

Impact of variety selection on Aphanomyces root rot management in field peas

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Interpreting results from these studies:

- These are studies with high Aphanomyces and low to moderate Fusarium root rot pressure
- The results are not applicable to fields that do not have Aphanomyces root rot pressure
- Completely different results will be obtained from fields with high Fusarium pressure and low Aphanomyces pressure or fields that do not have Aphanomyces root rot pressure

Major findings:

- **Commercially acceptable field pea agronomic performance under severe Aphanomyces root rot pressure** was obtained with the combined use of field pea variety selection, early planting (when soil temperatures averaged 42-50°F at the 2-inch seeding depth in the first 7 days after planting), and use of a fungicide seed treatment with efficacy against Rhizoctonia and Pythium. Testing was conducted in fields with native Aphanomyces root rot pressure that resulted from a long history of field pea and/or lentil production.
- **Results were replicable and broadly consistent** across locations differing in soil type, Aphanomyces root rot pressure, and climate
- **Field pea varieties exhibited large differences in tolerance to Aphanomyces.** The most tolerant variety tested (PG Greenback) consistently exhibited strong yields under Aphanomyces even when planted into warm soils after kochia emergence. Varieties with above-average tolerance (AAC Julius, AAC IronHorse, PG Bank) exhibited high yields under Aphanomyces when planted into cool soils in environments for which they were otherwise well-adapted; unlike PG Greenback, these varieties did not show strong drought tolerance. Multiple commercial varieties were identified (AAC Goldstorm, AAC Harrison, LG Amigo, Nette, Salamanca) that consistently had very low yields under Aphanomyces pressure irrespective of environment, soil temperatures at planting, and crop rotation interval.

The results indicate that field pea variety selection is critical for avoiding severe losses in fields with elevated Aphanomyces root rot pressure. Follow-up testing is being conducted in 2026 to develop stronger guidelines on optimizing field pea variety selection in fields with Aphanomyces pressure.

Field pea variety selection only confers partial management of Aphanomyces root rot. Field pea varieties differ in their tolerance to Aphanomyces; none are resistant. Many field pea varieties with above-average Aphanomyces tolerance have only conferred high yields under Aphanomyces pressure when planted early into cool soils (target 42-50°F at 2-inch depth in the first 7 days after planting). Combining field pea variety selection with early planting and longer crop rotation intervals improves Aphanomyces root rot management.

This report shows average results across field peas grown from fungicide-treated and non-treated seed. In all of studies conducted as a part of this research, field pea agronomic performance was assessed on fungicide-treated versus non-treated seed. Fungicide seed treatment facilitated gains in field pea agronomic performance but did not change the relative performance of field pea varieties under Aphanomyces root rot pressure.

Root rot pressure and the relative contribution of *Aphanomyces euteiches*, *Fusarium* spp. and *Rhizoctonia solani*, causal agent of Aphanomyces, Fusarium and Rhizoctonia root rots to observed root disease in the field pea root rot management studies conducted in 2024 (Carrington) and 2025 (Carrington and on-farm locations).

	Root rot % of epicotyl and tap root diseased	Diagnostic test results DNA copies (diseased tissue)	Root rot disease pressure DNA copies (healthy & diseased tissue)
MAKOTI, ND (2025) ON-FARM LOCATION			
<i>Aphanomyces euteiches</i>	15%	3,992,473	590,741
<i>Fusarium</i> spp.		39,233	5,805
<i>Rhizoctonia solani</i>		25,819	3,820
CARRINGTON, ND (2025) FIELD Q9B			
<i>Aphanomyces euteiches</i>	44%	15,787,767	6,974,514
<i>Fusarium</i> spp.		53,692	23,720
<i>Rhizoctonia solani</i>		173,606	76,693
CARRINGTON, ND (2025) FIELD 17 EAST			
<i>Aphanomyces euteiches</i>	74%	13,717,310	10,211,750
<i>Fusarium</i> spp.		40,145	29,885
<i>Rhizoctonia solani</i>		40,637	30,252
CARRINGTON, ND (2024) FIELD 17 WEST			
<i>Aphanomyces euteiches</i>	64%	17,406,448	11,057,446
<i>Fusarium</i> spp.		92,016	58,453
<i>Rhizoctonia solani</i>		not tested	not tested
CARRINGTON, ND (2024) FIELD 18 SOUTH			
<i>Aphanomyces euteiches</i>	43%	27,176,166	11,623,448
<i>Fusarium</i> spp.		165,124	70,625
<i>Rhizoctonia solani</i>		not tested	not tested
WEBSTER, ND (2025) ON-FARM LOCATION			
<i>Aphanomyces euteiches</i>	99%	24,386,018	24,229,012
<i>Fusarium</i> spp.		99,535	98,894
<i>Rhizoctonia solani</i>		214,981	213,597

Diagnostic testing was conducted on diseased epicotyl tissue; shown are the combined diagnostic testing results conducted across 4 experimental replicates and 6 field pea varieties (Carrington field 18, 2024; Carrington field 17, 2024; Makoti, 2025; Webster, 2025), 17 field pea varieties (Carrington field Q9B, 2025), and 13 field pea varieties (Carrington field 17, 2025).

- Shown are the combined results obtained from testing conducted in the first two planting dates of the corresponding planting date studies. **Diagnostic testing was on diseased epicotyl tissue collected when peas were at early to mid-vegetative growth**, an appropriate growth stage to detect differences in Aphanomyces and Fusarium root rot.
- In 2024, diagnostic testing was conducted for *Aphanomyces euteiches*, *Fusarium avenaceum*, and *F. oxysporum*. In 2025, diagnostic testing was conducted for *A. euteiches*, *Rhizoctonia solani*, *Pythium* spp., *F. avenaceum*, *F. acuminatum*, *F. redolens*, *F. solani*, and *F. oxysporum*.
- Diagnostic testing results are not shown for *Pythium* because diseased field pea root and epicotyl tissue was not collected at an appropriate growth stage to detect *Pythium* spp., which primarily causes seed decay and early seedling mortality.

Field pea agronomic performance under severe native *Aphanomyces* root rot pressure at an on-farm location located 3 miles south of Webster, ND (2025). In the large-plot study, the plot size for the field pea varieties was 1/8 acre. The large plots show the performance of each variety in 0.50 acre per variety per planting date across a > 6-acre footprint.

Impact of variety selection on field pea agronomic performance under *Aphanomyces* pressure: Webster, ND (2025): average results across fungicide-treated and non-treated seed

Webster, ND (2025) Large-plot study (35 x 150 ft plots, 4 replicates)

Large-plot study: plots 150 ft long x 35 ft wide (across all seed treatments) replicated 4 times
Average response across six seed treatments and non-treated seed

PLANTING DATE #1:
May 4
58.0°F soil temperature
in the first 7 days after planting

	Root rot June 8 7-8 nodes % of epicotyl and tap root diseased	Nodulation June 8 7-8 nodes % of plants with active nodulation	Vigor July 16-17 90-100% pod-fill % relative to optimal crop vigor	Yield 13.5% moisture bu/ac
Salamanca	99	6 b*	59 c*	24 b*
Iconic	100	21 a	61 bc	24 b
AAC Julius	100	28 a	59 c	30 b
AAC IronHorse	100	24 a	69 b	32 b
PG Greenback	98	21 a	85 a	44 a
<i>F, P>F:</i>		5.45, 0.0097 CV: 17.4	34.92, <0.0001 CV: 5.5	18.85, <0.0001 CV: 11.9

PLANTING DATE #2:
May 12-13
51.2°F soil temperature
in the first 7 days after planting

	Root rot June 25 8-10 nodes % of epicotyl and tap root diseased	Nodulation June 25 8-10 nodes % of plants with active nodulation	Vigor July 23-24 87-100% pod-fill % relative to optimal crop vigor	Yield 13.5% moisture bu/ac
Salamanca	99	9 b*	63 d*	23 c*
Iconic	100	14 ab	67 cd	26 bc
AAC Julius	99	32 ab	70 bc	32 ab
AAC IronHorse	100	14 ab	75 b	31 bc
PG Greenback	99	34 a	83 a	42 a
<i>F, P>F:</i>		4.69, 0.0165 CV: 52.1	26.61, <0.0001 CV: 4.1	11.81, 0.0004 CV: 13.9

Webster, ND (2025) Small-plot study
(10 x 30 ft plots, 5 replicates)

Planting date:
May 12
Soil temp.,
first 7 days
after planting:
52.1F

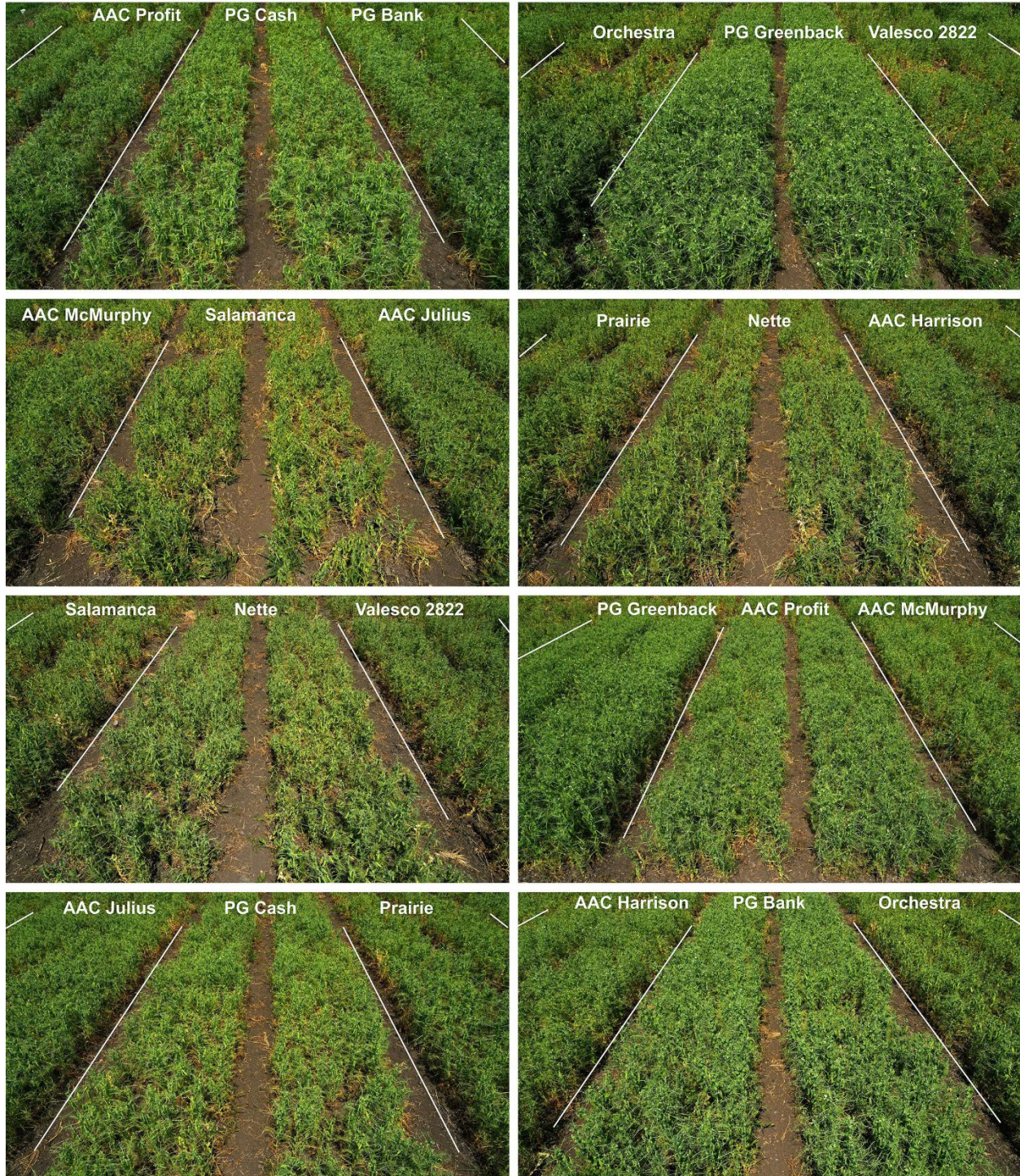
	Wilt July 21; late pod-fill % of plants	Field pea vigor July 21; late pod-fill %	Yield 13.5% moisture bu/ac
PG Greenback	0.2 a*‡	87 a*	45 a*
PG Bank	0.5 ab	80 ab	33 b
AAC Julius	0.4 ab	66 cd	30 bc
Orchestra	0.5 ab	63 cde	30 bc
PG Cash	0.6 abc	66 cd	29 bc
AAC Profit	0.9 bc	66 cd	26 bcd
AAC Harrison	0.5 ab	72 bc	24 cde
Prairie	0.7 bc	61 de	23 cde
Salamanca	1.3 c	64 cde	19 def
AAC McMurphy	1.0 bc	64 cde	19 def
Nette	1.1 bc	54 e	18 ef
AAC Goldstorm	0.7 abc	59 de	13 f
<i>F, P>F:</i>		7.36, 0.0092 CV: 42.4	19.23, <0.0001 4.1
			30.77, <0.0001 11.9

* Within-column means followed by different letters are significantly different ($P < 0.05$; Tukey procedure)

Field pea variety performance under severe *Aphanomyces* and *Fusarium* root rot pressure Webster, ND on-farm study (2025); May 12 planting date

Photos taken July 14, 2025. Shown are the full 30-foot plot lengths in a small-plot variety study.

All varieties and treatments are being tested in a randomized pattern five times in each of two planting dates; shown are results from one of the five times each variety was tested in the May 12 planting date. Each variety was tested with and without fungicide seed treatment (non-treated versus VibranceMaxx Pulses RTA @ 5 fl oz/100 lbs seed + Vayantis 0.1 fl oz/100 lbs seed)



Field pea agronomic performance under moderate native *Aphanomyces* root rot pressure at an on-farm location 12 miles SW of Makoti, ND (2025). The large plots show the performance of each variety in 0.50 acre per variety per planting date across a > 6-acre footprint.

Impact of variety selection on field pea agronomic performance under *Aphanomyces* pressure: Makoti, ND (2025): average results across fungicide-treated and non-treated seed

Makoti, ND (2025) Large-plot study (35 x 150 ft plots, 4 replicates)

Large-plot study: plots 150 ft long x 35 ft wide (across all seed treatments) replicated 4 times
Average response across six seed treatments and non-treated seed

	Root rot	Nodulation	Vigor	Yield
	June 3 3-6 nodes % of epicotyl and tap root diseased	June 26 early bloom % of plants with active nodulation	July 15 95-98% pod-fill % relative to optimal crop vigor	13.5% moisture bu/ac
Salamanca	6 a*	43 a*	85 b*	30 b*
Iconic	3 a	60 a	91 ab	32 ab
AAC Julius	9 a	49 a	90 ab	29 b
AAC IronHorse	5 a	50 a	95 a	31 ab
PG Greenback	4 a	72 a	95 a	35 a
	F, P>F: 0.83, 0.5317 CV: 92.9	2.54, 0.0944 CV: 26.2	9.53, 0.0010 CV: 2.8	5.42, 0.0100 CV: 6.4

	Root rot	Nodulation	Vigor	Yield
	June 26 8-11 nodes % of epicotyl and tap root diseased	June 26 8-11 nodes % of plants with active nodulation	July 25 95-98% pod-fill % relative to optimal crop vigor	13.5% moisture bu/ac
Salamanca	37 bc*	85 b*	85 b*	33 b*
Iconic	17 a	97 a	94 a	39 ab
AAC Julius	20 ab	97 a	86 b	35 b
AAC IronHorse	18 a	95 a	95 a	37 ab
PG Greenback	42 c	93 ab	94 a	41 a
	F, P>F: 9.62, 0.0012 CV: 26.4	6.31, 0.0057 CV: 4.1	2.94, 0.0006 CV: 3.3	5.59, 0.0089 CV: 7.6

Makoti, ND (2025) Small-plot study (5 ft x 30 ft plots)

on-farm study located 12 miles southwest of Makoti, ND (2025)
Soil temperature in the first 7 days after planting: 47.3°F (plant date #1), 47.1°F (plant date #2)

	PLANTING DATE #1: April 25		PLANTING DATE #2: May 11, 13		Combined analysis across both planting dates	
	Field pea vigor	Yield	Field pea vigor	Yield	Field pea vigor	Yield
	July 15; late pod-fill %	13.5% moisture bu/ac	July 25; late pod-fill %	13.5% moisture bu/ac	late pod-fill %	13.5% moisture bu/ac
PG Greenback	93 a*	31 a*	94 a*	36 a*	94 a*	33 a*
AAC Profit	79 b	29 a	78 bcd	30 abc	78 bc	30 ab
Prairie	80 ab	28 ab	80 bcd	31 ab	80 bc	29 ab
PG Cash	84 ab	29 a	79 bcd	29 abc	81 bc	29 abc
AAC McMurphy	75 b	27 ab	84 ab	31 ab	79 bc	29 abc
AAC Julius	84 ab	29 a	80 bcd	29 bc	82 bc	29 bc
PG Bank	85 ab	27 ab	87 ab	28 bc	86 ab	28 bc
AAC Goldstorm	78 b	26 ab	85 ab	27 bc	81 bc	27 bc
Orchestra	79 b	27 ab	71 cd	26 bc	75 c	27 bc
Salamanca	77 b	23 bc	83 abc	27 bc	80 bc	25 cd
AAC Harrison	76 b	25 ab	79 bcd	25 bc	78 bc	25 bcd
Nette	60 c	20 c	69 d	23 c	64 d	21 d
	F, P>F: 8.55, <0.0001 CV: 6.0	7.27, <0.0001 8.2	7.09, <0.0001 6.6	4.89, <0.0001 8.4	11.74, <0.0001 6.4	10.06, <0.0001 8.6

* Within-column means followed by different letters are significantly different (P < 0.05; Tukey procedure)

Field pea agronomic performance under very high (field 17) or high (field Q9B) native Aphanomyces root rot pressure in fields with a long history of field pea production in Carrington, ND (2025).

Field pea agronomic performance in fields with elevated Aphanomyces root rot pressure, Carrington, ND (2025) small-plot study: each variety planted to 10 ft x 30 ft plots (paired 5-ft plots seeded to non-treated and fungicide-treated seed); 6 replicates

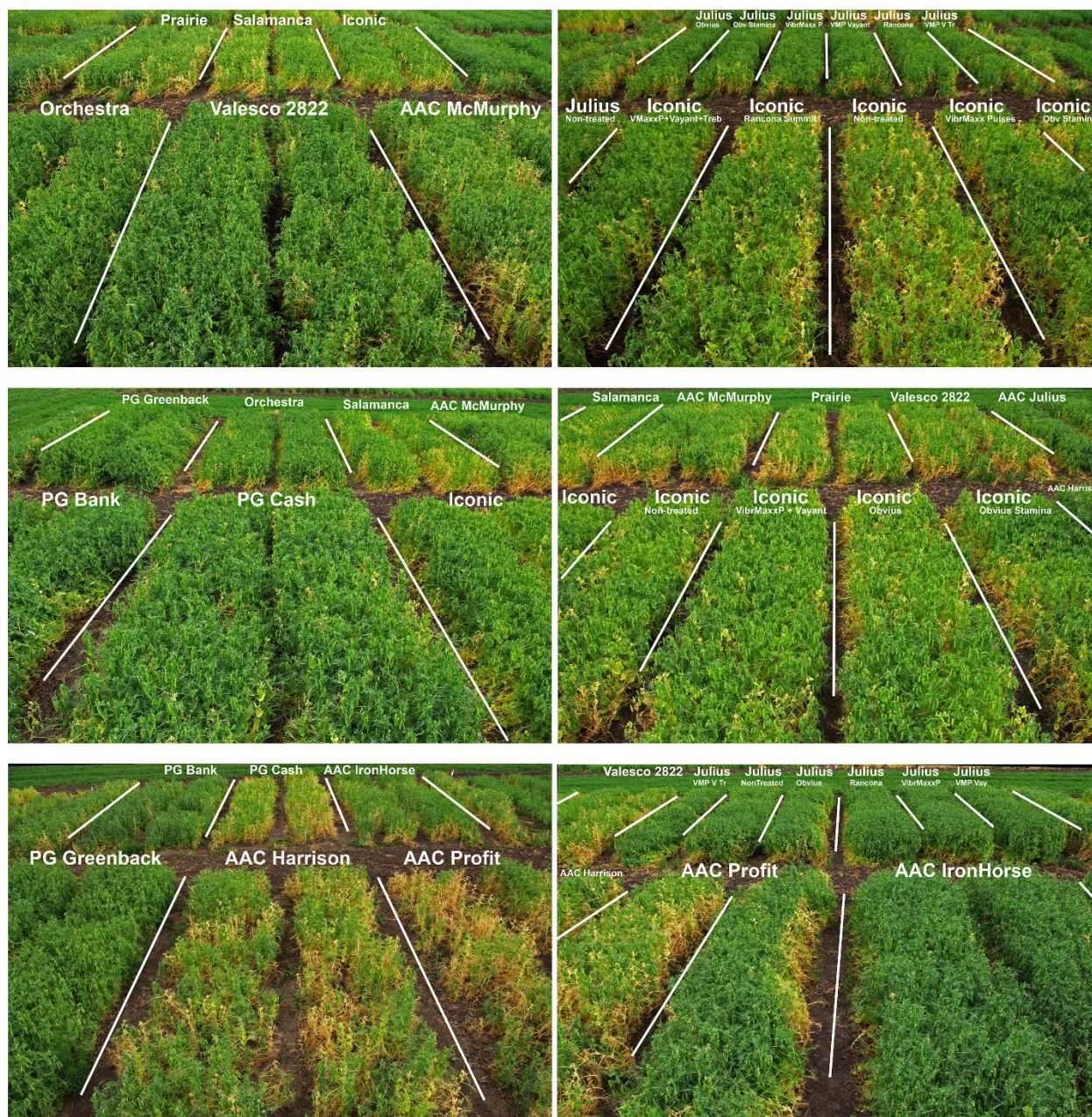
Field 17 Carrington, ND (2025)

Field pea variety (average across non-treated and fungicide-treated seed)	PLANTING DATE #1 April 24, 44.8°F		PLANTING DATE #2 May 4, 62.3°F		PLANTING DATE #3 May 27, 64.7°F		PLANTING DATE #4 June 5, 61.5°F		COMBINED ANALYSIS average across four plant dates	
	Wilt	Yield	Wilt	Yield	Wilt	Yield	Wilt	Yield	Wilt	Yield
	date assessed, July 14; 90-98% pods filled growth stage: % of plants	13.5% moisture bu/ac	July 14; 60-85% pods filled % of plants	13.5% moisture bu/ac	Aug. 1; 45-95% pods filled % of plants	13.5% moisture bu/ac	Aug. 10; 35-87% pods filled % of plants	13.5% moisture bu/ac	assessed at mid/late pod-fill % of plants	13.5% moisture bu/ac
PG Greenback	1 a	68 a	0 a	65 a	2 a	62 a	8 a	48 a	3 a	61 a
AAC IronHorse	2 a-d	62 ab	2 abc	60 abc	10 b	56 a	22 ab	44 ab	9 b	55 a
AAC Julius	1 ab	61 abc	1 ab	64 ab	23 b-f	51 ab	34 abc	43 ab	15 bc	55 a
Orchestra	4 b-e	47 cd	2 abc	60 abc	45 def	41 bc	56 cd	34 bcd	27 cde	45 b
PG Bank	3 a-e	51 bcd	3 bcd	47 abc	14 bc	41 bc	17 ab	37 abc	10 bc	44 bc
PG Cash	2 a-d	51 bcd	7 cd	49 abc	32 bcd	42 bc	61 cd	27 cde	26 cd	42 bcd
Iconic	2 a-d	49 bcd	2 a-d	51 abc	30 b-e	37 cd	83 d	17 efg	29 cde	39 b-e
AAC Profit	8 e	53 bcd	15 d	51 abc	48 def	26 d	59 cd	22 d-g	32 ef	38 cde
Salamanca	1 abc	51 bcd	3 bcd	47 abc	50 def	34 cde	82 d	17 efg	34 def	37 cde
AAC Harrison	5 de	50 bcd	8 bcd	47 bc	43 def	24 e	48 bc	23 d-g	26 def	36 de
Prairie	4 cde	40 d	5 cd	47 bc	33 c-f	30 c-f	60 cd	24 def	26 def	35 def
AAC McMurphy	2 a-d	50 bcd	4 bcd	48 abc	58 ef	19 fg	80 d	13 fg	36 def	32 ef
AAC Goldstorm	5 b-e	46 cd	7 cd	45 c	56 f	12 g	87 d	10 g	38 f	28 f
F, P>F: 6.49, <0.0001 5.97, <0.0001 5.13, <0.0001 3.72, 0.0003 16.80, <0.0001 29.57, <0.0001 16.72, <0.0001 21.65, <0.0001 28.31, <0.0001 37.75, <0.0001 CV: 26.5 9.4 36.9 11.0 10.7 12.7 14.8 11.4 15.0 11.2										
Fungicide seed treatment (average across 13 field pea varieties)										
Non-treated seed	4	50 b*	6	50 b*	38 b*	34 b*	55 b*	26 b*	26 b*	40 b*
VibranceMaxx Pulses RTA 5 fl oz + Vayantis 0.1 fl oz/cwt	2	54 a	3	55 a	30 a	39 a	52 a	29 a	22 a	44 a
F, P>F: 25.34, <0.0001 24.14, <0.0001 44.90, <0.0001 33.32, <0.0001 26.90, <0.0001 44.67, <0.0001 7.31, 0.0087 43.52, <0.0001 101.75, <0.0001 134.43, <0.0001 CV: 26.5 9.4 36.9 11.0 10.7 36.9 14.8 11.4 15.0 11.2										

Field Q9B Carrington, ND (2025)

Field pea variety (average across non-treated and fungicide-treated seed)	PLANTING DATE #1 April 23, 43.2°F		PLANTING DATE #2 May 1, 60.1°F		PLANTING DATE #3 May 27, 63.6°F		PLANTING DATE #4 June 5, 59.6°F		COMBINED ANALYSIS average across four planting dates	
	Wilt	Yield	Wilt	Yield	Wilt	Yield	Wilt	Yield	Wilt	Yield
	date, soil temp. at 2" depth, first 7 days after planting: July 14; 80-95% pod-fill when assessed: %	13.5% moisture bu/ac	July 14; 50-70% pod-fill %	13.5% moisture bu/ac	Aug. 4; 60-85% pod-fill %	13.5% moisture bu/ac	Aug. 14-25; 65-100% pod-fill %	13.5% moisture bu/ac	assessed at mid/late pod-fill % of plants	13.5% moisture bu/ac
PG Greenback	0 a	76 a	0 a	80 a	0 a	66 a	14 abc	57 ab	4 ab	70 a
AAC Julius	0 a	72 ab	0 a	72 ab	7 b-e	57 ab	10 abc	54 abc	4 ab	64 b
NDP150412G	0 a	62 bc	0 a	71 abc	2 ab	60 ab	7 ab	57 ab	2 a	63 bc
NDP140510Y	0 a	65 abc	0 a	68 bcd	3 abc	58 ab	3 a	58 a	2 a	62 bcd
NDP150231Y	0 a	67 ab	1 a	70 abc	11 b-e	56 ab	16 bcd	47 b-e	7 bc	60 b-e
Orchestra	1 a	67 ab	1 a	69 a-d	14 c-f	58 ab	50 d	43 def	16 cd	59 b-e
Nette	1 a	62 bc	1 a	70 abc	27 ef	54 b	36 cd	48 a-d	16 cd	59 b-e
PG Cash	0 a	68 ab	0 a	71 abc	16 def	53 bc	28 cd	42 def	11 cd	59 b-e
PG Bank	0 a	66 ab	0 a	68 bcd	5 bcd	50 bcd	6 ab	46 cde	3 a	58 c-f
Salamanca	0 a	64 abc	1 a	67 bcd	12 b-e	54 bc	34 cd	43 de	12 cd	57 def
Iconic	0 a	70 ab	0 a	68 bcd	15 c-f	49 bcd	50 d	37 efg	16 cd	56 ef
Prairie	0 a	66 ab	0 a	70 a-d	19 def	43 cde	41 d	33 fgh	15 cd	53 fg
AAC Profit	0 a	65 ab	0 a	60 cde	15 c-f	41 de	40 cd	33 fgh	14 cd	50 gh
AAC McMurphy	0 a	67 ab	0 a	65 bcd	41 f	29 f	53 d	30 gh	24 d	48 gh
AAC Harrison	0 a	61 bc	1 a	59 de	21 ef	37 ef	29 cd	32 gh	13 cd	47 h
AAC Goldstorm	0 a	53 cd	1 a	53 e	22 ef	35 ef	43 d	27 h	16 cd	42 i
ND Victory	1 a	47 d	0 a	52 e	20 def	28 f	29 cd	26 h	12 cd	38 i
F, P>F: 1.28, 0.28 7.2, <0.0001 1.62, 0.0630 10.51, <0.0001 10.75, <0.0001 29.33, <0.0001 49.48, <0.0001 29.31, <0.0001 19.33, <0.0001 55.87, <0.0001 CV: 131.2 5.3 116.8 5.6 13.5 6.7 14.6 10.9 21.7 6.8										
Fungicide seed treatment (average across 17 field pea varieties)										
Non-treated seed	0 a	65 b	1 a	66 b	17 b	47 b	36 b	40 b	13 b	54 b
VibranceMaxx Pulses RTA 5 fl oz + Vayantis 0.1 fl oz/cwt	0 a	65 a	0 a	67 a	12 a	50 a	22 a	44 a	9 a	57 a
F, P>F: 3.75, 0.0560 0.08, 0.7720 18.39, <0.0001 7.13, 0.0091 58.89, <0.0001 31.76, <0.0001 11.27, <0.0001 40.31, <0.0001 122.9, <0.0001 99.47, <0.0001 CV: 131.2 5.3 116.8 5.6 13.5 6.7 14.6 10.9 21.7 6.8										

Carrington, May 5 planting date



Field pea variety performance under severe *Aphanomyces* and *Fusarium* root rot pressure; Carrington, ND (2025)

Pictures taken July 14, 2025; shown is variety performance in two of six experimental replicates.

Yellow = plants wilted due to *Aphanomyces* and *Fusarium* root rot.

All varieties and treatments are being tested in a randomized pattern six times in each of four planting dates; shown are results from two of the six times each variety was tested in the second planting date. Iconic and AAC Julius were tested with non-treated seed versus Obvius @ 4.6 fl oz/100 lbs, Obvius 4.6 fl oz + Stamina @ 1.5 fl oz/100 lbs, VibranceMaxx Pulses RTA @ 5 fl oz/100 lbs seed, VibranceMaxx Pulses RTA 5 fl oz + Vayantis 0.1 fl oz/100 lbs seed: VibranceMaxx Pulses RTA 5 fl oz + Vayantis 0.1 fl oz + Trebuset 0.614 fl oz/100 lbs seed, and Rancona Summit 4 fl oz/100 lbs seed. All other varieties were tested as non-treated seed versus VibranceMaxx Pulses RTA 5 fl oz + Vayantis 0.1 fl oz/100 lbs.

Field pea agronomic performance under very high native *Aphanomyces* root rot pressure in fields with a long history of field pea production in Carrington, ND (2024). Results show the performance of each variety in 0.10 acre per planting date across a > 4-acre footprint.

Field pea agronomic performance under elevated *Aphanomyces* root rot pressure; Fields 17 and 18, Carrington, ND (2024)
Average results across four fungicide seed treatments and non-treated seed
large-plot study: each variety was planted to 25 ft x 30 ft plots in each replicate (five 5-ft plots, four seed treatments vs non-treated); 6 replicates

Carrington, ND (2024)		Planting date #1: April 23-24		Planting date #2: May 10		Planting date #3: May 22		Planting date #4: June 12-13	
FIELD 17		soil temperature = 45.2°F (ave. at 2" depth, first 7 days after planting)		soil temperature = 60.3°F (ave. at 2" depth, first 7 days after planting)		soil temperature = 56.4°F (ave. at 2" depth, first 7 days after planting)		soil temperature = 67.6°F (ave. at 2" depth, first 7 days after planting)	
last time peas or lentils were grown: 2021		Wilt	Yield	Wilt	Yield	Wilt	Yield	Wilt	Yield
		80-97% pod-fill	13.5% moisture	75-90% pod-fill	13.5% moisture	85-100% pod-fill	13.5% moisture	40-85% pod-fill	13.5% moisture
		% of plants	bu/ac	% of plants	bu/ac	% of plants	bu/ac	% of plants	bu/ac
AAC IronHorse	3 a	78 a	15 a	49 a	25 a	41 a	50 a	18 a	
AAC Julius	8 a	80 a	24 ab	42 a	52 b	23 bc	68 ab	14 a	
ND Dawn	6 a	56 a	36 b	39 a	42 b	30 ab	60 a	15 a	
Caphorn	11 a	57 a	63 c	26 b	74 c	12 cd	84 bc	4 b	
AAC Profit	33 a	53 b	80 d	16 bc	77 c	11 cd	87 c	3 b	
LG Amigo	58 a	19 c	85 d	8 c	86 c	7 d	63 a	6 b	
F, P>F: 28.62, <0.0001		29.73, <0.0001		80.26, <0.0001		27.32, <0.0001		39.02, <0.0001	
CV: 34.9		12.9		14.6		20.1		15.5	
Carrington, ND (2024)		Planting date #1: April 23		Planting date #2: May 12		Planting date #3: May 22		Planting date #4: June 12	
FIELD 18		soil temperature = 45.8°F (ave. at 2" depth, first 7 days after planting)		soil temperature = 58.6°F (ave. at 2" depth, first 7 days after planting)		soil temperature = 55.3°F (ave. at 2" depth, first 7 days after planting)		soil temperature = 57.0°F (ave. at 2" depth, first 7 days after planting)	
last time peas or lentils were grown: 2015		Wilt	Yield	Wilt	Yield	Wilt	Yield	Wilt	Yield
		85-100% pod-fill	13.5% moisture	70-100% pod-fill	13.5% moisture	85-100% pod-fill	13.5% moisture	78-100% pod-fill	13.5% moisture
		% of plants	bu/ac	% of plants	bu/ac	% of plants	bu/ac	% of plants	bu/ac
AAC IronHorse	2 a	66 a	5 a	45 a	7 a	45 a	74 a	23 a	
AAC Julius	3 a	58 ab	11 b	34 b	23 c	34 b	90 b	19 a	
ND Dawn	3 a	56 ab	13 b	38 ab	15 b	37 b	91 b	21 a	
Caphorn	15 ab	57 ab	27 bc	32 bc	28 d	30 b	88 b	12 b	
AAC Profit	15 b	53 b	40 c	25 c	55 e	19 c	97 b	5 c	
LG Amigo	20 b	19 c	33 c	11 d	57 e	9 d	90 b	6 c	
F, P>F: 10.02, <0.0001		6.77, <0.0001		11.72, <0.0001		36.23, <0.0001		64.38, <0.0001	
CV: 26.4		8.9		30.3		13.5		8.5	
								49.56, <0.0001	
								10.6	
								9.68, <0.0001	
								7.1	
								61.73, <0.0001	
								14.2	

* Within-column means followed by different letters are significantly different (P < 0.05; Tukey multiple comparison procedure)

Impact of variety selection on field pea agronomic performance under Aphanomyces pressure: Makoti and Webster, ND (2025): average results across fungicide-treated and non-treated seed

Makoti, ND on-farm study (2025) AVERAGE RESPONSE ACROSS 6 FUNGICIDE SEED TREATMENTS AND CONTROL
 large plot sizes: plots were 150 feet long x total 35 feet wide (across all seed treatments)

	PLANT DATE #1: April 25										
	WEATHER, first 7 days Soil temperature: 47.3°F (average, day and night, first 7 days after planting) after planting: Rainfall: 0.05 inch. Daytime high temperature: 61.0°F average										
	Dry weather during bloom and pod-fill period reduced yields.										
	Root rot		Active Rhizobium		Wilt	Vigor	Yield	Protein	Test weight		
	June 3, 3-6 nodes		June 26; early bloom		July 15, 95-98% pod-fill		13.5% moisture		lbs/bu		
	% of plants	% sev index	% of plants	% active nodules	%	%	bu/ac	%			
Salamanca	13 a*	6 a*	43 a*	11 b*	0.3 a*‡	85 b*	30 b*	23.9 a*	65.7 b*		
Iconic	9 a	3 a	60 a	21 ab	0.1 a	91 ab	32 ab	23.8 a	66.7 a		
AAC Julius	16 a	9 a	49 a	14 ab	0.0 a	90 ab	29 b	22.7 b	66.5 a		
AAC IronHorse	17 a	5 a	50 a	13 ab	0.1 a	95 a	31 ab	22.9 b	67.1 a		
PG Greenback	11 a	4 a	72 a	23 a	0.1 a	95 a	35 a	21.6 c	66.9 a		
	F, P>F: 0.64, 0.6439		0.83, 0.5317	2.54, 0.0944	4.65, 0.0168	2.33, 0.1153	9.53, 0.0010	5.42, 0.0100	23.71, <0.0001	11.54, 0.0004	
	CV: 66.6		92.9	26.2	30.4	102.9	2.8	6.4	1.6	0.5	

	PLANT DATE #2: May 13										
	WEATHER, first 7 days Soil temperature: 47.1°F (average, day and night, first 7 days after planting) after planting: Rainfall: 6.26 inch. Daytime high temperature: 46.7°F average										
	Rains in second half of July (mid to late pod-fill) increased yields.										
	Root rot		Active Rhizobium		Wilt	Vigor	Yield	Protein	Test weight		
	June 26		June 26; 8-11 nodes		July 25, 95-98% pod-fill		13.5% moisture		lbs/bu		
	% of plants	% sev index	% of plants	% active nodules	%	%	bu/ac	%			
Salamanca	56 ab*	37 bc*	85 b*	50 c*	0.3 a*	85 b*	33 b*	25.9 a*	63.3 c*		
Iconic	39 a	17 a	97 a	73 a	0.1 a	94 a	39 ab	25.3 ab	63.5 bc		
AAC Julius	49 a	20 ab	97 a	67 ab	0.1 a	86 b	35 b	24.7 abc	63.8 abc		
AAC IronHorse	53 ab	18 a	95 a	60 c	0.0 a	95 a	37 ab	23.8 c	64.2 a		
PG Greenback	70 b	42 c	93 ab	55 bc	0.0 a	94 a	41 a	23.9 bc	64.1 ab		
	F, P>F: 6.80, 0.0042		9.26, 0.0012	6.31, 0.0057	13.04, 0.0003	2.94, 0.0657	10.88, 0.0006	5.59, 0.0089	8.32, 0.0019	11.72, 0.0004	
	CV: 16.5		28.4	4.1	8.5	126.1	3.3	7.6	2.6	0.4	

Webster, ND on-farm study (2025) AVERAGE RESPONSE ACROSS 6 SEED TREATMENTS AND CONTROL
 large plot sizes: 150 ft long x total 35 ft wide (across all seed treatments)

	PLANT DATE #1: May 4									
	WEATHER, first 7 days Soil temperature: 58.0°F (average, day and night, first 7 days after planting) after planting: Rainfall: 0.01 inch. Daytime high temperature: 80.3°F average									
	Wet, heavy clay soils precluded earlier planting.									
	Root rot		Active Rhizobium		Wilt	Vigor	Yield	Protein	Test weight	
	June 8, 7-8 nodes		June 8, 7-8 nodes		July 16-17, 90-100% pod-fill		13.5% moisture		lbs/bu	
	% of plants	% sev index	% of plants	% active nodules	%	%	bu/ac	%		
Salamanca	100	99	6 b*‡		2.7 b*‡	59 c*	24 b*	21.7 a*	63.1 c*	
Iconic	100	100	21 a		2.2 ab	61 bc	24 b	21.1 a	63.2 bc	
AAC Julius	100	100	28 a		0.5 a	59 c	30 b	21.7 a	63.8 ab	
AAC IronHorse	100	100	24 a		0.5 a	69 b	32 b	20.6 a	63.9 a	
PG Greenback	99	98	21 a		0.6 a	85 a	44 a	21.7 a	64.3 a	
	F, P>F:		5.45, 0.0097		6.42, 0.0053	34.92, <0.0001	18.85, 0.0001	1.42, 0.2977	20.60, <0.0001	
	CV:		17.4		43.9	5.5	11.9	1.4	0.3	

	PLANT DATE #2: May 12-13										
	WEATHER, first 7 days Soil temperature: 51.2°F (average, day and night, first 7 days after planting) after planting: Rainfall: 1.91 inch. Daytime high temperature: 60.6°F average										
	Cold, wet weather occurred after planting.										
	Root rot		Active Rhizobium		Wilt	Vigor	Yield	Protein	Test weight		
	June 25, 8-10 nodes		June 25, 8-10 nodes		July 23-24, 87-100% pod-fill		13.5% moisture		lbs/bu		
	% of plants	% sev index	% of plants	% active nodules	%	%	bu/ac	%			
Salamanca	100	99	9 b*	2 b*	1.7 b*‡	63 d*	23 c*	22.3 a*	63.3 c*		
Iconic	100	100	14 ab	3 ab	0.8 ab	67 cd	26 bc	21.8 a	63.6 bc		
AAC Julius	100	99	32 ab	7 a	0.3 a	70 bc	32 ab	22.0 a	63.8 ab		
AAC IronHorse	100	100	14 ab	2 ab	0.3 a	75 b	31 bc	21.7 a	64.2 a		
PG Greenback	100	99	34 a	6 ab	0.2 a	83 a	42 a	22.0 a	64.2 a		
	F, P>F:		4.69, 0.0164		4.89, 0.0143	12.87, 0.0003	26.61, <0.0001	11.81, 0.0004	1.09, 0.4049	11.22, 0.0005	
	CV:		52.1		56.3	41.1	4.1	13.9	2.3	0.4	

* Within-column means followed by different letters are significantly different ($P < 0.05$; Tukey multiple comparison procedure). ‡ To meet model assumptions of homoskedasticity and/or normality, analysis of variance was conducted on data subjected to a systematic natural-log transformation. For ease of interpretation, treatments means are presented for non-transformed data.

Impact of field pea variety selection

on field pea agronomic performance under *Aphanomyces* pressure Makoti & Webster, ND (2025)

average results across fungicide-treated and non-treated seed

FIELD PEA VARIETY PERFORMANCE: Combined analysis across non-treated and fungicide-treated seed

SEED TREATMENT: Combined analysis, 12 field pea varieties

Webster, ND on-farm study (2025)

SMALL-PLOT STUDY
5 ft x 30 ft, 5 replicates

PLANTING DATE: May 12	WEATHER, first 7 days after planting:		Soil temp.: 52.1°F (average, day & night, first 7 days after planting)			
	Rainfall: 1.91 inch. Daytime high temperature: 60.6°F average					
	WEATHER, first 14 days after planting:		Soil temp.: 52.1°F (average, day & night, first 14 days after planting)			
Rainfall: 2.52 inch. Daytime high temperature: 62.1°F average						
Wilt		Vigor	Yield	Protein	Test weight	
July 21; late pod-fill		13.5% moisture				
% of plants		%	bu/ac	%	lbs/bu	
PG Greenback	0.2 a*†	87 a*	45 a*	22.6 bc*	63.8 ab*	
PG Bank	0.5 ab	80 ab	33 b	22.7 ab	63.7 ab	
AAC Julius	0.4 ab	66 cd	30 bc	22.3 d	64.1 ab	
Orchestra	0.5 ab	63 cde	30 bc	25.1 cd	64.1 a	
PG Cash	0.6 abc	66 cd	29 bc	22.7 ab	64.0 ab	
AAC Profit	0.9 bc	66 cd	26 bcd	24.3 e	63.8 ab	
AAC Harrison	0.5 ab	72 bc	24 cde	24.4 a	63.7 ab	
Prairie	0.7 bc	61 de	23 cde	22.4 d	64.1 ab	
Salamanca	1.3 c	64 cde	19 def	22.9 cd	63.4 abc	
AAC McMurphy	1.0 bc	64 cde	19 def	22.8 d	63.0 bc	
Nette	1.1 bc	54 e	18 ef	21.0 d	64.6 a	
AAC Goldstorm	0.7 abc	59 de	13 f	23.7 cd	62.3 c	
F, P>F:		7.36, 0.0092	19.23, <0.0001	30.77, <0.0001	26.25, <0.0001	6.61, <0.0001
CV:		42.4	4.1	11.9	2.5	1.0
Non-treated seed		0.8 a*†	66.6 a*	25.3 a*	23.1 a*	63.7 a*
VibranceMaxx Pulses 5 fl oz + Vayantis 0.1 fl oz/cwt		0.6 a	67.1 a	26.3 a	23.1 a	63.8 a
F, P>F:		5.77, <0.0001	1.72, 0.1962	3.66, 0.0620	0.30, 0.5876	1.08, 0.3040
CV:		42.4	4.1	11.9	2.5	1.0

on-farm study located 12 miles southwest of Makoti, ND (2025)

SMALL-PLOT STUDY
5 ft x 30 ft plots, 5 replica

WEATHER, first 7 days after planting:		Soil temperature: 47.3°F (average, day & night, first 7 days after planting)		
Rainfall: 0.05 inch. Daytime high temperature: 61.0°F average				
WEATHER, first 14 days after planting:		Soil temperature: 51.2°F (average, day & night, first 14 days after planting)		
Rainfall: 0.05 inch. Daytime high temperature: 51.2°F average				
PLANTING DATE: April 25		PLANTING DATE: May 11, 13		

FIELD PEA VARIETY PERFORMANCE: Combined analysis across non-treated and fungicide-treated seed

	Wilt		Vigor	Yield	Protein	Test weight	Wilt		Vigor	Yield	Protein	Test weight
	July 15; late pod-fill		13.5% moisture				July 25; late pod-fill		13.5% moisture			
	% of plants		%	bu/ac	%	lbs/bu	% of plants		%	bu/ac	%	lbs/bu
AAC Goldstorm	5 bc*†	78 b*	26 ab*	24.9 abc*	64.0 ab*	1 ab*†	85 ab*	27 bc*	23.9 bcd*	63.4 bc*		
AAC Harrison	6 c	76 b	25 ab	24.1 a-d	63.8 b	1 ab	79 bcd	25 bc	23.1 cd	63.6 bc		
AAC Julius	2 ab	84 ab	29 a	24.2 a-d	64.3 ab	1 ab	80 bcd	29 bc	24.6 ab	63.8 abc		
AAC McMurphy	4 bc	75 b	27 ab	23.7 a-d	64.3 ab	1 ab	84 ab	31 ab	24.2 bcd	63.1 c		
AAC Profit	3 abc	79 b	29 a	22.9 d	64.8 ab	2 b	78 bcd	30 abc	23.2 cd	63.9 ab		
Nette	3 abc	60 c	20 c	23.5 cd	64.1 ab	2 b	69 d	23 c	23.8 bcd	63.2 bc		
Orchestra	3 abc	79 b	27 ab	25.1 ab	64.6 ab	2 b	71 cd	26 bc	25.8 a	63.8 abc		
PG Bank	3 abc	85 ab	27 ab	24.8 abc	64.7 ab	1 ab	87 ab	28 bc	24.9 ab	63.8 abc		
PG Cash	4 abc	84 ab	29 a	24.7 abc	64.3 ab	1 ab	79 bcd	29 abc	24.3 bc	63.5 bc		
PG Greenback	1 a	93 a	31 a	22.9 d	64.8 ab	0 a	94 a	36 a	23.3 cd	64.5 a		
Prairie	3 abc	80 ab	28 ab	23.6 bcd	64.8 a	2 b	80 bcd	31 ab	23.0 d	63.9 ab		
Salamanca	4 abc	77 b	23 bc	25.3 a	63.9 b	1 ab	83 abc	27 bc	24.9 ab	63.1 c		
F, P>F:		3.22, 0.0027	8.55, <0.0001	7.27, <0.0001	6.69, <0.0001	2.22, 0.0302	6.22, 0.0161	7.09, <0.0001	4.89, <0.0001	9.67, <0.0001	6.78, <0.0001	
CV:		26.5	6.0	8.2	2.3	0.6	64.5	6.6	8.4	3.1	0.5	

RESPONSE TO FUNGICIDE SEED TREATMENT: Combined analysis across 12 field pea varieties

	Wilt		Vigor	Yield	Protein	Test weight	Wilt		Vigor	Yield	Protein	Test weight
	July 15; late pod-fill		13.5% moisture				July 25; late pod-fill		13.5% moisture			
	% of plants		%	bu/ac	%	lbs/bu	% of plants		%	bu/ac	%	lbs/bu
Non-treated seed	4 a*†	78 a*	26.4 b*	24.2 a*	64.3 a*	1 a*	81 a*	28.5 a*	24.0 a*	63.7 a*		
VibranceMaxx Pulses 5 fl oz + Vayantis 0.1 fl oz/cwt	3 a	80 a	27.2 a	24.1 a	64.4 a	1 a	81 a	28.4 a	24.2 a	63.6 b		
F, P>F:		3.56, 0.0651	7.69, 0.0069	5.74, 0.0205	1.08, 0.3035	1.61, 0.2108	2.78, 0.0079	0.05, 0.8278	0.31, 0.5803	1.10, 0.2992	5.73, 0.0209	
CV:		26.5	6.0	8.2	2.3	0.6	64.5	6.6	8.4	3.1	0.5	

* Within-column means followed by different letters are significantly different (P < 0.05; Tukey multiple comparison procedure). † To meet model assumptions of normality and/or homoskedasticity, analysis of variance was conducted on data subjected to a systematic natural-log transformation. For ease of interpretation, treatments means are presented for the non-transformed data.

Field pea agronomic performance under elevated Aphanomyces root rot pressure, Field 17, Carrington, ND (2025)
 small-plot study: each variety planted to 10 ft x 30 ft plots (paired 5-ft plots seeded to non-treated and fungicide-treated seed); 6 replicates

WILTED PLANTS AND GRAIN YIELD

	Planting date #1		Planting Date #2		Planting date #3		Planting Date #4		
	Wilt	Yield	Wilt	Yield	Wilt	Yield	Wilt	Yield	
date; soil temperature at 2-in. depth, first 7 days after planting:	April 24, 44.8°F		May 4, 62.3°F		May 27, 64.7°F		June 5, 61.5°F		
date when assessed:	July 14	13.5% moisture	July 14	13.5% moisture	Aug. 1	13.5% moisture	Aug. 10	13.5% moisture	
growth stage:	90-98% pods filled		60-85% pods filled		45-95% pods filled		35-87% pods filled		
	%	bu/ac	%	bu/ac	%	bu/ac	%	bu/ac	
PERFORMANCE OF FIELD PEA VARIETIES: average across peas grown from non-treated and fungicide-treated seed									
AAC Goldstorm	5 b-e*‡	46 cd	7 cd*‡	45 c	56 f*‡	12 g	87 d	10 g	
AAC Harrison	5 de	50 bcd	8 bcd	47 bc	43 def	24 efg	48 bc	23 d-g	
AAC IronHorse	2 a-d	62 ab	2 abc	60 abc	10 b	56 a	22 ab	44 ab	
AAC McMurphy	2 a-d	50 bcd	4 bcd	48 abc	58 ef	19 fg	80 d	13 fg	
AAC Profit	8 e	53 bcd	15 d	51 abc	48 def	26 def	59 cd	22 d-g	
Orchestra	4 b-e	47 cd	2 abc	60 abc	45 def	41 bc	56 cd	34 bcd	
PG Bank	3 a-e	51 bcd	3 bcd	47 abc	14 bc	41 bc	17 ab	37 abc	
PG Cash	2 a-d	51 bcd	7 cd	49 abc	32 bcd	42 bc	61 cd	27 cde	
PG Greenback	1 a	68 a	0 a	65 a	2 a	62 a	8 a	48 a	
Prairie	4 cde	40 d	5 cd	47 bc	33 c-f	30 c-f	60 cd	24 def	
Salamanca	1 abc	51 bcd	3 bcd	47 abc	50 def	34 cde	82 d	17 efg	
AAC Julius	1 ab	61 abc	1 ab	64 ab	23 b-f	51 ab	34 abc	43 ab	
Iconic	2 a-d	49 bcd	2 a-d	51 abc	30 b-e	37 cd	83 d	17 efg	
	F, P>F:	6.49, <0.0001	5.97, <0.0001	5.13, <0.0001	3.72, 0.0003	16.80, <0.0001	29.57, <0.0001	16.72, <0.0001	21.65, <0.0001
	CV:	26.5	9.4	36.9	11.0	10.7	12.7	14.8	11.4
Response to fungicide seed treatment: average across 13 field pea varieties									
Non-treated seed	4	50 b*	6	50 b*	38 b*	34 b*	55 b*	26 b*	
VibranceMaxx Pulses + Vayantis	2	54 a	3	55 a	30 a	39 a	52 a	29 a	
	F, P>F:	25.34, <0.0001	24.14, <0.0001	44.90, <0.0001	33.32, <0.0001	26.90, <0.0001	44.67, <0.0001	7.31, 0.0087	43.52, <0.0001
	CV:	26.5	9.4	36.9	11.0	10.7	36.9	14.8	11.4

GRAIN QUALITY: PROTEIN, TEST WEIGHT

	Planting date #1		Planting Date #2		Planting date #3		Planting Date #4		
	Protein	Test weight	Protein	Test weight	Protein	Test weight	Protein	Test weight	
date; soil temperature at 2-in. depth, first 7 days after planting:	April 24, 44.8°F		May 4, 62.3°F		May 27, 64.7°F		June 5, 61.5°F		
PERFORMANCE OF FIELD PEA VARIETIES: average across peas grown from non-treated and fungicide-treated seed									
AAC Goldstorm	64.1 a-d*	22.4 ab*	63.5 a-d*	22.9 ab*	63.2 b*	24.7 ab*	63.3 cde*	25.3 a*	
AAC Harrison	64.3 abc	22.2 ab	63.8 abc	23.0 ab	63.4 ab	24.9 a	63.3 cde	24.5 ab	
AAC IronHorse	64.4 a	22.1 ab	64.1 a	22.5 ab	63.8 a	23.3 b	64.0 ab	24.0 b	
AAC McMurphy	63.9 a-d	22.2 ab	63.1 cd	21.6 b	62.7 b	24.3 ab	63.0 de	24.0 b	
AAC Profit	64.0 a-d	22.4 b	63.8 ab	22.6 ab	63.3 ab	23.9 ab	63.0 de	24.6 ab	
Orchestra	64.0 a-d	23.4 a	63.7 ab	24.1 a	63.1 ab	24.2 ab	64.2 a	24.9 ab	
PG Bank	64.3 ab	22.4 ab	63.8 abc	22.7 ab	63.2 ab	24.8 ab	63.5 bcd	24.7 ab	
PG Cash	63.5 cd	22.8 ab	63.0 d	22.2 b	62.6 b	24.7 ab	63.1 de	24.4 ab	
PG Greenback	64.3 abc	21.8 b	64.1 a	22.3 b	63.3 ab	23.9 ab	63.1 de	24.0 b	
Prairie	64.3 ab	21.8 a	63.9 ab	21.7 b	63.0 ab	24.1 ab	63.4 abc	23.9 b	
Salamanca	63.3 d	22.3 ab	63.2 bcd	22.4 ab	62.3 b	24.0 ab	62.7 e	24.4 ab	
AAC Julius	63.9 a-d	21.8 b	63.6 a-d	22.0 b	63.2 ab	23.4 ab	63.4 b-e	23.6 b	
Iconic	63.6 bcd	22.3 ab	63.4 bcd	21.6 b	62.8 ab	23.9 ab	63.2 cde	24.5 ab	
	F, P>F:	4.57, <0.0001	2.36, 0.0146	6.99, <0.0001	4.14, 0.0001	2.97, 0.0036	2.20, 0.0270	9.73, <0.0001	3.35, 0.0014
	CV:	0.6	2.4	0.7	3.4	0.6	2.7	0.8	1.7
Response to fungicide seed treatment: average across 13 field pea varieties									
Non-treated seed	64.0 a*	22.3 a*	63.6 a*	22.3 a*	63.1 a*	24.3 a*	63.4 a*	24.4 a*	
VibranceMaxx Pulses + Vayantis	64.0 a	22.3 a	63.7 a	22.5 a	63.0 a	24.1 a	63.4 a	24.4 a	
	F, P>F:	0.29, 0.5898	0.24, 0.6256	1.67, 0.2014	2.09, 0.1533	0.31, 0.5779	1.51, 0.2248	0.01, 0.9333	0.09, 0.7673
	CV:	0.6	2.4	0.7	3.4	0.6	2.7	0.8	1.7

* Within-column means followed by different letters are significantly different (P < 0.05; Tukey multiple comparison procedure). ‡ To meet model assumptions of normality and/or homoskedasticity, analysis of variance was conducted on data subjected to a systematic natural-log transformation. For ease of interpretation, treatments means are presented for the non-transformed data.

Field pea agronomic performance under elevated Aphanomyces root rot pressure; Field Q9B, Carrington, ND (2025)
 small-plot study: each variety planted to 10 ft x 30 ft plots (paired 5-ft plots seeded to non-treated and fungicide-treated seed); 6 replicates

WILTED PLANTS AND YIELD: % of plants exhibiting wilt at mid to late pod-fill

	Planting date #1		Planting Date #2		Planting date #3		Planting Date #4		
date; soil temperature at 2-in. depth, first 7 days after planting:	April 23, 43.2°F		May 5, 60.1°F		May 27, 63.6°F		June 5, 59.5°F		
	Wilt	Yield	Wilt	Yield	Wilt	Yield	Wilt	Yield	
date when assessed:	July 14	13.5% moisture	July 14	13.5% moisture	Aug. 4	13.5% moisture	Aug. 14, 15, 25	13.5% moisture	
growth stage:	80-95% pods filled	bu/ac	50-70% pods filled	bu/ac	60-85% pods filled	bu/ac	65-100% pod-fill	bu/ac	
	%		%		%		%		
PERFORMANCE OF FIELD PEA VARIETIES: average across peas grown from untreated and treated seed (VibranceMaxx Pulses RTA @ 5 fl oz + Vayantis @ 0.1 fl oz/cwt)									
AAC Goldstorm	0 a*†	53 cd*	1 a*†	53 e*	22 ef*†	35 ef*	43 d*†	27 h*	
AAC Harrison	0 a	61 bc	1 a	59 de	21 ef	37 ef	29 cd	32 gh	
AAC Julius	0 a	72 ab	0 a	72 ab	7 b-e	57 ab	10 abc	54 abc	
AAC McMurphy	0 a	67 ab	0 a	65 bcd	41 f	29 f	53 d	30 gh	
AAC Profit	0 a	65 ab	0 a	60 cde	15 c-f	41 de	40 cd	33 fgh	
ICONIC	0 a	70 ab	0 a	68 bcd	15 c-f	49 bcd	50 d	37 efg	
ND Victory	1 a	47 d	0 a	52 e	20 def	28 f	29 cd	26 h	
NDP140510Y	0 a	65 abc	0 a	68 bcd	3 abc	58 ab	3 a	58 a	
NDP150231Y	0 a	67 ab	1 a	70 abc	11 b-e	56 ab	16 bcd	47 b-e	
NDP150412G	0 a	62 bc	0 a	71 abc	2 ab	60 ab	7 ab	57 ab	
Nette	1 a	62 bc	1 a	70 abc	27 ef	54 b	36 cd	48 a-d	
Orchestra	1 a	67 ab	1 a	69 a-d	14 c-f	58 ab	50 d	43 def	
PG Bank	0 a	66 ab	0 a	68 bcd	5 bcd	50 bcd	6 ab	46 cde	
PG Cash	0 a	68 ab	0 a	71 abc	16 def	53 bc	28 cd	42 def	
PG Greenback	0 a	76 a	0 a	80 a	0 a	66 a	14 abc	57 ab	
Prairie	0 a	66 ab	0 a	70 a-d	19 def	43 cde	41 d	33 fgh	
Salamanca	0 a	64 abc	1 a	67 bcd	12 b-e	54 bc	34 cd	43 de	
	F, P>F:	1.28, 0.28	7.2, <0.0001	1.62, 0.0630	10.51, <0.0001	10.75, <0.0001	29.33, <0.0001	49.48, <0.0001	29.31, <0.0001
	CV:	131.2	5.3	116.8	5.6	13.5	6.7	14.6	10.9
Response to fungicide seed treatment: average across 17 field pea varieties, non-treated vs. VibranceMaxx Pulses RTA @ 5 fl oz/cwt + Vayantis @ 0.1 fl oz/cwt									
Non-treated seed	0 a*†	65 b*	1 a*†	66 b*	17 b*†	47 b*	36 b*	40 b*	
VibranceMaxx Pulses + Vayantis	0 a	65 a	0 a	67 a	12 a	50 a	22 a	44 a	
	F, P>F:	3.75, 0.0560	0.08, 0.7720	18.39, <0.0001	7.13, 0.0091	58.89, <0.0001	31.76, <0.0001	11.27, <0.0001	40.31, <0.0001
	CV:	131.2	5.3	116.8	5.6	13.5	6.7	14.6	10.9

QUALITY OF HARVESTED GRAIN: PROTEIN AND TEST WEIGHT

	Planting date #1		Planting Date #2		Planting date #3		Planting Date #4		
date; soil temperature at 2-in. depth, first 7 days after planting:	April 23, 43.2°F		May 5, 60.1°F		May 27, 63.6°F		June 5, 59.5°F		
	Protein	Test weight	Protein	Test weight	Protein	Test weight	Protein	Test weight	
	%	lbs/bu	%	lbs/bu	%	lbs/bu	%	lbs/bu	
PERFORMANCE OF FIELD PEA VARIETIES: average across peas grown from untreated and treated seed (VibranceMaxx Pulses RTA @ 5 fl oz + Vayantis @ 0.1 fl oz/cwt)									
AAC Goldstorm	24.1 ab*	62.6 a-f*	24.4 a*	62.5 b-f*	24.8 abc*	63.4 a-d	25.0 a*	62.1 ab*	
AAC Harrison	24.0 ab	63.0 abc	23.2 a-d	63.2 ab	24.7 abc	63.8 a-d	25.1 a	61.8 ab	
AAC Julius	23.3 ab	62.4 c-h	23.0 b-e	62.1 def	24.0 bcd	64.7 a-d	23.9 b-e	62.6 ab	
AAC McMurphy	23.3 ab	62.3 e-h	22.8 b-e	62.5 b-f	23.8 cd	64.6 a-d	24.2 a-d	62.2 ab	
AAC Profit	24.3 a	62.9 a-e	23.8 abc	63.5 a	24.4 bc	64.6 a-d	24.5 ab	62.9 ab	
ICONIC	22.8 abc	62.5 b-g	22.7 cde	62.2 c-f	24.6 abc	63.0 cd	24.5 ab	62.3 ab	
ND Victory	24.1 ab	63.1 abc	24.1 ab	62.6 b-f	24.8 ab	64.3 a-d	24.8 ab	62.7 ab	
NDP140510Y	22.5 bc	62.5 b-g	22.3 de	62.7 a-e	22.6 e	65.2 ab	23.1 e	63.1 ab	
NDP150231Y	22.9 abc	63.0 a-d	22.6 cde	62.8 a-d	22.6 e	65.4 a	23.3 de	63.0 ab	
NDP150412G	23.5 ab	61.9 h	23.8 abc	61.7 f	23.4 de	64.2 a-d	24.6 ab	62.0 ab	
Nette	21.3 c	62.1 fgh	21.8 e	62.6 b-f	22.9 e	65.2 a	23.0 e	63.1 a	
Orchestra	24.3 a	62.5 b-g	24.4 a	62.0 def	24.8 ab	64.8 abc	24.9 a	62.3 ab	
PG Bank	24.1 ab	62.9 a-e	23.7 abc	63.0 abc	25.3 a	63.1 bcd	25.2 a	63.1 a	
PG Cash	23.7 ab	62.3 d-h	23.7 abc	61.9 ef	24.8 ab	64.3 a-d	24.9 a	62.3 ab	
PG Greenback	23.2 ab	63.1 ab	22.6 cde	63.1 ab	23.4 de	62.9 cd	23.8 b-e	63.2 a	
Prairie	23.1 ab	63.2 a	22.6 cde	63.0 abc	23.1 de	65.2 ab	23.4 cde	62.6 ab	
Salamanca	23.7 ab	62.0 gh	22.8 cde	61.7 f	23.9 bcd	62.7 d	24.4 abc	61.5 b	
	F, P>F:	5.41, <0.0001	9.85, <0.0001	8.55, <0.0001	9.89, <0.0001	22.99, <0.0001	4.72, <0.0001	12.40, <0.0001	2.27, 0.0088
	CV:	2.8	0.5	2.5	0.9	2.1	1.9	2.2	1.8
Response to fungicide seed treatment: average across 17 field pea varieties, non-treated vs. VibranceMaxx Pulses RTA @ 5 fl oz/cwt + Vayantis @ 0.1 fl oz/cwt									
Non-treated seed	23.4 a*	62.6 a*	23.2 a*	62.5 a*	23.9 b*	64.3 a*	24.2 b*	62.4 a*	
VibranceMaxx Pulses + Vayantis	23.5 a	62.6 a	23.2 a	62.6 a	24.1 a	64.1 a	24.4 a	62.6 a	
	F, P>F:	1.79, 0.1850	1.01, 0.3187	0.13, 0.7228	0.13, 0.7195	8.21, 0.0053	2.16, 0.1450	6.11, 0.0155	1.26, 0.2657
	CV:	2.8	0.5	2.5	0.9	2.1	1.9	2.2	1.8

* Within-column means followed by different letters are significantly different (P < 0.05; Tukey multiple comparison procedure). † To meet model assumptions of normality and/or homoscedasticity, analysis of variance was conducted on data subjected to a systematic natural-log transformation. For ease of interpretation, treatments means are presented for the non-transformed data.

Field pea agronomic performance under elevated *Aphanomyces* root rot pressure; Carrington, ND (2025)
 small-plot study: each variety planted to 10 ft x 30 ft plots (paired 5-ft plots seeded to non-treated and fungicide-treated seed); 6 replicates

Carrington, ND 'field 17' (2025)

Each variety was assessed as a pair of plots within each replicate, with and without seed treatment
 Plot sizes: 30 feet long x 5 feet wide at seeding. Number of experimental replicates = 6.

ROOT ROT INCIDENCE & SEVERITY

ACTIVE RHIZOBIUM NODULATION

	Planting date #1		Planting Date #2		Planting date #1		Planting Date #2		
	April 24, 44.8°F		May 4, 62.3°F		April 24, 44.8°F		May 4, 62.3°F		
	June 11		June 24		June 11		June 24		
	mid-vegetative growth (11-12 nodes)		late vegetative growth (12-17 nodes)		mid-vegetative growth (11-12 nodes)		late vegetative growth (12-17 nodes)		
	% of plants	% sev index	% of plants	% sev index	% of plants	% nodules	% of plants	% nodules	
PERFORMANCE OF FIELD PEA VARIETIES: average across peas grown from non-treated and fungicide-treated seed									
AAC Goldstorm	94 a*	72 ab*	99 a*	90 a*	76 a*	34 b*	36 a*	11 a*	
AAC Harrison	85 a	55 ab	96 a	75 a	86 a	40 ab	50 a	17 a	
AAC IronHorse	81 a	52 ab	95 a	74 a	91 a	58 ab	45 a	18 a	
AAC McMurphy	84 a	56 ab	100 a	91 a	84 a	42 ab	43 a	10 a	
AAC Profit	87 a	73 ab	96 a	80 a	81 a	49 ab	47 a	16 a	
Orchestra	82 a	64 ab	97 a	79 a	85 a	58 ab	42 a	16 a	
PG Bank	87 a	61 ab	99 a	84 a	83 a	45 ab	37 a	9 a	
PG Cash	89 a	75 ab	100 a	95 a	85 a	48 ab	31 a	7 a	
PG Greenback	78 a	47 a	96 a	67 a	90 a	62 a	60 a	22 a	
Prairie	91 a	70 ab	100 a	89 a	78 a	42 ab	20 a	6 a	
Salamanca	86 a	75 ab	100 a	85 a	70 a	36 ab	29 a	8 a	
AAC Julius	88 a	73 ab	95 a	80 a	78 a	43 ab	37 a	11 a	
Iconic	96 a	79 b	98 a	93 a	69 a	37 ab	18 a	4 a	
	F, P>F:	0.84, 0.6092	2.59, 0.0138	1.09, 0.3941	1.28, 0.2716	1.38, 0.2212	2.40, 0.0210	1.36, 0.2290	1.15, 0.3571
	CV:	19.2	21.1	4.9	15.1	11.4	21.9	50.0	40.2
Response to fungicide seed treatment: average across 13 field pea varieties									
Non-treated seed	92 b*	67 a*	98 a*	83 a*	81 a*	45 a*	39 a*	12 a*	
VibranceMaxx Pulses + Vayantis	82 a	64 a	97 a	83 a	81 a	47 a	37 a	12 a	
	F, P>F:	9.14, 0.0044	1.83, 0.1836	1.48, 0.2316	0.00, 0.9564	0.07, 0.7922	0.94, 0.3374	0.09, 0.7605	0.16, 0.6945
	CV:	19.2	21.1	4.9	15.1	11.4	21.9	50.0	40.2

Carrington, ND 'field Q9B' (2025)

Each variety was assessed as a pair of plots within each replicate, one plot with and one plot without fungicide seed treatment.
 Plot sizes: 30 feet long x 5 feet wide at seeding. Number of experimental replicates = 6.

ROOT ROT: % of plants with root rot; % root rot severity

NODULATION: % of plants with active nodulation; % of nodules that are active

	Planting date #1		Planting Date #2		Planting date #1		Planting Date #2			
	April 23, 43.2°F		May 4, 60.1°F		April 23, 43.2°F		May 4, 60.1°F			
	June 12-13; mid-vegetative assessments were taken: growth (9-12 nodes)		June 19; mid-vegetative growth (10-12 nodes)		June 12-13; mid-vegetative growth (9-12 nodes)		June 19; mid-vegetative growth (10-12 nodes)			
	% of plants	% sev index	% of plants	% of plants	% sev index	% of plants	% nodules	% of plants	% nodules	
PERFORMANCE OF FIELD PEA VARIETIES: average across peas grown from non-treated and fungicide-treated seed										
AAC Goldstorm	56 a*	16 a*	0	92 ab*	48 a*	0	95 a*	64 a*	78 a*	38 a*
AAC Harrison	55 a	21 a	5	93 ab	65 a	2	87 a	38 ab	63 a	25 a
AAC Julius	73 a	40 a	2	78 ab	52 a	0	86 a	39 ab	79 a	36 a
AAC McMurphy	68 a	37 a	0	76 a	41 a	0	94 a	53 ab	79 a	42 a
AAC Profit	57 a	18 a	0	96 ab	63 a	0	95 a	60 ab	79 a	40 a
ICONIC	68 a	31 a	0	98 ab	73 a	6	86 a	48 ab	60 a	23 a
ND Victory	68 a	36 a	3	99 b	56 a	0	86 a	32 b	72 a	26 a
NDP140510Y	63 a	23 a	0	88 ab	53 a	2	87 a	38 ab	71 a	33 a
NDP150231Y	79 a	47 a	5	90 ab	61 a	0	87 a	38 ab	60 a	29 a
NDP150412G	67 a	26 a	0	95 ab	55 a	0	92 a	48 ab	80 a	37 a
Nette	61 a	31 a	3	85 ab	61 a	0	86 a	42 ab	71 a	39 a
Orchestra	62 a	25 a	3	96 ab	59 a	0	90 a	60 ab	83 a	43 a
PG Bank	79 a	46 a	0	92 ab	56 a	2	81 a	44 ab	85 a	41 a
PG Cash	65 a	41 a	0	96 ab	68 a	6	87 a	46 ab	70 a	26 a
PG Greenback	61 a	22 a	0	85 ab	46 a	0	95 a	60 ab	71 a	41 a
Prairie	76 a	40 a	8	83 ab	40 a	0	88 a	51 ab	80 a	39 a
Salamanca	65 a	31 a	5	96 ab	73 a	0	84 a	58 ab	47 a	19 a
	F, P>F:	0.84, 0.6406	1.48, 0.1486	1.9, 0.0438	0.81, 0.6627		1.09, 0.3908	2.26, 0.0150	0.94, 0.5362	1.03, 0.4433
	CV:	27.3	46.2	13.4	36.6		13.1	26.8	20.4	39.0
Response to fungicide seed treatment: average across 17 field pea varieties										
Non-treated seed	78 b*	39 b*	3	95 b*	60 b*	2	87 a*	45 b*	73 a*	35 a*
VibranceMaxx Pulses + Vayantis	54 a	24 a	1	86 a	54 a	0	90 a	51 a	71 a	33 a
	F, P>F:	56.83, <0.0001	36.46, <0.0001	18.1, <0.0001	2.28, 0.1369		2.26, 0.1387	6.29, 0.0154	1.07, 0.3067	0.3, 0.5891
	CV:	27.3	46.2	13.4	36.6		13.1	26.8	20.4	39

* Within-column means followed by different letters are significantly different (P < 0.05; Tukey multiple comparison procedure).

METHODS – on-farm study conducted near Webster, ND (2025)

GPS coordinates: 48.2368, -98.8791 (plot 101); approximately 3 miles south of Webster, ND

Description: approximately 3 miles south of Webster, ND

PATHOGEN PRESSURE

Native pathogen pressure This study was established in a field that exhibited severe losses to *Aphanomyces* root rot when it was seeded to field peas in 2024. All disease was due to ambient, native pathogen pressure.

Characterization and quantification of the pathogens contributing to observed root rot symptoms: Pathogen diagnostic testing via qPCR was conducted by the National Agricultural Genotyping Center in Fargo, ND. Pathogen diagnostic testing was conducted in the large-plot study, with one sample submitted from each field pea variety in each experimental replicate in each planting date of the study (total 8 samples submitted for testing per variety). Epicotyl sections were excised in conjunction with root rot severity assessments. Each sample consisted of 2, 6, or 7 sections of diseased epicotyl tissue, each 1 cm long. Disease tissue characteristic of typical disease symptoms observed in the corresponding plot was selected. For PG Greenback, Iconic, AAC Julis and Salamanca, the epicotyl tissue sample consisted of one epicotyl section from each of the each of the seven plots with different seed treatments tested on that variety within the corresponding experimental replicate (total of 7 epicotyl sections). For AAC IronHorse, the epicotyl tissue sample consisted of three epicotyl sections (planting date #1) or one epicotyl section (planting date #2) from each of the each of the two plots with different seed treatments tested on that variety within the corresponding experimental replicate (total of 2 or 6 epicotyl sections).

Average pathogen levels in symptomatic epicotyl tissue as detected by qPCR across the full study (5 field pea varieties, 2 planting dates) are presented below. For detailed results broken down by planting date, field pea variety, and sample, see the tab labeled 'pathogen diagnostic testing'.

Aphanomyces euteiches: 24,386,018 target copies per gram of epicotyl tissue

Fusarium acuminatum: 46,602 target copies per gram of epicotyl tissue

Fusarium avenaceum: 250 target copies per gram of epicotyl tissue

Phoma medicaginis: 0 target copies per gram of epicotyl tissue

Pythium spp. 0 target copies per gram of epicotyl tissue

Rhizoctonia solani: 214,981 target copies per gram of epicotyl tissue

Fusarium oxysporum: 24,510 target copies per gram of epicotyl tissue

Fusarium redolens: 27,996 target copies per gram of epicotyl tissue

Fusarium solani: 176 target copies per gram of epicotyl tissue

Interpretation of the results: The results suggest that *Aphanomyces* was a major contributor to the observed native pathogen pressure in this study, *Rhizoctonia* was a moderate contributor to the observed native pathogen pressure in this study, and *Fusarium* was a minor contributor to the native pathogen pressure in this study. The low levels of *F. oxysporum* suggest that *Fusarium oxysporum* vascular wilt was not an important contributor to the observed differences in field pea wilt, vigor or yield. The qPCR testing did not detect any *Pythium*, but the sampling was not conducted in a manner that would have permitted proper quantification of the levels of *Pythium* pressure. *Pythium* spp. primarily causes seed decay and damping-off in field peas, not root rot in established plants. To detect *Pythium*, testing would need to be conducted on seeds and germinating seeds exhibiting seed decay and damping-off.

AGRONOMICS:

Previous crop field peas followed by a cover crop

Tillage This study was direct-seeded into residues of a cover crop seeded the previous fall. The cooperating grower managed this field under conventional tillage.

Experimental design: Small-plot variety screening: Randomized complete block with a split-plot arrangement; main factor = field pea variety, sub-factor = fungicide seed treatment. Number of experimental replicates = 5. Large-plot study: Randomized complete block with a split-split-plot arrangement; main factor = planting date, sub-factor = field pea variety, sub-sub-factor = fungicide seed treatment. Number of experimental replicates = 4.

Fertility: No fertilizer was applied. Granular *Rhizobium* inoculant was applied in-furrow with the seed at planting in accordance with the manufacturer's application instructions. *Rhizobium* inoculant brand: Lalfix Start Spherical Pulses. Manufacturer: Lallemand Plant Care. Type: granular. Active ingredients (<1% w/w): 7.5×10^7 CFU/g *Rhizobium leguminosarum* bv. viciae, 7.5×10^7 CFU/g *Mesorhizobium ciceri*, 5.0×10^7 CFU/g *Bacillus velezensis*. Other ingredients (>99% w/w): an undefined carrier. Application rate: 7.36 lb/ac. The manufacturer's recommended application rate for the 7.5-inch row spacing utilized: 3.55 lb/ac

Row spacing: Plots consisted of 7 rows, each 7.5 inches apart

Planter type: Cone-type planter

Plot size: Large-plot study: 150 feet x 5 feet at seeding; average 134.5 feet at harvest. The field pea varieties Salamanca, Iconic, AAC Julis, and PG Greenback were seeded in blocks 35 feet wide x 150 feet long in each replicate of each planting date, with the 35-foot wide block consisting of 7 strips, each 5 feet wide, planted to non-treated seed or seed treated with one of six different fungicide seed treatments.

Small-plot study: 30 feet x 5 feet at seeding; average 21.5 feet at harvest. All varieties were seeded in blocks 10 feet wide x 30 feet long in each experimental replicate, with the 10-foot wide block consisting of 2 plots, each 5 feet wide, planted to non-treated seed or seed treated with seed treated with the fungicide seed treatments 'VibranceMaxx Pulses RTA' @ 5.0 fl oz/cwt + 'Vayantis' @ 0.1 fl oz/cwt.

Seeding rate: 330,000 viable seeds/ac.

Planting date, seeding depth: The first planting date (May 4) was one of the first days that soils had dried enough to permit planting. This date corresponded to the start of planting in this area; the cooperating producer seeded the surrounding field to wheat the same day, and few, if any, of the neighboring fields had been seeded by this date. By the second planting date (May 12-13), most of the neighboring fields had been seeded.

- Early planting date, small-plot study: May 4, 10:00 am - noon. Seeding depth = approx. 2.0-2.5 inches. We had significant problems with the planter plugging due to very high soil moisture at this seeding depth. This resulted in skipped rows in many plots; due to the skipped rows, this planting date of this study was abandoned.
- Early planting date, large-plot study: May 4, noon - 8:30 pm. Seeding depth = approx. 1.5 inches. The shallower seeding depth eliminated the problems with plugging, resulting in a successful planting.
- Late planting date, small-plot study: May 12, 3:30-4:30 pm Seeding depth = approx. 2.0 inches.
- Late planting date, large-plot study: May 12, 7:00-10:00 pm (replicates 1 and 2); May 13, 8:30-11:30 am (replicates 3 and 4). Seeding depth = approx. 2.0 inches.

Soil temperature: Soil temperature assessment methods: WatchDog B100 temperature data logger soil temperature sensors (Spectrum Technologies; Aurora, IL) programmed to record soil temperatures once every 2 hours were installed in non-harvested guard plots within each experimental replicate of each planting date (total 4 sensors per planting date). Sensors were installed approx. 2 inches below the surface immediately after planting.

Average soil temperature, first 7 days after planting: 58.0°F for the first planting date, 51.2°F for the second planting date.

Average soil temperature, first 30 days after planting: 58.0°F for the first planting date, 58.4°F for the second planting date.

PEST MANAGEMENT

Weed management

- Pre-emergence herbicide, planting date #1: Aquesta 4F (sulfentrazone, 4 lbs a.i./gal) @ 4 fl oz/ac + Glory (metribuzin, 75% by weight) @ 4 oz/ac + Buchaneer 5 Extra (glyphosate, 5.4 lbs/gal of its isopropylamine salt, equivalent to 4.0 lbs/gal of the acid; Tenkoz, Inc., Alpharetta, GA), 32 fl oz/ac + 2.5% v/v ClassAct NG (ammonium sulfate, 50.5%; Winfield Solutions, River Falls, WI) applied on May 7 in 20 gal/ac
- Pre-emergence herbicide, planting date #2: Not applied. We drove to the site to apply the PRE herbicide shortly after planting but had to return without spraying due to unexpectedly strong winds.
- Post-emergence grass herbicide, planting date #1: Targa (quizalofop-p-ethyl, 0.88 lb ai/gal; Gowan Corp., Yuma, AZ) @ 12 fl oz/ac + COC @ 12 fl oz/ac, applied June 26 in 20 gal/ac. This application was made late when foxtail was already several inches tall. Because the peas were entering bloom, clethodim was not applied.
- Post-emergence grass herbicide, planting date #2: Targa (quizalofop-p-ethyl, 0.88 lb ai/gal; Gowan Corp., Yuma, AZ) @ 12 fl oz/ac + Trizenta 3EC (clethodim, 3 lbs ai/gal; Arysta LifeScience, Cary, NC) @ 5 fl oz/ac + COC @ 12 fl oz/ac, applied June 26 in 20 gal/ac
- Post-emergence broadleaf herbicide, planting date #1: Not applied.
- Post-emergence broadleaf herbicide, planting date #2: Basagran (sodium salt of bentazon, 4 lbs ai/gal; Arysta LifeScience Cary, NC) @ 12 fl oz/ac + Metalis 21.3 fl oz/ac (S-metolachlor, 7.62 lbs a.i./gal) + MSO @ 24 fl oz/ac + AMS 8.5 lbs/100 gal, applied July 2 in 15 gal/ac
- Significant supplemental hand weeding was conducted throughout the season.

Weed management was not satisfactory as field peas entered mid to late pod-fill. Windy conditions during May and June resulted in a limited number of days with acceptable wind conditions. Wind conditions were similar in Webster and Carrington; the days with acceptable conditions for spraying were the same across sites. With only one sprayer available for our plot research, we often had to complete our spraying in Carrington on the days with acceptable wind conditions, limiting our ability to accomplish timely spraying at this on-farm study near Webster. To ensure that this problem does not occur again, we are adding a second plot sprayer to our program. In the winter 2025-26, we are building a second sprayer and procuring the associated tractor such that we will be able to make applications in Carrington and on-farm sites on the same days using different sprayers.

IN-SEASON NOTES

Wilt: Large-plot study: The percent of plants exhibiting wilt symptoms was visually estimated on July 16-17 when 90-100% of pods were fully filled in planting date #1 and on July 23 when 87-100% of pods were fully filled in planting date #2. Small-plot study: The percent of plants exhibiting wilt symptoms was visually estimated on July 21 when 90-100% of pods were fully filled.

Vigor: Large-plot study: Assessed as a percentage relative to optimal (perfect) vigor. Assessments were made on July 16-17 when 90-100% of pods were fully filled in planting date #1 and on July 24 when 87-100% of pods were fully filled in planting date #2. Small-plot study: The percent of plants exhibiting wilt symptoms was visually estimated on July 21 when 90-100% of pods were fully filled.

Active nodulation: Active Rhizobium nodulation only assessed in the large-plot study. Roots were collected from each end of plots outside of the area assessed for yield. Planting date #1: Plants were dug on JPlants were dug on June 8 when peas had 7-8 nodes and washed & evaluated on June 10-11. Planting date #2: Plants were dug on June 25 when peas had 8-10 nodes and were washed & evaluated on June 27. Roots were washed carefully, and the percent of nodules that had the fleshy, pink appearance characteristic of active nodules engaged in nitrogen fixation was visually evaluated. For each plot, the number of plants in which approximately 0%, 1-33%, 34-67%, 68-99% and 100% of the nodules appeared active was recorded. On average, 14 plants were evaluated per plot.

Root rot assessments: Root rot severity was only assessed in the large-plot study. Roots were collected from each end of plots outside of the area assessed for yield. Planting date #1: Plants were dug on June 8 when peas had 7-8 nodes and washed & evaluated for root rot severity on June 10-11. Planting date #2: Plants were dug on June 25 when peas had 8-10 nodes and were washed & evaluated for root rot severity on June 27. The length of the epicotyl plus top 2.5 cm of the tap root was recorded for 3 representative plants per plot. The length that was diseased along this length was recorded on an average 14 plants per plot.

HARVEST:

Harvest date: August 19-20, 2025. Harvested with a Zurn plot combine equipped with a Harvestmaster system. The Harvestmaster system provides accurate assessments of yield but not test weight or moisture. A subsample was taken from each plot and assessed for moisture on a calibrated GAC benchtop grain quality assessment unit (Dickey-John; Auburn, IL) and assessed for protein and test weight on a calibrated FOSS benchtop grain quality assessment unit (FOSS North America; Eden Prairie, MN).

Seed yield and quality: Yields were calculated on the basis of a 5-ft plot width and the measured plot length, and seed moisture was assessed after grain was cleaned. Seed yield and test weight were adjusted from the grain actual moisture to a standard 13.5% moisture level.

STATISTICAL ANALYSIS

Analysis of variance Data were evaluated with analysis of variance. (1) The assumption of constant variance was assessed with Levene's test for homogeneity of variances and visually confirmed by plotting residuals against predicted values. (2) The assumption of normality was assessed the Shapiro-Wilk test and visually confirmed with a normal probability plot. (3) The assumption of additivity of main-factor effects across replicates (no replicate-by-treatment interaction) was evaluated with Tukey's test for nonadditivity. If data did not meet model assumptions, a systematic natural-log transformation was applied to correct deviations from normality and/or homoskedasticity, and analysis of variance was conducted on the transformed data. Data subjected to a systematic natural-log transformation are identified by the symbol '‡' placed at the top of the applicable column of data in the summary table; for ease of transformation, treatments for non-transformed data are presented in the summary table. All other data met model assumptions. Single-degree-of-freedom contrasts were performed for all pairwise comparisons of isolates; to control the Type I error rate at the level of the experiment, the Tukey multiple comparison procedure was employed. Analyses were conducted with replicate and treatment as main factor effects, and they were implemented in PROC UNIVARIATE and PROC GLM of SAS (version 9.4; SAS Institute, Cary, NC).

METHODS – on-farm study conducted near Makoti, ND (2025)

GPS coordinates: 47.8329, -101.8832; northeast corner of study (plot 101 of small-plot study)

Description: approximately 12 miles southwest of Makoti, ND

PATHOGEN PRESSURE

Native pathogen pressure This study was established in a field with a long history of field pea and lentil production; losses to *Aphanomyces* root rot were observed the last time these crops were grown. All disease was due to native pathogen pressure.

Characterization and quantification of the pathogens contributing to observed root rot symptoms: Pathogen diagnostic testing via qPCR was conducted by the National Agricultural Genotyping Center in Fargo, ND. Pathogen diagnostic testing was conducted in the large-plot study, with one sample submitted from each field pea variety in each experimental replicate in each planting date of the study (total 8 samples submitted for testing per variety). Epicotyl sections were excised in conjunction with root rot severity assessments. Each sample consisted of 2, 6, or 7 sections of diseased epicotyl tissue, each 1 cm long. Disease tissue characteristic of typical disease symptoms observed in the corresponding plot was selected. For PG Greenback, Iconic, AAC Julius and Salamanca, the epicotyl tissue sample consisted of one epicotyl section from each of the each of the seven plots with different seed treatments tested on that variety within the corresponding experimental replicate (total of 7 epicotyl sections). For AAC IronHorse, the epicotyl tissue sample consisted of three epicotyl sections from each of the each of the two plots (planting date #1) or one epicotyl section from each of the two plots (planting date #2) with different seed treatments tested on that variety within the corresponding experimental replicate (total of 2 or 6 epicotyl sections).

Average pathogen levels in symptomatic epicotyl tissue as detected by qPCR across the full study (5 field pea varieties, 2 planting dates) are presented below. For detailed results broken down by planting date, field pea variety, and sample, see the tab labeled 'pathogen diagnostic testing'.

Aphanomyces euteiches: 3,992,473 target copies per gram of epicotyl tissue

Fusarium acuminatum: 0 target copies per gram of epicotyl tissue

Fusarium avenaceum: 0 target copies per gram of epicotyl tissue

Phoma medicaginis: 0 target copies per gram of epicotyl tissue

Pythium spp. 0 target copies per gram of epicotyl tissue

Rhizoctonia solani: 25,819 target copies per gram of epicotyl tissue

Fusarium oxysporum: 16,816 target copies per gram of epicotyl tissue

Fusarium redolens: 22,417 target copies per gram of epicotyl tissue

Fusarium solani: 0 target copies per gram of epicotyl tissue

Interpretation of the results: The results suggest that *Aphanomyces* was a major contributor to the observed native pathogen pressure in this study and that *Rhizoctonia* and *Fusarium* were minor contributors to the observed native pathogen pressure in this study. The low levels of *F. oxysporum* suggest that *Fusarium oxysporum* vascular wilt was not an important contributor to the observed differences in field pea wilt, vigor or yield. The qPCR testing did not detect any *Pythium*, but the sampling was not conducted in a manner that would have permitted proper quantification of the levels of *Pythium* pressure. *Pythium* spp. primarily causes seed decay and damping-off in field peas, not root rot in established plants. To detect *Pythium*, testing would need to be conducted on seeds and germinating seeds exhibiting seed decay and damping-off.

AGRONOMICS:

Previous crop hard red winter wheat (2024). The last time peas or lentils were grown in this field was 2022, when field peas were grown.

Tillage Long-term no-till

Experimental design: Small-plot variety screening: Randomized complete block with a split-plot arrangement; main factor = field pea variety, sub-factor = fungicide seed treatment. Number of experimental replicates = 5. Each planting date was established as a separate study. Large-plot study: Randomized complete block with a split-split-plot arrangement; main factor = planting date, sub-factor = field pea variety, sub-sub-factor = fungicide seed treatment. Number of experimental replicates = 4.

Soil fertility Nitrogen, 26 lbs/ac in the top 12 inches (13 lbs/ac at 0-6 in. deep, 13 lbs/ac at 6-12 in. deep); phosphorous, 14 ppm; potassium, 182 ppm; chloride, 3 lbs/ac at 0-6 in. deep and 3 lbs/ac at 6-12 in. deep; sulfur, 12 lbs/ac at 0-6 in. deep and 12 lbs/ac at 6-12 in. deep; cooper, 0.53 ppm; organic matter, 4.4%; soluble salts, 0.12 mmho/cm at 0-6 in. deep and 0.17 mmho/cm at 6-12 in. deep. organic matter, 4.4%; pH, 0-6 in. deep = 6.4; pH, 6-12 in. deep = 7.5

Soil texture medium soil texture: loam; 45% sand, 38% silt, 17% clay

Fertility: No fertilizer was applied. Granular Rhizobium inoculant was applied in-furrow with the seed at planting in accordance with the manufacturer's application instructions. Rhizobium inoculant brand: Lalfix Start Spherical Pulses. Manufacturer: Lallemand Plant Care. Type: granular. Active ingredients (<1% w/w): 7.5×10^7 CFU/g *Rhizobium leguminosarum* bv. *viciae*, 7.5×10^7 CFU/g *Mesorhizobium ciceri*, 5.0×10^7 CFU/g *Bacillus velezensis*. Other ingredients (>99% w/w): an undefined carrier. Application rate: 7.36 lb/ac. The manufacturer's recommended application rate for the 7.5-inch row spacing utilized: 3.55 lb/ac

Row spacing: Plots consisted of 7 rows, each 7.5 inches apart

Planter type: Cone-type planter

Plot size: Large-plot study: 150 feet x 5 feet at seeding; average 142.0 feet at harvest. The field pea varieties Salamanca, Iconic, AAC Julius, and PG Greenback were seeded in blocks 35 feet wide x 150 feet long in each replicate of each planting date, with the 35-foot wide block consisting of 7 strips, each 5 feet wide, planted to non-treated seed or seed treated with one of six different fungicide seed treatments.

Small-plot study: 30 feet x 5 feet at seeding; average 23.6 feet at harvest. All varieties were seeded in blocks 10 feet wide x 30 feet long in each experimental replicate, with the 10-foot wide block consisting of 2 plots, each 5 feet wide, planted to non-treated seed or seed treated with the fungicide seed treatments 'VibranceMaxx Pulses RTA' @ 5.0 fl oz/cwt + 'Vayantis' @ 0.1 fl oz/cwt.

Seeding rate: 330,000 viable seeds/ac.

Planting date, seeding depth: Commentary on first planting date (April 25): This date corresponded to the start of significant planting in this area; approximately 10-15% of fields had been planted by this date. Commentary on the second planting date (May 11 and 13): By the second planting date, most of the neighboring fields had been seeded.

- Early planting date, small-plot study: April 25, 10:00 am - noon. Seeding depth = approx. 1.6 inches. A relatively shallow planting date was utilized on April 25 because soil moisture was high, and deeper planting would have increased planting problems (plugged rows).
- Early planting date, large-plot study: April 25, noon to 8:00 pm. Seeding depth = approx. 1.6 inches. A relatively shallow planting date was utilized on April 25 because soil moisture was high, and deeper planting would have increased planting problems (plugged rows).

- Late planting date, small-plot study: May 11, 1:00-2:30 pm, and May 13, 4:30-5:30 pm. The first four planter passes of the small-plot variety screening were seeded on May 11. Planting was not finished that day due to problems with the planter that could not be resolved on-site, and planting was finished on May 13. Seeding depth = approx. 2 inches.
- Late planting date, large-plot study: May 13, 5:30-9:30 pm. Seeding depth = approx. 2 inches.

Soil temperature: Soil temperature assessment methods: WatchDog B100 temperature data logger soil temperature sensors (Spectrum Technologies; Aurora, IL) programmed to record soil temperatures once every 2 hours were installed in non-harvested guard plots within each experimental replicate of each planting date (total 4 sensors per planting date). Sensors were installed approx. 2 inches below the surface immediately after planting. The reported soil temperatures in the first 7 days and first 30 days after planting are the average values across four soil sensors (planting date #1) and three soil sensors (planting date #2); one of the four soil sensors installed in the second planting date failed during the growing season.

Average soil temperature, first 7 days after planting: 47.3°F for the first planting date, 47.1°F for the second planting date.

Average soil temperature, first 30 days after planting: 51.8°F for the first planting date, 54.4°F for the second planting date.

PEST MANAGEMENT

Weed management Pre-emergence herbicide, planting date #1: Aquesta 4F (sulfentrazone, 4 lbs a.i./gal) @ 4 fl oz/ac + Glory (metribuzin, 75% by weight) @ 4 oz/ac applied on April 25 in 20 gal/ac

Very windy conditions in spring 2025 resulted in a limited number of days with wind conditions that were acceptable for conducting applications to a planting date study, in which even trace levels of drift cannot extend beyond the 5-foot-wide guard plots established on the edge of each planting date. Weed pressure was very low in this study, and hand weeding was conducted as needed throughout the season to maintain acceptable weed management. We only had one plot sprayer in 2025 and had to prioritize where we sprayed (Carrington, this on-farm site or the other field pea root rot on-farm study near Webster) on the limited number of days with acceptable wind conditions. To avoid this problem in 2026, we are currently in the process of purchasing a tractor that can be utilized for plot sprayer and refurbishing a sprayer to be utilized with that tractor. In 2026, we will have the ability to make pesticide applications both in Carrington and at on-farm sites concurrently.

Supplemental hand weeding was conducted throughout the season.

IN-SEASON NOTES

Wilt: The percent of plants exhibiting wilt symptoms was visually estimated on July 15 when 95-98% of pods were fully filled in planting date #1 and on July 25 when 95-98% of pods were fully filled in planting date #2.

Vigor: Assessed as a percentage relative to optimal vigor. Assessments were made on July 15 when 95-98% of pods were fully filled in planting date #1 and on July 25 when 95-98% of pods were fully filled in planting date #2.

Active nodulation: Active Rhizobium nodulation only assessed in the large-plot study. Roots were collected from each end of plots outside of the area assessed for yield. Planting date #1: Plants were dug on June 26 when peas were at early bloom and washed & evaluated on June 30. Planting date #2: Plants were dug on June 26 when peas had 8-11 nodes and were washed & evaluated on June 30. Roots were washed carefully, and the percent of nodules that had the fleshy, pink appearance characteristic of active nodules engaged in nitrogen fixation was visually evaluated. For each plot, the number of plants in which approximately 0%, 1-33%, 34-67%, 68-99% and 100% of the nodules appeared active was recorded. On average, 13.7 plants were assessed per plot.

Root rot assessments: Root rot severity was only assessed in the large-plot study. Roots were collected from each end of plots outside of the area assessed for yield. Planting date #1: Plants were dug on June 3 when peas had 3-6 nodes and washed & evaluated for root rot severity on June 6. Planting date #2: Plants were dug on June 26 when peas had 8-11 nodes and were washed & evaluated for root rot severity on June 30. The length of the epicotyl plus top 2.5 cm of the tap root was recorded for 3 representative plants per plot. The length that was diseased along this length was recorded. On average, 13.6 plants were assessed per plot.

HARVEST:

Harvest date:

Small-plot study, planting date #1: August 6

Small-plot study, planting date #2: August 23

Large-plot study, planting date #1: August 6

Large-plot study, planting date #2: August 22

Harvested with a Zurn plot combine equipped with a Harvestmaster system. The Harvestmaster system provides accurate assessments of yield but not test weight or moisture. A subsample was taken from each plot and assessed for moisture on a calibrated GAC benchtop grain quality assessment unit (Dickey-John; Auburn, IL) and assessed for protein and test weight on a calibrated FOSS benchtop grain quality assessment unit (FOSS North America; Eden Prairie, MN).

Seed yield and quality: Yields were calculated on the basis of a 5-ft plot width and the measured plot length, and seed moisture was assessed after grain was cleaned. Seed yield and test weight were adjusted from the grain actual moisture to a standard 13.5% moisture level.

STATISTICAL ANALYSIS

Analysis of variance Data were evaluated with analysis of variance. (1) The assumption of constant variance was assessed with Levene's test for homogeneity of variances and visually confirmed by plotting residuals against predicted values. (2) The assumption of normality was assessed the Shapiro-Wilk test and visually confirmed with a normal probability plot. (3) The assumption of additivity of main-factor effects across replicates (no replicate-by-treatment interaction) was evaluated with Tukey's test for nonadditivity. If data did not meet model assumptions, a systematic natural-log transformation was applied to correct deviations from normality and/or homoskedasticity, and analysis of variance was conducted on the transformed data. Data subjected to a systematic natural-log transformation are identified by the symbol '†' placed at the top of the applicable column of data in the summary table; for ease of transformation, treatments for non-transformed data are presented in the summary table. All other data met model assumptions. Single-degree-of-freedom contrasts were performed for all pairwise comparisons of isolates; to control the Type I error rate at the level of the experiment, the Tukey multiple comparison procedure was employed. Analyses were conducted with replicate and treatment as main factor effects, and they were implemented in PROC UNIVARIATE and PROC GLM of SAS (version 9.4; SAS Institute, Cary, NC).

METHODS – Carrington, ND (2025), field 17

GPS coordinates: 47.50171, -99.12297; southwest corner of study (plot 101)

Description: approximately 3 miles north of Carrington, ND

PATHOGEN PRESSURE

Native pathogen pressure This study was established in a field with a long history of field pea and lentil production; losses to Aphanomyces root rot were observed the last time these crops were grown. All disease was due to native pathogen pressure. Characterization and quantification of the pathogens contributing to observed root rot symptoms: Pathogen diagnostic testing via qPCR was conducted by the National Agricultural Genotyping Center in Fargo, ND.

Pathogen diagnostic testing was conducted on diseased epicotyl tissue collected from four replicates in planting dates #1 and #2.

Testing was conducted on epicotyl sections excised from field peas exhibiting root rot symptoms characteristic of the typical symptoms observed in that plot. Epicotyl sections were excised in conjunction with root rot severity assessments. For all varieties other than 'AAC Julius' and 'Iconic', two pathogen diagnostic tests were conducted per field pea variety in each of planting dates #1 and #2. Every diagnostic testing sample consisted of 8 sections of epicotyl tissue: 2 epicotyl sections collected from plants grown from non-treated seed + 2 epicotyl sections collected from plants grown from fungicide treated seed (VibranceMaxx Pulses RTA + Vayantis) in each of two different experimental replicates. For the varieties 'AAC Julius' and 'Iconic', four pathogen diagnostic tests were conducted per field pea variety in each of planting dates #1 and #2. Two of the diagnostic tests (per planting date) consisted of 8 sections of epicotyl tissue: 2 epicotyl sections collected from plants grown from non-treated seed + 2 epicotyl sections collected from plants grown from fungicide treated seed (VibranceMaxx Pulses RTA + Vayantis) in each of two different experimental replicates. Two of the diagnostic tests (per planting date) consisted of 14 sections of epicotyl tissue: 1 epicotyl section collected from peas grown from non-treated seed and peas grown from six different fungicide seed treatments in each of two different experimental replicates.

Average pathogen levels in symptomatic epicotyl tissue as detected by qPCR across the full study (13 field pea varieties, planting dates #1 and #2) are presented below. For detailed results broken down by planting date, field pea variety, and sample, see the tab labeled 'pathogen diagnostic testing'.

Aphanomyces euteiches: 13,717,310 target copies per gram of epicotyl tissue

Fusarium acuminatum: 6,800 target copies per gram of epicotyl tissue

Fusarium avenaceum: 2,333 target copies per gram of epicotyl tissue

Phoma medicaginis: 0 target copies per gram of epicotyl tissue

Pythium spp. 423 target copies per gram of epicotyl tissue

Rhizoctonia solani: 40,637 target copies per gram of epicotyl tissue

Fusarium oxysporum: 24,508 target copies per gram of epicotyl tissue

Fusarium redolens: 6,170 target copies per gram of epicotyl tissue

Fusarium solani: 334 target copies per gram of epicotyl tissue

Interpretation of the results: The results suggest that Aphanomyces was a major contributor to the observed native pathogen pressure in this study and that Rhizoctonia and Fusarium were minor contributors to the observed native pathogen pressure in this study. The low levels of F. oxysporum suggest that Fusarium oxysporum vascular wilt was not an important contributor to the observed differences in field pea wilt, vigor or yield. The qPCR testing detected Pythium at only very low levels, but the sampling was not conducted in a manner that would have permitted proper quantification of the levels of Pythium pressure. Pythium spp. primarily causes seed decay and damping-off in field peas, not root rot in established plants. To properly quantify Pythium pressure, testing would need to be conducted on seeds and germinating seeds exhibiting seed decay and damping-off.

AGRONOMICS:

Previous crop Forage barley (2024). The last time peas or lentils were grown in this field was 2021, when field peas were grown.

Significant losses to Aphanomyces root rot were experienced when the field was seeded to peas in 2021.

Soil fertility Nitrogen, 23 lbs/ac in the top 18 inches (18 lbs/ac at 0-6 in. deep, 5 lbs/ac at 6-18 in. deep); phosphorous, 44 ppm; potassium, 323 ppm; sulfur, 13 lbs/ac at 0-6 in. deep and 20 lbs/ac at 6-12 in. deep; zinc, 2.59 ppm; boron, 0.75 ppm; soluble salts, 0.26 mmho/cm at 0-6 in. deep and 0.26 mmho/cm at 6-12 in. deep. organic matter, 4.25%; pH, 0-6 in. deep = 7.5; pH, 6-18 in. deep = 8.1

Fertility: No fertilizer was applied. Granular Rhizobium inoculant was applied in-furrow with the seed at planting in accordance with the manufacturer's application instructions. Rhizobium inoculant brand: Lalfix Start Spherical Pulses. Manufacturer: Lallemand Plant Care. Type: granular. Active ingredients (<1% w/w): 7.5×10^7 CFU/g Rhizobium leguminosarum bv. viciae, 7.5×10^7 CFU/g Mesorhizobium ciceri, 5.0×10^7 CFU/g Bacillus velezensis. Other ingredients (>99% w/w): an undefined carrier. Application rate: 7.36 lb/ac. The manufacturer's recommended application rate for the 7.5-inch row spacing utilized: 3.55 lb/ac

Tillage This study was direct-seeded into forage barley stubble in a field that has traditionally been managed with conventional tillage. Experimental design: Randomized complete block with a split-split-plot arrangement; main factor = planting date, sub-factor = field pea variety, sub-sub-factor = fungicide seed treatment. Number of experimental replicates = 6.

Row spacing: Plots consisted of 7 rows, each 7.5 inches apart

Planter type: Cone-type planter

Plot size: 30 feet x 5 feet at seeding; average 22.0 feet at harvest. All varieties were seeded in blocks 10 feet wide x 30 feet long in each experimental replicate, with the 10-foot wide block consisting of 2 plots, each 5 feet wide, planted to non-treated seed or seed treated with seed treated with the fungicide seed treatments 'VibranceMaxx Pulses RTA' @ 5.0 fl oz/cwt + 'Vayantis' @ 0.1 fl oz/cwt.

Seeding rate: 330,000 viable seeds/ac.

Planting date, seeding depth: Commentary on first planting date (April 24): This date corresponded to the start of significant planting in the Carrington area.

Planting date #1: April 24, 9:30 am - 2:00 pm. Seeding depth = 2 inches.

Planting date #2: May 5, 4:15-8:00 pm. Seeding depth = 2 inches.

Planting date #3: May 27, 5:15 -7:30 pm. Seeding depth = 2 inches.

Planting date #4: June 5, 2:15 - 4:50 pm. Seeding depth = 2 inches.

Soil temperature: Soil temperature assessment methods: WatchDog B100 temperature data logger soil temperature sensors (Spectrum Technologies; Aurora, IL) programmed to record soil temperatures once every 2 hours were installed in non-harvested guard plots within each experimental replicate of each planting date (total 4 sensors per planting date). Sensors were installed approx. 2 inches below the surface immediately after planting. The reported soil temperatures in the first 7 days and first 30 days after planting are the average values across three

soil sensors (planting date #1) and four soil sensors (planting dates #2-4); one of the four soil sensors installed in the first planting date failed during the growing season.

Average soil temperature, first 7 days after planting: 44.8°F for the first planting date, 62.9°F for the second planting date, 64.7°F for the third planting date, 61.5°F for the fourth planting date.

Average soil temperature, first 30 days after planting: 52.6°F for the first planting date, 59.6°F for the second planting date, 64.7°F for the third planting date, 68.1°F for the fourth planting date.

PEST MANAGEMENT

Weed management

- Pre-emergence, planting date #1: Aquesta 4F (sulfentrazone, 4 lbs a.i./gal) @ 4 fl oz/ac + Glory (metribuzin, 75% by weight) @ 4 oz/ac + Buchaneer 5 Extra (glyphosate, 5.4 lbs/gal of its isopropylamine salt, equivalent to 4.0 lbs/gal of the acid; Tenkoz, Inc., Alpharetta, GA), 32 fl oz/ac + 2.5% v/v ClassAct NG (ammonium sulfate, 50.5%; Winfield Solutions, River Falls, WI) @ 20gpa applied April 25.
- Pre-emergence, planting date #2: Buccaneer 5 Extra 42froz + ClassAct NG 2.5%v/v + Aquesta 4froz+ Glory 4oz @ 20gpa applied May 7
- Pre-emergence, planting date #3: Buccaneer 5 Extra 42froz + ClassAct NG 2.5%v/v applied May 7; Buccaneer 5 Extra 64froz + ClassAct NG 2.5%v/v + Aquesta 4froz+ Glory 4oz @ 20gpa applied May 27.
- Pre-emergence, planting date #4: Buccaneer 5 Extra 42froz + ClassAct NG 2.5%v/v applied May 7; Buccaneer 5 Extra 64froz + ClassAct NG 2.5%v/v @ 20gpa applied May 27; Aquesta 4froz+ Glory 4oz @ 20 gpa applied June 5.
- Post-emergence grass herbicide: Targa (quizalofop-p-ethyl, 0.88 lb ai/gal; Gowan Corp., Yuma, AZ) + Trizenta 3 EC (clethodim, 3 lb ai/gal) 5froz + COC 12froz @20 gpa applied May 29 in planting dates #1 and #2 and applied June 25 in planting dates #3 and 4.
- Post-emergence broadleaf herbicide: Sprayed Beyond Extra (ammonium salt of imazamox, 1 lb ai/gal; BASF Corp, Raleigh, NC) 4froz+ Basagran 5L (sodium salt of bentazon, 4 lbs ai/gal; Arysta LifeScience North America, Cary, NC) 12froz + Metalis (S-metolachlor, 7.62 lbs a.i./gal) 16froz+COC 12froz + AMS 8.5lbs/100gal applied in 20 gpa on May 30 in planting dates #1 and #2 and applied in 15 gpa on July 2 in planting dates #3 and 4.
- Supplemental hand weeding was conducted throughout the season.

Foliar fungicide: Proline (5.7 fl oz/ac; prothioconazole, 480 grams ai/liter) was applied in 10 gal/ac to planting dates #1 on July 8 and was applied in 12 gal/ac to planting dates #3 and 4 on July 23. This was a preventative fungicide application targeting powdery mildew.

Insecticide: Asana XL (9.6 fl oz/ac; esfenvalerate, 0.66 lbs ai/gal) was applied in 15 gal/ac to the entire study (all planting dates) on July 16. This insecticide application was made at the first appearance of aphids.

IN-SEASON NOTES

Wilt: The percent of plants exhibiting wilt symptoms was visually estimated on July 14 when 90-98% of pods were fully filled in planting date #1; on July 14 when 60-85% of pods were fully filled in planting date #2; on Aug. 1 when 45-95% of pods were fully filled in planting date #3; on Aug. 10 when 35-87% of pods were fully filled.

Active nodulation: Active Rhizobium nodulation was only assessed in planting dates #1 and #2. Roots were collected from each end of plots outside of the area assessed for yield. Planting date #1: Plants were dug on June 11 when peas had 11-12 nodes and were washed & evaluated on June 11-12. Planting date #2: Plants were dug on June 24 when peas had 12-17 nodes and were washed & evaluated on June 26-27. Roots were washed carefully, and the percent of nodules that had the fleshy, pink appearance characteristic of active nodules engaged in nitrogen fixation was visually evaluated. For each plot, the number of plants in which approximately 0%, 1-33%, 34-67%, 68-99% and 100% of the nodules appeared active was recorded. On average, 13.5 plants were assessed per plot.

Root rot assessments: Root rot severity was only assessed in planting dates #1 and #2. Roots were collected from each end of plots outside of the area assessed for yield. Planting date #1: Plants were dug on June 11 when peas had 11-12 nodes and were washed & evaluated on June 11-12. Planting date #2: Plants were dug on June 24 when peas had 12-17 nodes and were washed & evaluated on June 26-27. The length of the epicotyl plus top 2.5 cm of the tap root was recorded for 3 representative plants per plot. The length that was diseased along this length was recorded. On average, 13.5 plants were assessed per plot.

HARVEST:

Harvest date:

- Planting date #1: August 2 and 11
- Planting date #2: August 11-12
- Planting date #3: August 26
- Planting date #4: August 26-27

Harvested with a Zurn plot combine equipped with a Harvestmaster system. The Harvestmaster system provides accurate assessments of yield but not test weight or moisture. A subsample was taken from each plot and assessed for moisture on a calibrated GAC benchtop grain quality assessment unit (Dickey-John; Auburn, IL) and assessed for protein and test weight on a calibrated FOSS benchtop grain quality assessment unit (FOSS North America; Eden Prairie, MN).

Seed yield and quality: Yields were calculated on the basis of a 5-ft plot width and the measured plot length, and seed moisture was assessed after grain was cleaned. Seed yield and test weight were adjusted from the grain actual moisture to a standard 13.5% moisture level.

STATISTICAL ANALYSIS

Analysis of variance Data were evaluated with analysis of variance. (1) The assumption of constant variance was assessed with Levene's test for homogeneity of variances and visually confirmed by plotting residuals against predicted values. (2) The assumption of normality was assessed the Shapiro-Wilk test and visually confirmed with a normal probability plot. (3) The assumption of additivity of main-factor effects across replicates (no replicate-by-treatment interaction) was evaluated with Tukey's test for nonadditivity. If data did not meet model assumptions, a systematic natural-log transformation was applied to correct deviations from normality and/or homoskedasticity, and analysis of variance was conducted on the transformed data. Data subjected to a systematic natural-log transformation are identified by the symbol '†' placed at the top of the applicable column of data in the summary table; for ease of transformation, treatments for non-transformed data are presented in the summary table. All other data met model assumptions. Single-degree-of-freedom contrasts were performed for all pairwise comparisons of isolates; to control the Type I error rate at the level of the experiment, the Tukey multiple comparison procedure was employed. Analyses were conducted with replicate and treatment as main factor effects, and they were implemented in PROC UNIVARIATE and PROC GLM of SAS (version 9.4; SAS Institute, Cary, NC).

METHODS – Carrington, ND (2025), field Q9B

GPS coordinates: 47.5153, -99.1292; southeast corner of study (plot 101)

Description: approximately 4 miles north of Carrington, ND

PATHOGEN PRESSURE

Native pathogen pressure This study was established in a field with a long history of field pea and lentil production; losses to *Aphanomyces* root rot were observed the last time these crops were grown. All disease was due to native pathogen pressure.

Characterization and quantification of the pathogens contributing to observed root rot symptoms: Pathogen diagnostic testing via qPCR was conducted by the National Agricultural Genotyping Center in Fargo, ND.

Pathogen diagnostic testing was conducted on diseased epicotyl tissue collected from four replicates in planting dates #1 and #2.

Testing was conducted on epicotyl sections excised from field peas exhibiting root rot symptoms characteristic of the typical symptoms observed in that plot. Epicotyl sections were excised in conjunction with root rot severity assessments. For all varieties other than 'AAC Julius' and 'Iconic', two pathogen diagnostic tests were conducted per field pea variety in each of planting dates #1 and #2. Every diagnostic testing sample consisted of 8 sections of epicotyl tissue: 2 epicotyl sections collected from plants grown from non-treated seed + 2 epicotyl sections collected from plants grown from fungicide treated seed (VibranceMaxx Pulses RTA + Vayantis) in each of two different experimental replicates. For the varieties 'AAC Julius' and 'Iconic', four pathogen diagnostic tests were conducted per field pea variety in each of planting dates #1 and #2. Two of the diagnostic tests (per planting date) consisted of 8 sections of epicotyl tissue: 2 epicotyl sections collected from plants grown from non-treated seed + 2 epicotyl sections collected from plants grown from fungicide treated seed (VibranceMaxx Pulses RTA + Vayantis) in each of two different experimental replicates. Two of the diagnostic tests (per planting date) consisted of 14 sections of epicotyl tissue: 1 epicotyl section collected from peas grown from non-treated seed and peas grown from six different fungicide seed treatments in each of two different experimental replicates.

Average pathogen levels in symptomatic epicotyl tissue as detected by qPCR across the full study (17 field pea varieties, planting dates #1 and #2) are presented below. For detailed results broken down by planting date, field pea variety, and sample, see the tab labeled 'pathogen diagnostic testing'.

Aphanomyces euteiches: 15,787,767 target copies per gram of epicotyl tissue

Fusarium acuminatum: 10,714 target copies per gram of epicotyl tissue

Fusarium avenaceum: 28,959 target copies per gram of epicotyl tissue

Phoma medicaginis: 0 target copies per gram of epicotyl tissue

Pythium spp. 0 target copies per gram of epicotyl tissue

Rhizoctonia solani: 173,606 target copies per gram of epicotyl tissue

Fusarium oxysporum: 8,659 target copies per gram of epicotyl tissue

Fusarium redolens: 5,361 target copies per gram of epicotyl tissue

Fusarium solani: 6 target copies per gram of epicotyl tissue

Interpretation of the results: The results suggest that *Aphanomyces* was a major contributor to the observed native pathogen pressure in this study and that *Rhizoctonia* and *Fusarium* were minor contributors to the observed native pathogen pressure in this study. The low levels of *F. oxysporum* suggest that *Fusarium oxysporum* vascular wilt was not an important contributor to the observed differences in field pea wilt, vigor or yield. The qPCR testing detected *Pythium* at only very low levels, but the sampling was not conducted in a manner that would have permitted proper quantification of the levels of *Pythium* pressure. *Pythium* spp. primarily causes seed decay and damping-off in field peas, not root rot in established plants. To properly quantify *Pythium* pressure, testing would need to be conducted on seeds and germinating seeds exhibiting seed decay and damping-off.

AGRONOMICS:

Previous crop Spring wheat (2024) The last time peas or lentils were grown in this field was 2015, when field peas were grown.

Significant losses to *Aphanomyces* root rot were not experienced when the field was seeded to peas in 2015.

Fertility: No fertilizer was applied. Granular Rhizobium inoculant was applied in-furrow with the seed at planting in accordance with the manufacturer's application instructions. Rhizobium inoculant brand: Lalfix Start Spherical Pulses. Manufacturer: Lallemand Plant Care. Type: granular. Active ingredients (<1% w/w): 7.5×10^7 CFU/g Rhizobium leguminosarum bv. viciae, 7.5×10^7 CFU/g Mesorhizobium ciceri, 5.0×10^7 CFU/g Bacillus velezensis. Other ingredients (>99% w/w): an undefined carrier. Application rate: 7.36 lb/ac. The manufacturer's recommended application rate for the 7.5-inch row spacing utilized: 3.55 lb/ac

Tillage Conventional tillage. Disked in October 2024; cultivated on April 21 and April 23, 2025.

Experimental design: Randomized complete block with a split-split-plot arrangement; main factor = planting date, sub-factor = field pea variety, sub-sub-factor = fungicide seed treatment. Number of experimental replicates = 6.

Row spacing: Plots consisted of 7 rows, each 7.5 inches apart

Planter type: Cone-type planter

Plot size: 30 feet x 5 feet at seeding; average 23.4 feet at harvest. All varieties were seeded in blocks 10 feet wide x 30 feet long in each experimental replicate, with the 10-foot wide block consisting of 2 plots, each 5 feet wide, planted to non-treated seed or seed treated with seed treated with the fungicide seed treatments 'VibranceMaxx Pulses RTA' @ 5.0 fl oz/cwt + 'Vayantis' @ 0.1 fl oz/cwt.

Seeding rate: 330,000 viable seeds/ac.

Planting date, seeding depth: Commentary on first planting date (April 23): This date corresponded to the start of significant planting in the Carrington area.

Planting date #1: April 23, 9:30 am to 12:30 pm. Seeding depth = 2 inches.

Planting date #2: May 5, 10 am to 3:15 pm. Seeding depth = 2 inches.

Planting date #3: May 27, 10 am to 4 pm. Seeding depth = 2 inches.

Planting date #4: June 5, 9:30 am to 12:30 pm. Seeding depth = 2 inches.

Soil temperature: Soil temperature assessment methods: WatchDog B100 temperature data logger soil temperature sensors (Spectrum Technologies; Aurora, IL) programmed to record soil temperatures once every 2 hours were installed in non-harvested guard plots within each experimental replicate of each planting date (total 4 sensors per planting date). Sensors were installed approx. 2 inches below the surface immediately after planting. The reported soil temperatures in the first 7 days and first 30 days after planting are the average values across three soil sensors (planting date #1) and four soil sensors (planting dates #2-4); one of the four soil sensors installed in the first planting date failed during the growing season.

Average soil temperature, first 7 days after planting: 43.2°F for the first planting date, 60.1°F for the second planting date, 63.6°F for the third planting date, 59.5°F for the fourth planting date.

Average soil temperature, first 30 days after planting: 51.9°F for the first planting date, 58.8°F for the second planting date, 63.7°F for the third planting date, 66.4°F for the fourth planting date.

PEST MANAGEMENT

Weed management

- Pre-plant incorporated, all planting dates: Sonalan (ethalfluralin, 3 lbs a.i./gal) applied at 2 pt/ac on April 21; incorporated April 21 and 23.
- Pre-emergence, planting date #1: Aquesta 4F (sulfentrazone, 4 lbs a.i./gal) @ 4 fl oz/ac + Glory (metribuzin, 75% by weight) @ 4 oz/ac + Buchaneer 5 Extra (glyphosate, 5.4 lbs/gal of its isopropylamine salt, equivalent to 4.0 lbs/gal of the acid; Tenkoz, Inc., Alpharetta, GA), 32 fl oz/ac + 2.5% v/v ClassAct NG (ammonium sulfate, 50.5%; Winfield Solutions, River Falls, WI) @ 20gpa applied April 25.
- Pre-emergence, planting date #2: Aquesta 4froz+ Glory 4oz @ 20gpa applied May 7
- Pre-emergence, planting date #3: Buccaneer 5 Extra 64froz + ClassAct NG 2.5%v/v applied May 27; Buccaneer 5 Extra 64froz + ClassAct NG 2.5%v/v + Aquesta 4froz+ Glory 4oz @ 20gpa applied May 28.
- Pre-emergence, planting date #4: Buccaneer 5 Extra 42froz + ClassAct NG 2.5%v/v applied May 27; Buccaneer 5 Extra 64froz + ClassAct NG 2.5%v/v @ 20gpa applied May 27; Aquesta 4froz+ Glory 4oz @ 20 gpa applied June 5.
- Post-emergence grass herbicide: Targa (quizalofop-p-ethyl, 0.88 lb ai/gal; Gowen Corp., Yuma, AZ) + Trizenta 3 EC (clethodim, 3 lb ai/gal) 5froz + COC 12froz @20 gpa applied May 30 in planting dates #1 and #2 and applied June 25 in planting date #3
- Post-emergence broadleaf herbicide: Sprayed Beyond Extra (ammonium salt of imazamox, 1 lb ai/gal; BASF Corp, Raleigh, NC) 4froz+ Basagran 5L (sodium salt of bentazon, 4 lbs ai/gal; Arysta LifeScience North America, Cary, NC) 12froz + Metalis (S-metolachlor, 7.62 lbs a.i./gal) 16froz +COC 12froz + AMS 8.5lbs/100gal applied in 15 gpa on July 2 in planting dates #3 and 4.
- Supplemental hand weeding was conducted throughout the season.

Foliar fungicide: Proline (5.7 fl oz/ac; prothioconazole, 480 grams ai/liter) was applied in 10 gal/ac to planting dates #1 on July 8 and was applied in 12 gal/ac to planting dates #3 and 4 on July 23. The target of this application was *Ascochyta* blight and powdery mildew.

Insecticide: Asana XL (9.6 fl oz/ac; esfenvalerate, 0.66 lbs ai/gal) was applied in 15 gal/ac to the entire study (all planting dates) on July 16 at the first sign of aphids.

IN-SEASON NOTES

Wilt: The percent of plants exhibiting wilt symptoms was visually estimated on July 14 when 80-95% of pods were fully filled in planting date #1; on July 14 when 50-70% of pods were fully filled in planting date #2; on Aug. 4 when 60-85% of pods were fully filled in planting date #3; on Aug. 14, 15, and 25 when 65-100% of pods were fully filled.

Active nodulation: Active *Rhizobium* nodulation was only assessed in planting dates #1 and #2. Roots were collected from each end of plots outside of the area assessed for yield. Planting date #1: Plants were dug on June 12-13 when peas had 9-12 nodes and were washed & evaluated on June 13 and 16-17. Planting date #2: Plants were dug on June 19 when peas had 10-12 nodes and were washed & evaluated on June 20 and 23-26. Roots were washed carefully, and the percent of nodules that had the fleshy, pink appearance characteristic of active nodules engaged in nitrogen fixation was visually evaluated. For each plot, the number of plants in which approximately 0%, 1-33%, 34-67%, 68-99% and 100% of the nodules appeared active was recorded. On average, 13.0 plants were assessed per plot (planting date #1) and 12.7 plants were assessed per plot (planting date #2).

Root rot assessments: Root rot severity was only assessed in planting dates #1 and #2. Roots were collected from each end of plots outside of the area assessed for yield. Planting date #1: Plants were dug on June 12-13 when peas had 9-12 nodes and were washed & evaluated on June 13 and 16-17. Planting date #2: Plants were dug on June 19 when peas had 10-12 nodes and were washed & evaluated on June 20 and 23-26. The length that was diseased along the epicotyl and top 2.5-cm length of the tap root was recorded for every plant, and the total length of the epicotyl plus top 2.5 cm of the tap root was recorded for 3 representative plants per plot. Root rot severity was calculated by dividing the average length diseased for each plot by the average length of the epicotyl plus tap root for that planting date in the corresponding experimental replicate. On average, 13.0 plants were assessed per plot (planting date #1) and 12.7 plants were assessed per plot (planting date #2).

Vascular necrosis: The percent of plants exhibiting vascular necrosis characteristic of colonization by the *Fusarium oxysporum* wilt pathogen was visually estimated on July 14 when 80-95% of pods were fully filled in planting date #1; on July 14 when 50-70% of pods were fully filled in planting date #2; on Aug. 4 when 60-85% of pods were fully fill. On roots in which the epicotyl tissue was not diseased 1 cm below the trifid bract, the transverse cut was made through the epicotyl tissue 1 cm below the trifid bract and visually examined for brown-red discoloration in the vascular cylinder (xylem tissues). The incidence of plants exhibiting vascular discoloration in the epicotyl was recorded.

HARVEST:

Harvest date: Planting date #1: August 12-13; Planting date #2: August 25; Planting date #3: August 27, 29; Planting date #4: Sept. 2, 8, 9

Harvest and quality assessment: Harvested with a Zurn plot combine equipped with a Harvestmaster system. The Harvestmaster system provides accurate assessments of yield but not test weight or moisture. A subsample was taken from each plot and assessed for moisture on a calibrated GAC benchtop grain quality assessment unit (Dickey-John; Auburn, IL) and assessed for protein and test weight on a calibrated FOSS benchtop grain quality assessment unit (FOSS North America; Eden Prairie, MN).

Yield calculations: Yields were calculated on the basis of a 5-ft plot width and the measured plot length, and seed moisture was assessed after grain was cleaned. Seed yield was adjusted from the grain actual moisture to a standard 13.5% moisture level.

STATISTICAL ANALYSIS

Analysis of variance Data were evaluated with analysis of variance. (1) The assumption of constant variance was assessed with Levene's test for homogeneity of variances and visually confirmed by plotting residuals against predicted values. (2) The assumption of normality was assessed the Shapiro-Wilk test and visually confirmed with a normal probability plot. (3) The assumption of additivity of main-factor effects across replicates (no replicate-by-treatment interaction) was evaluated with Tukey's test for nonadditivity. If data did not meet model assumptions, a systematic natural-log transformation was applied to correct deviations from normality and/or homoskedasticity, and analysis of variance was conducted on the transformed data. Data subjected to a systematic natural-log transformation are identified by the symbol '‡' placed at the top of the applicable column of data in the summary table; for ease of transformation, treatments for non-transformed data are presented in the summary table. All other data met model assumptions. Single-degree-of-freedom contrasts were performed for all pairwise comparisons of isolates; to control the Type I error rate at the level of the experiment, the Tukey multiple comparison procedure was employed. Analyses were conducted with replicate and treatment as main factor effects, and they were implemented in PROC UNIVARIATE and PROC GLM of SAS (version 9.4; SAS Institute, Cary, NC).