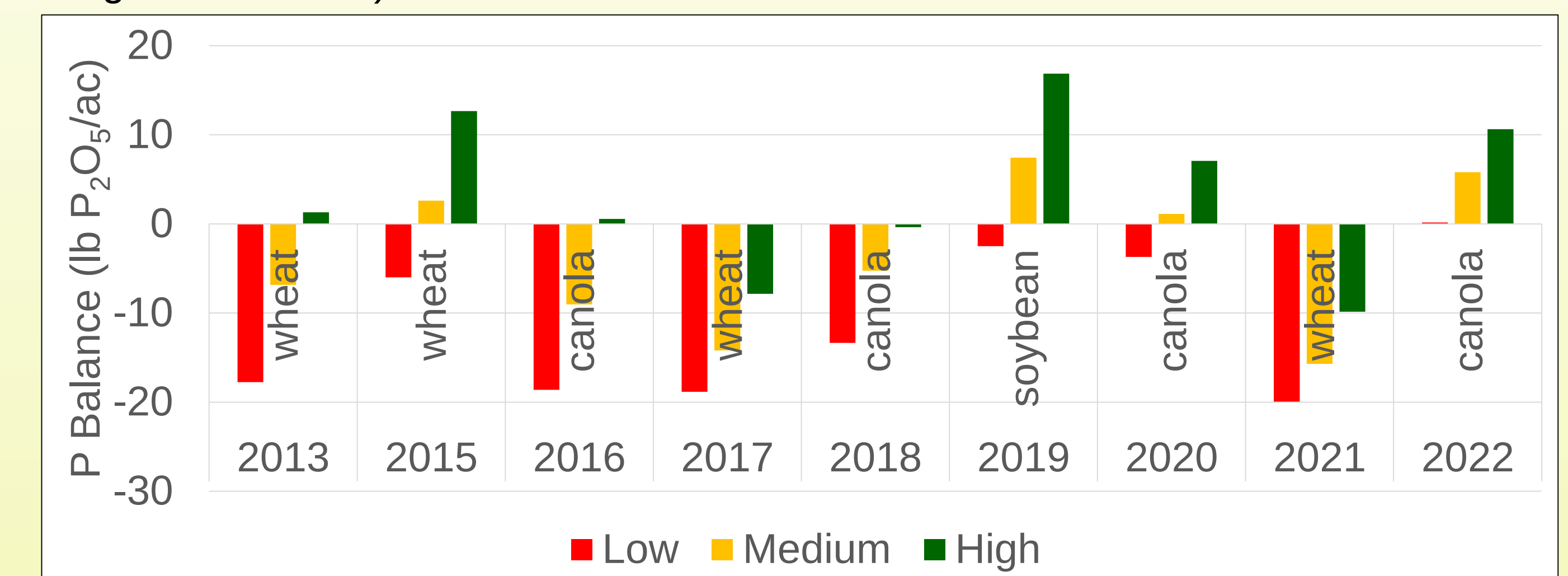


Figure 7. Phosphorus balance.

- 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 P₂O₅/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 P₂O₅ 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

¹Heard, J. Updating Values of Prairie Crop Nutrient Uptake and Removal. Part 1.