Northern Plains
PROGRAM
an initiative of
COLLECTIVE IMPACT
LEADING AGRICULTURE'S FUTURE

OAT–PEA INTERCROPPING AT NARF

Effects of Cropping System and Nitrogen Fertility

Northeast Agriculture Research Foundation • Melfort, Saskatchewan • 2025

Prepared by Collective Impact | Northern Plains Program

Executive Summary

The trial showed economic promise from reducing nitrogen in oat production, while oat-pea intercropping added a marketable pea crop and potential rotational and soil-health value that was not fully captured in the one-year economic comparison.

The Northern Plains Program sponsored this 2025 demonstration trial at the NARF site near Melfort, Saskatchewan. Five treatments compared oat monocrops and oat–pea intercrops under full, 50% and zero supplemental-nitrogen programs. All treatments received the same P-K-S fertility blend.

Key findings

- The 50% N oat monocrop yielded 130.3 bu/ac, compared with 135.5 bu/ac under full fertility; the original analysis did not detect a significant difference.
- Oat yield was lower in the intercrops, but peas contributed 18.2–18.6 bu/ac of additional harvested grain.
- Intercropping increased oat protein by 0.55 percentage points and slightly reduced leaf-disease ratings, although disease pressure was very low.
- Using the selected seed, nitrogen and provisional grain-separation costs, the 50% N oat monocrop produced the highest return after selected costs at $281.37/ac.
- The zero-N oat-pea intercrop returned $203.79/ac after selected costs—$77.58/ac less than the highest-returning monocrop—while producing both oat and pea grain without supplemental nitrogen.
- Potential benefits from biological nitrogen fixation, more diverse rooting and nitrogen-rich pea residues were not assigned an economic value. Residual soil nitrogen after harvest was not measured.
- The provisional $0.89/bu grain-separation charge materially affected intercrop returns and should be updated when a local quote is available.

Bottom line: The 50% N oat monocrop produced the highest one-year return after the selected costs included in this analysis. However, the oat-pea intercrops produced two marketable crops and may provide longer-term rotational and soil-health benefits that were not measured or monetized. These results should therefore not be interpreted as showing that monocropping is definitively the better system.

These findings represent one growing season at one site. Economic results are returns after selected costs—not return on investment or net profit. Intercrop conclusions should be revisited if fall soil-nitrogen results or following-crop data become available.

Table of Contents

1. Project Objective

The objective of the 2025 demonstration trial was to evaluate how oat–pea intercropping and different nitrogen fertilizer rates affected oat and pea yield, oat grain protein, test weight, leaf-disease severity and nitrogen-use efficiency under growing conditions at the Northeast Agriculture Research Foundation (NARF) research site near Melfort, Saskatchewan.

The trial also included a preliminary economic analysis comparing crop revenue with selected treatment costs, including nitrogen fertilizer, seed and seed cleaning.

2. Methodology

Experimental Design

The demonstration trial was conducted in 2025 at the NARF research site near Melfort. It compared oat monocrops and oat–pea intercrops under different nitrogen fertility programs. Treatments were arranged in field plots using a randomized complete block design. Nutrient applications were based on site-specific soil-test recommendations, and all treatments received the standard macro- and micronutrients included in the trial fertility program.

The zero-nitrogen treatments received no nitrogen fertilizer. All treatments received a common fertility blend supplying 50-10-5 lb/ac of actual phosphorus, potassium and sulfur.

NARF subsequently confirmed that a common fertility blend supplying 50-10-5 lb/ac of actual phosphorus, potassium and sulfur was applied across all treatments. The full nitrogen program was based on a total-N target of 111 lb/ac. The reduced-rate treatments received 50% of the urea rate calculated from that target.

Table 1. Treatment structure at the NARF research site in 2025

Treatment	Treatment name	Description
1	Oats only, full fertility	Oat monocrop receiving the full nitrogen rate and the standard fertility program.
2	Oats only, 50% nitrogen	Oat monocrop receiving 50% of the full nitrogen rate and the standard fertility program.
3	Oats only, zero nitrogen	Oat monocrop receiving no nitrogen fertilizer. The common 50-10-5 lb/ac P-K-S blend was applied.
4	Oats and peas, 50% nitrogen	Oat–pea intercrop receiving 50% of the full nitrogen rate and the standard fertility program.
5	Oats and peas, zero nitrogen	Oat–pea intercrop receiving no nitrogen fertilizer. The common 50-10-5 lb/ac P-K-S blend was applied.

Site Conditions

Soil fertility, crop management and weather conditions were documented to provide context for treatment responses. Pre-seeding soil tests characterized baseline soil fertility and chemical properties.

Growing-season temperature and precipitation from May through September 2025 were compared with long-term averages using data from a nearby weather station. Seasonal mean temperature was slightly above the long-term average, while total precipitation was similar to the long-term seasonal total. Rainfall distribution varied considerably throughout the season.

The first substantial rainfall occurred on June 7, when 14.7 mm was recorded. Additional rainfall later in June contributed to several weed flushes. Above average precipitation in August encouraged secondary growth and green tiller development, delaying crop maturity and harvest.

Data Collection and Measurements

- Stand establishment: Oat and pea plant densities were assessed after crop establishment by counting and identifying plants within two one-metre sections of crop row in each plot.
- Leaf disease: Ten oat flag leaves per plot were visually assessed at heading using a rating scale from 1 to 9.
- Grain yield: Oat and pea grain yields were measured at maturity and reported in bu/ac. Grain from intercrop treatments was separated by crop. Oat yield was converted using 40 lb/bu and pea yield using 60 lb/bu.
- Grain quality: Oat protein was measured as a percentage. Test weight was determined from a 0.5-L sample and scaled to the Canadian Avery bushel volume of 36.37 L, then reported in lb/bu.

Nitrogen-Use Efficiency

Nitrogen-use efficiency was evaluated using agronomic efficiency of nitrogen and grain nitrogen-uptake efficiency. Agronomic efficiency represents the increase in oat grain yield per pound of applied nitrogen:

$$AE_n = (Y_n - Y_0) \div \text{N applied}$$

Y_n is oat grain yield under the fertilized treatment, Y_0 is oat grain yield from the corresponding zero-nitrogen treatment, and N applied is the reported fertilizer nitrogen rate.

Oat grain nitrogen uptake was estimated as:

$$U = [Y \times (P \div 100)] \div 5.83$$

U is estimated grain nitrogen uptake, Y is oat grain yield corrected to 0% moisture, P is grain protein concentration, and 5.83 is the nitrogen-to-protein conversion factor.

$$NUpE = (U_n - U_0) \div \text{N applied}$$

The zero-nitrogen treatments served as calculation baselines and were not assigned nitrogen-efficiency values.

3. Results

Table 2. Simplified agronomic performance of oat monocrop and oat–pea intercrop systems at NARF, 2025

Treatment	Oat density (plants/m²)	Pea density (plants/m²)	Leaf disease (0–9)	Oat yield (bu/ac)	Pea yield (bu/ac)	Test weight (lb/bu)	Protein (%)	N applied (lb/ac)
Oats only, full fertility	106	—	0.6	135.5	—	40.1	9.8	111.0
Oats only, 50% N	122	—	0.5	130.3	—	40.9	8.7	55.5
Oats only, zero N	132	—	0.9	104.2	—	40.9	8.2	0.0
Oats + peas, 50% N	65	35	0.4	88.1	18.2	40.5	9.1	55.5
Oats + peas, zero N	62	39	0.5	77.3	18.6	41.1	8.8	0.0

** All treatments received 100 lb/ac of PKS Blend (0-50-10-5), supplying 50 lb P/ac, 10 lb K/ac and 5 lb S/ac. Full-N treatments received 111 lb actual N/ac and 50% N treatments received 55.5 lb actual N/ac from urea.*

Conclusions from Table 2

- The 50% N oat monocrop produced 130.3 bu/ac, compared with 135.5 bu/ac under full fertility. The original analysis did not detect a significant yield difference between these treatments.
- Oat yield was significantly lower in the oat–pea intercrops. Peas added 18.2–18.6 bu/ac, and pea yield did not differ significantly between the 50% N and no-supplemental-N intercrops.

- On a grain-weight basis, the no-supplemental-N intercrop produced approximately the same combined oat-and-pea mass as the corresponding oat monocrop. At 50% N, combined intercrop grain mass remained lower than oat production in the corresponding monocrop. Combined grain mass was not statistically analyzed.
- Test weight was similar across treatments, ranging from 40.1 to 41.1 lb/bu.
- Oat protein was slightly higher and leaf-disease ratings slightly lower in the intercrops than in comparable monocrops. Disease pressure was very low.

Table 3. Contrast comparison of oat monocrop and oat–pea intercrop systems at NARF, 2025

Variable	Mean difference ± SE	P-value	Interpretation
Leaf disease (0–9)	0.26 ± 0.09	0.033	Lower in the intercrop
Oat yield (bu/ac)	34.5 ± 2.5	<0.001	Higher in the monocrop
Test weight (lb/bu)	0.11 ± 0.16	0.968	No detected difference
Protein (percentage points)	−0.55 ± 0.16	0.002	Higher in the intercrop

Differences are expressed as the oat monocrop average minus the oat–pea intercrop average. The comparison averages the zero-N and 50% N treatments within each cropping system.

Conclusions from Table 3

- Oat monocrops produced an average of 34.5 bu/ac more oat grain than oat–pea intercrops when comparable fertility treatments were averaged. This difference was statistically significant.
- Oat protein was 0.55 percentage points higher in the intercrops. Its practical value will depend on buyer specifications and potential premiums.
- Leaf-disease ratings were slightly lower in the intercrops, but low disease pressure limits the practical conclusion.
- Test weight did not differ between cropping systems.
- The contrast considers only the oat component. It does not include pea yield, combined grain production, crop revenue or additional intercrop costs.

4. Preliminary Economic Analysis

The economic analysis will compare crop revenue with selected treatment costs, including nitrogen fertilizer, oat and pea seed, and seed cleaning. Results will be reported as revenue remaining after the selected costs rather than as net profit, since not all material production and operating costs are included.

Confirmed price and cost assumptions

Item	2025 benchmark	Basis
Oat grain	$2.79/bu	December 10 price supplied for the analysis
Pea grain	$6.96/bu	December 10 price supplied for the analysis
Fertilizer nitrogen	$0.96/lb actual N	Full-N treatment: 111 lb N/ac; 50% N: 55.5 lb N/ac
Certified oat seed	$0.27/lb	Black soil zone: $34.29/ac ÷ 127 lb/ac
Certified yellow pea seed	$0.30/lb	Black soil zone: $53.40/ac ÷ 178 lb/ac
Oat-pea grain separation	$0.89/bu handled	Provisional 2025-26 Prairie commercial cleaning benchmark

Source: Saskatchewan Ministry of Agriculture, 2025 Crop Planning Guide. Seed costs are certified-seed planning benchmarks for the Black soil zone, not a survey of Melfort retail invoices. AAC Profit is a yellow field pea. https://publications.saskatchewan.ca/api/v1/products/122661/formats/142532/download

Estimated seed cost at the NARF trial rates

Cropping system	Seed rate	Seed value	Estimated seed cost
Oat monocrop	107 lb oat/ac	$0.27/lb	$28.89/ac
Oat-pea intercrop	64 lb oat/ac	$0.27/lb	$17.28/ac
Oat-pea intercrop	129 lb pea/ac	$0.30/lb	$38.70/ac
Oat-pea intercrop total	64 lb oat/ac + 129 lb pea/ac	Combined	$55.98/ac

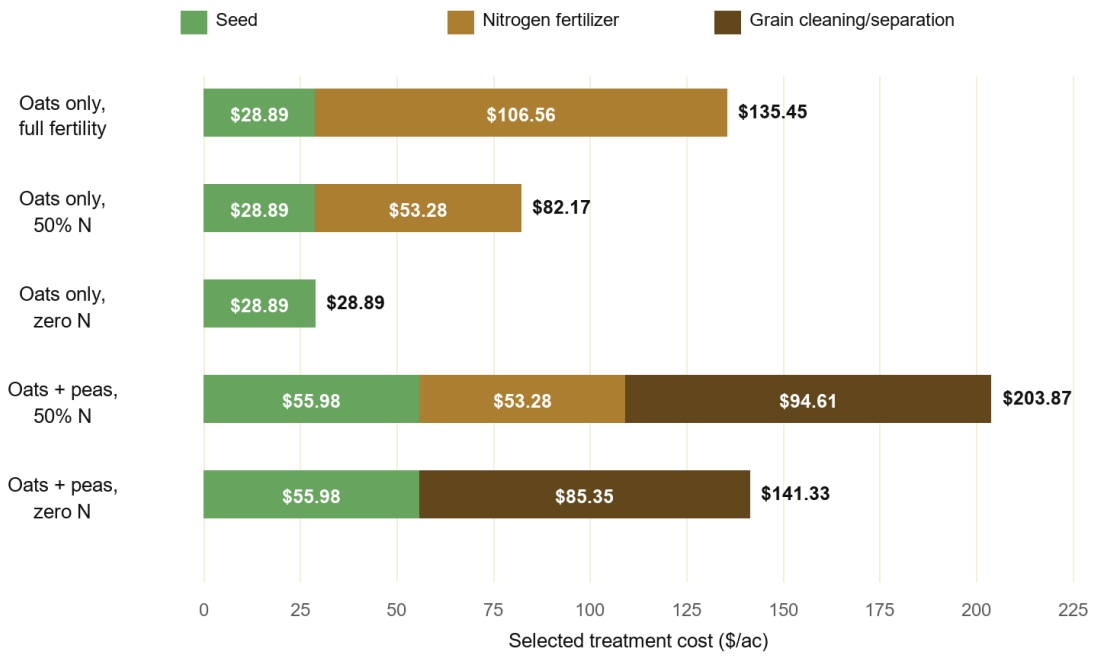
At these benchmark values, seed cost was estimated at $28.89/ac for the oat monocrop and $55.98/ac for the oat-pea intercrop, an additional $27.09/ac for the intercrop before seed cleaning and other treatment-specific costs.

Provisional oat-pea separation cost

Intercrop treatment	Oat yield	Pea yield	Total handled	Cost at $0.89/bu
50% N	88.1 bu/ac	18.2 bu/ac	106.3 bu/ac	$94.61/ac
Zero N	77.3 bu/ac	18.6 bu/ac	95.9 bu/ac	$85.35/ac

The $0.89/bu rate is provisional and is applied to the combined harvested oat and pea bushels handled. It is based on a published 2025-26 Prairie seed-cleaning rate. Actual separation costs may vary with mixture condition, required equipment, number of passes and minimum-volume charges. Source: Wetaskiwin Seed & Grain Co-operative, https://www.wetaskiwinseedclean.com/machines-and-services/

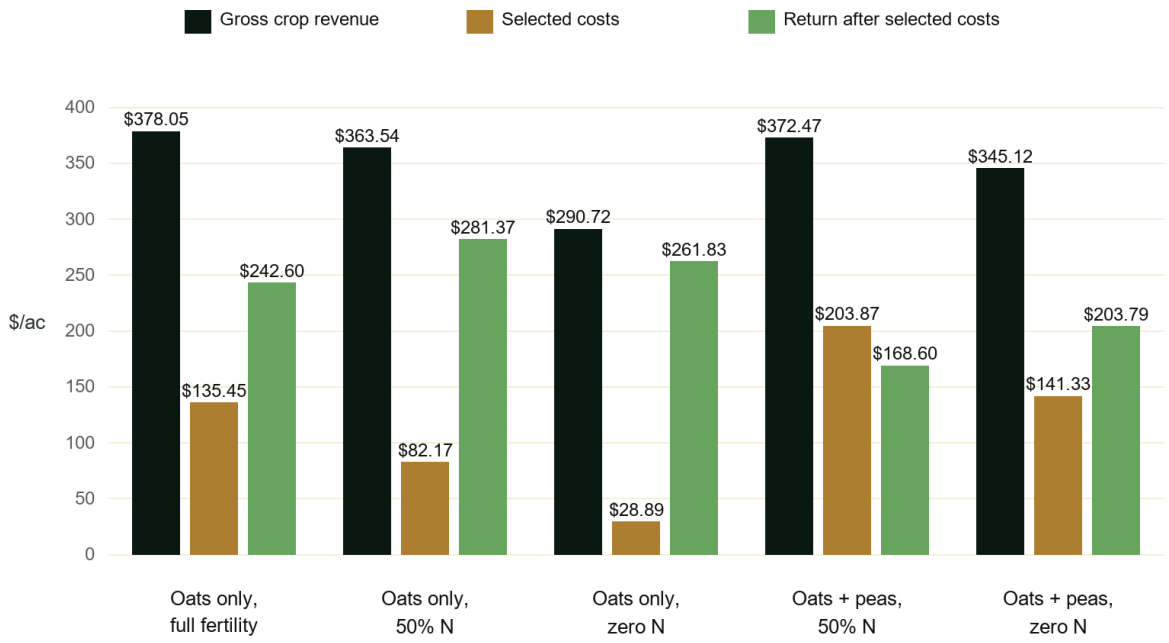
Figure 1. Selected treatment costs for the NARF oat and oat-pea systems, 2025



Seed costs use 2025 certified-seed benchmarks. Nitrogen cost is based on $0.96/lb actual N. Grain cleaning/separation is included only for the intercrops at the provisional rate of $0.89/bu of combined harvested grain. The common P-K-S blend is excluded because its cost was consistent across treatments.

Conclusion: The oat-pea intercrops had the highest selected costs because they combined higher seed costs with the additional grain-separation charge. The zero-N oat monocrop had the lowest selected cost, while reducing nitrogen from the full rate to 50% lowered the oat-monocrop cost by $53.28/ac.

Figure 2. Gross crop revenue, selected costs and return after selected costs, NARF 2025



Gross crop revenue was calculated using oat yield × $2.79/bu plus pea yield × $6.96/bu. Selected costs include seed, fertilizer nitrogen and provisional oat-pea grain separation. Return after selected costs equals gross crop revenue minus those costs; it is not net profit.

Conclusion: The full-fertility oat monocrop generated the highest gross crop revenue ($378.05/ac), but the 50% N oat monocrop produced the highest return after selected costs ($281.37/ac). After including the provisional separation charge, returns were $168.60/ac for the 50% N intercrop and $203.79/ac for the zero-N intercrop. The highest-returning monocrop therefore exceeded the highest-returning intercrop by $77.58/ac.

A provisional oat-pea separation charge of $0.89/bu of combined harvested grain has been included. Because this is not a local quote and the analysis does not include every production and operating cost, results are described as revenue after selected variable costs rather than as net profit.

Potential rotational benefit: In addition to producing a marketable pea crop, the oat-pea intercrop may provide rotational benefits through biological nitrogen fixation, more diverse rooting, and the return of relatively nitrogen-rich pea residues. Using a general Saskatchewan field-pea guideline of 0.5-1 lb of nitrogen per bushel of peas, the pea yields measured in this trial suggest a potential contribution of approximately 9-19 lb N/ac. This range is exploratory only: nitrogen fixation and residual soil nitrogen were not measured, the peas were harvested for grain, and the guideline was not developed specifically for oat-pea intercrops. Post-harvest or spring soil testing and measurement of the following crop's nitrogen response would be required before assigning a fertilizer-N credit. This estimate should be revisited if fall soil-sampling results from NARF become available.

5. Interpretation Limitations

- The findings represent one growing season at one research site.
- Biological nitrogen fixation and nitrogen transfer from peas to oats were not directly measured.
- Combined oat-and-pea yield was calculated descriptively but was not included in the original statistical analysis.
- The zero-N treatments received the common P-K-S blend but no nitrogen fertilizer.
- Economic conclusions should remain preliminary until all selected costs and pricing assumptions are confirmed.

6. Technical Reference

Nakhforoosh, Alireza. Evaluating Intercropping Practices for Enhanced Protein, Weight, Milling Quality and Leaf Disease in Oats: 2025 Report. South East Research Farm, January 2026. Used as the technical source for NARF trial methods, statistical analysis and results.

Appendix A. Pre-Seeding Soil Properties

Pre-seeding soil-test results for the 2025 NARF trial site are summarized below.

Parameter	Unit	Depth	NARF result
Nitrogen	lb/ac	0–6"	18
Nitrogen	lb/ac	6–24"	21
Phosphorus	lb/ac	0–6"	30
Potassium	lb/ac	0–6"	692
Sulfur	lb/ac	0–6"	16
Sulfur	lb/ac	6–24"	30
Organic matter	%	0–6"	9.1
pH	—	0–6"	6.2
pH	—	6–24"	7.3
Electrical conductivity	mmho/cm	0–6"	0.30
Electrical conductivity	mmho/cm	6–24"	0.35

Source: Pre-seeding soil-properties summary supplied for the 2025 trial. Only NARF results are included in this report.

Appendix B. Fertility Program by Treatment

The table below compares pre-seeding soil-test results with the actual nutrients and fertilizer-product rates applied to each treatment.

Treatment	Soil N (lb/ac)	Actual N added (lb/ac)	Urea 46-0-0 (lb/ac product)	Soil P (lb/ac)	Actual P added (lb/ac)	Soil K (lb/ac)	Actual K added (lb/ac)	Soil S (lb/ac)	Actual S added (lb/ac)	PKS Blend 0-50-10-5 (lb/ac product)
Oats only, full fertility	39	111.0	241.3	30	50	692	10	46	5	100
Oats only, 50% N	39	55.5	120.7	30	50	692	10	46	5	100
Oats only, zero N	39	0.0	0.0	30	50	692	10	46	5	100
Oats + peas, 50% N	39	55.5	120.7	30	50	692	10	46	5	100
Oats + peas, zero N	39	0.0	0.0	30	50	692	10	46	5	100

Pre-seeding soil values: N = 39 lb/ac over 0–24 in.; P = 30 lb/ac over 0–6 in.; K = 692 lb/ac over 0–6 in.; S = 46 lb/ac over 0–24 in.

Urea product rates were calculated as actual N ÷ 0.46. PKS Blend product rate was calculated as 50 lb P/ac ÷ 0.50 = 100 lb/ac; this rate also supplied 10 lb K/ac and 5 lb S/ac.

Soil-test quantities and applied fertilizer quantities are shown side by side for context. They should not be interpreted as directly equivalent measures of plant-available nutrients.

Appendix C. Crop Management

Cropping system	Crop and variety	Target rate (seeds/m²)	Germination (%)	Seeding rate (lb/ac)	Stubble
Intercrop	Pea – AAC Profit	60	99	129	Canola
Intercrop	Oat – AAC Neville	150	91	64	Canola
Monocrop	Oat – AAC Neville	250	91	107	Canola

Source: Seeding information supplied by NARF

Appendix D. Weather Conditions

Mean Monthly Air Temperature

Month	2025 NARF (°C)	Long-term NARF, 1997–2021 (°C)
May	13.8	10.1
June	15.0	15.2
July	17.0	17.8
August	18.0	16.7
September	15.0	11.7
Seasonal mean	15.8	14.3

Monthly Precipitation

Month	2025 NARF (mm)	Long-term NARF, 1997–2021 (mm)
May	4.8	33.4
June	93.2	79.5
July	25.9	69.6
August	113.5	45.9
September	20.3	36.0
Seasonal total	257.7	264.4

Source: 2025 NARF site-characterization and crop-management summary.

Appendix E. Key Field Operations

Operation	NARF timing or treatment
Seeding	May 22, 2025
Pre-emergent herbicide	Heat LQ (21 mL/ac) + StartUp (670 mL/ac), May 15, 2025
Post-emergent weed control	No herbicide application; hand weeding
Harvest	September 10, 2025

Source: 2025 NARF site-characterization and crop-management summary.

Appendix F. Leaf Disease Rating Scale

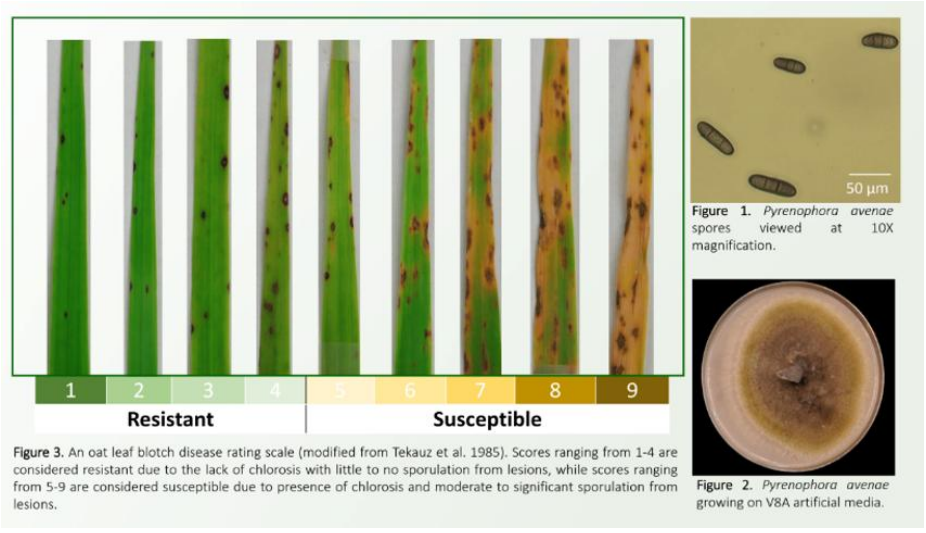


Figure S1. Scale used for visual ratings of oat leaf disease, as provided by the University of Saskatchewan.

Ratings of 1–4 indicate resistant responses, while ratings of 5–9 indicate increasingly susceptible responses.