


Maximizing Yields of Pea &Lentil
Optimizing Agronomy

Cropsphere January 14th, 2020

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SASKATCHEWAN pulse Growers

Western Applied Research Corporation
WARC
Research from our farm to yours

Maximizing Yield

SPG Strategy for 2025

Lentils 27 bu/ac (^3)

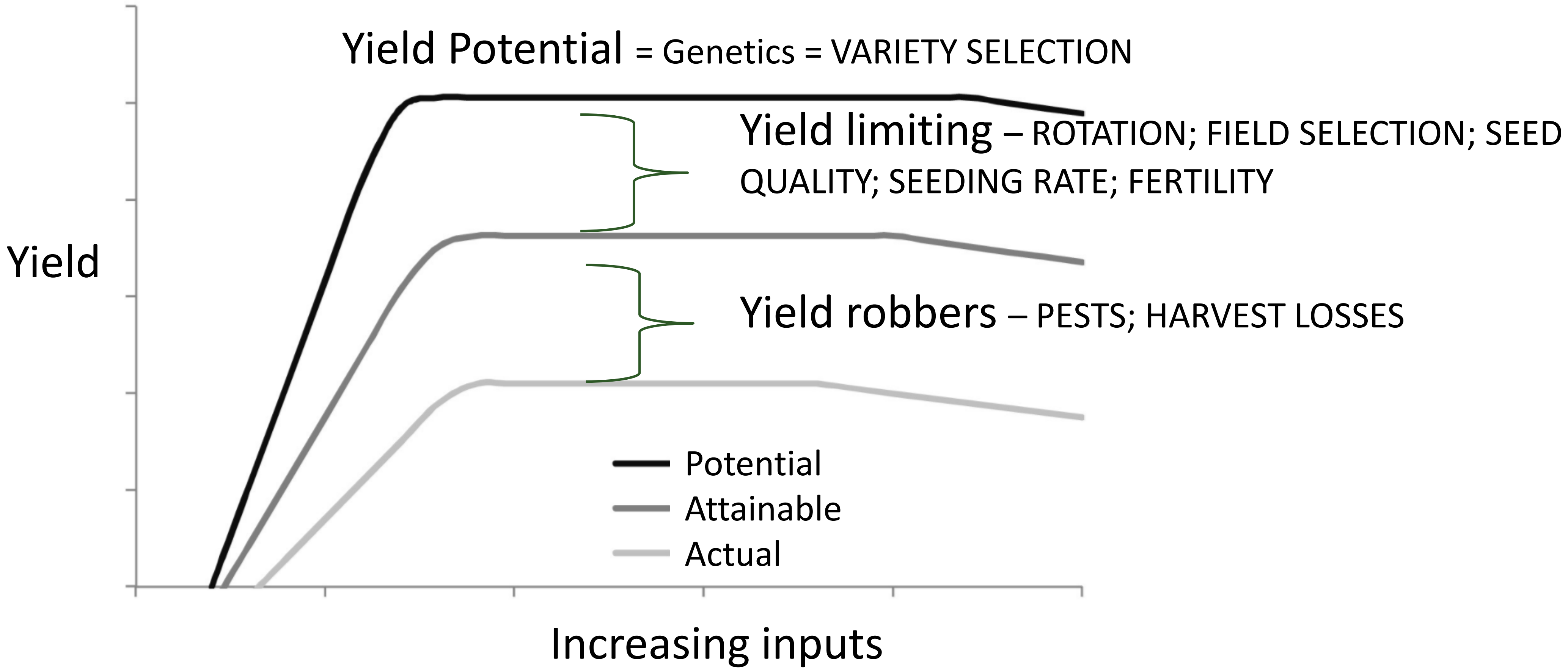
Peas 43 bu/ac (^4)

Seeds/acre = # plants x seed/plant

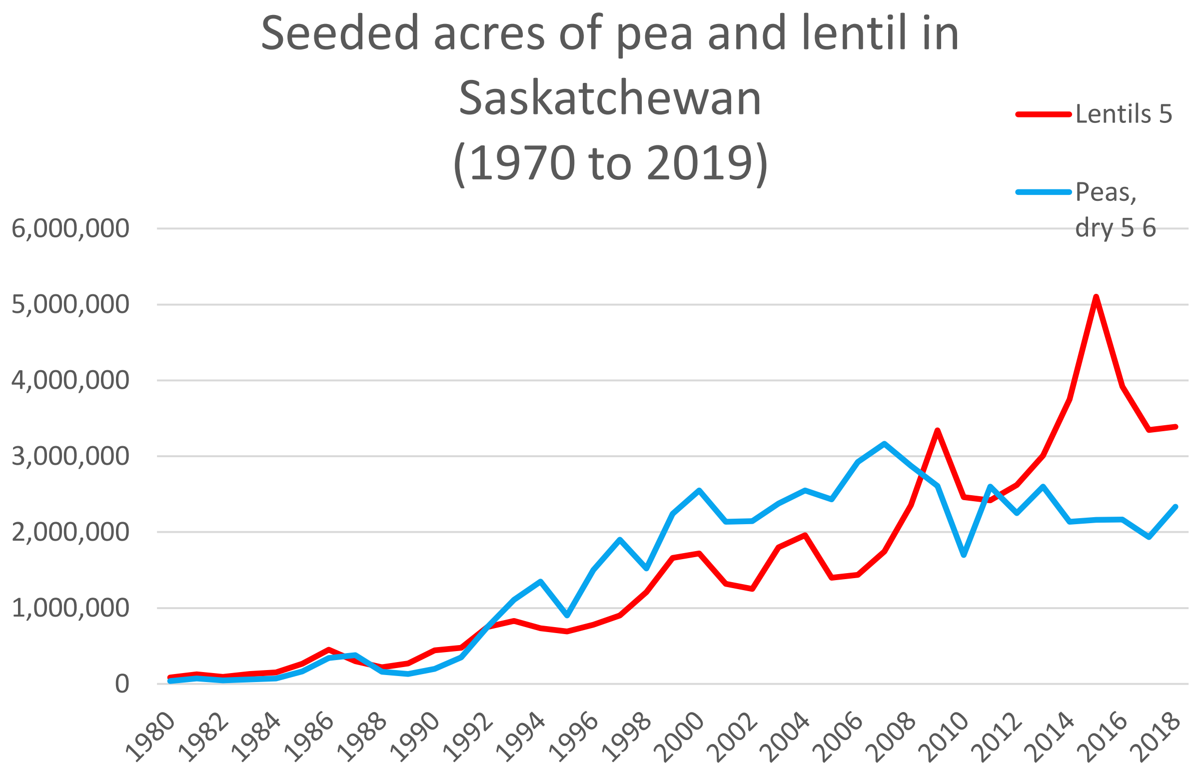
- Optimizing plant density
- Maximize crop growth and health
- Manage pest
- Harvest management = seeds in the bin

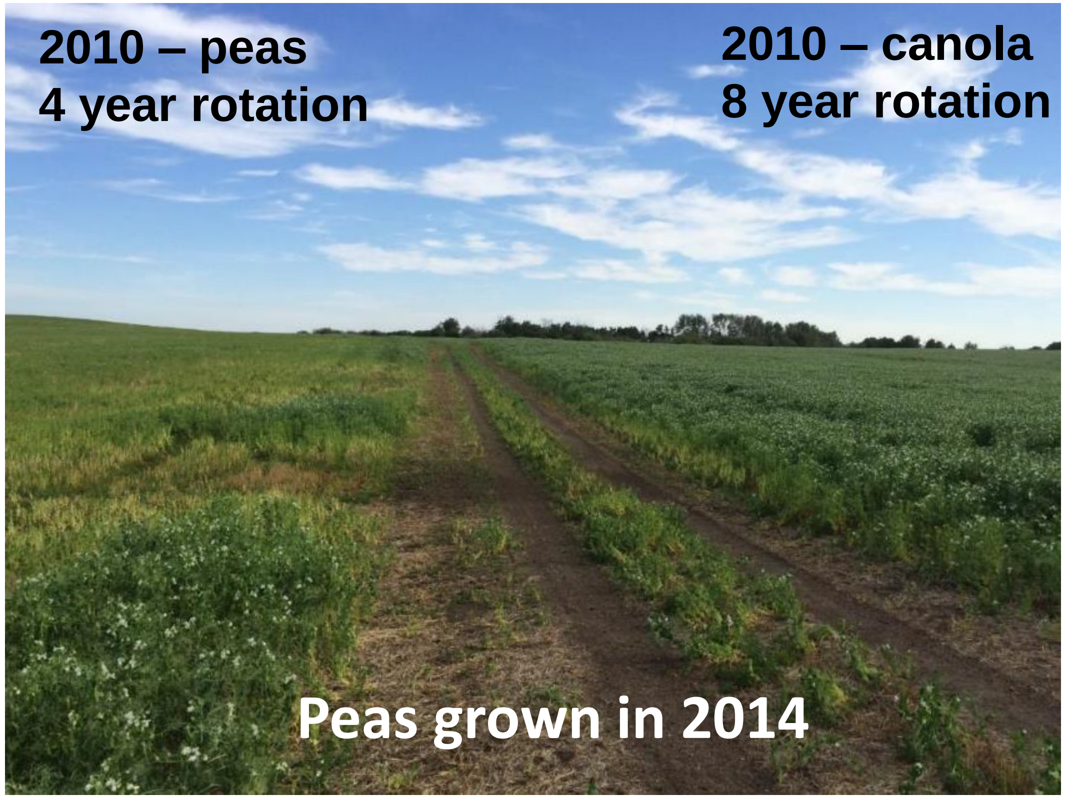
Maximizing seed increase

Yield – factors we control



Rotation & Field Choice





Seed Quality

Good quality is critical!

Seed Testing Provides:

1. Germination/vigor
2. TKW
3. Disease levels
4. Mechanical damage/herbicide damage

$$\text{Seeding Rate (kg/ha)} = \frac{\text{Target Plant Stand x Seed Size (TKW)}}{\text{\% Emergence}}$$

SGS BIOVISION @Seed_Testing · 10 Nov 2015
Pea germination results can include (L to R): normal seedlings, abnormal (mechanical damage), fresh and hard seeds .

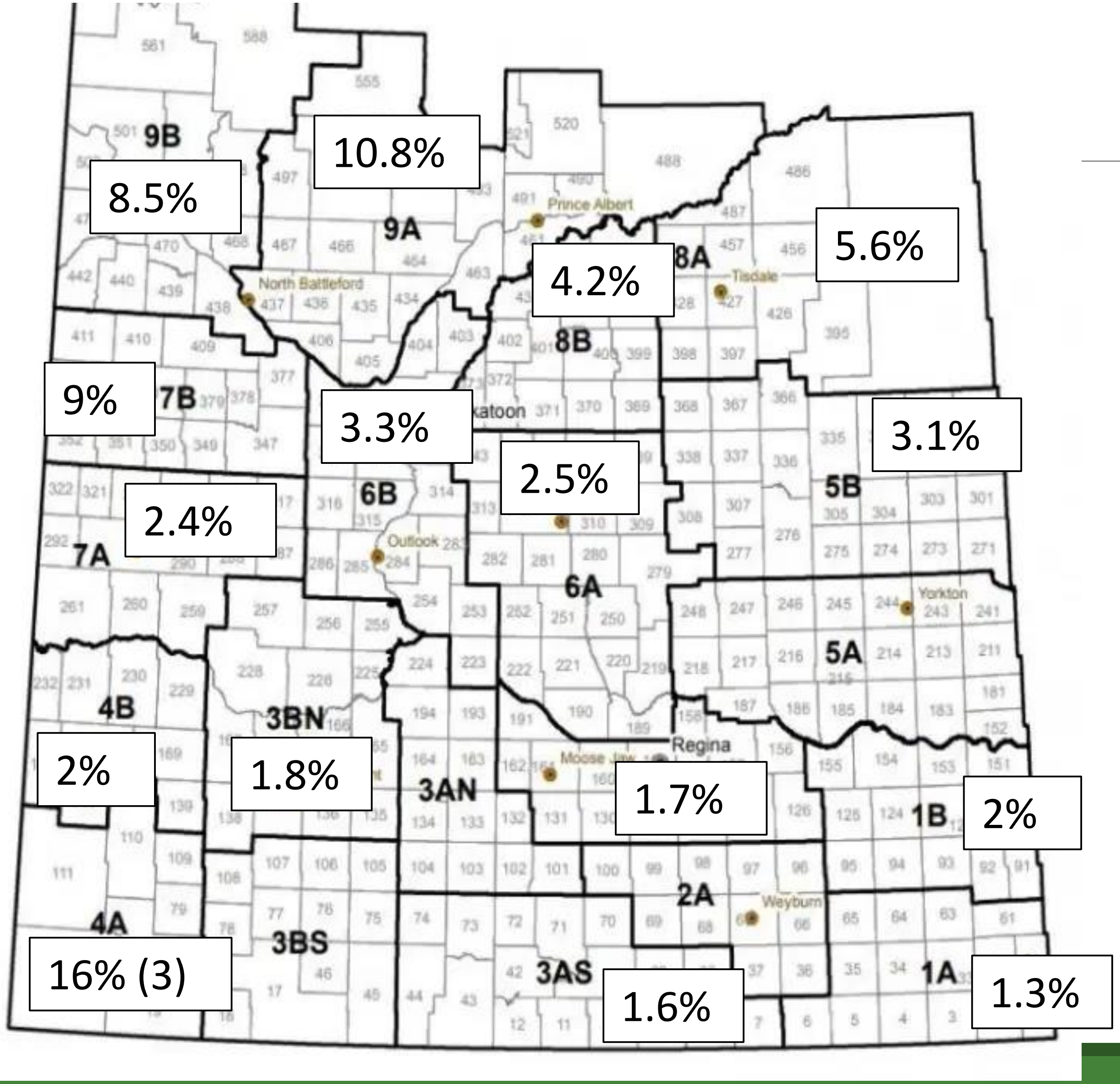
Seed Quality from 2019 (preliminary results)

Crop	Pathogen	2019 interim	
		% PFS	Mean % Infection
Lentil	*Ascochyta lentis*	*97.9*	*0.4*
	Colletotrichium lentis	*80.8*	*0.9*
	Botrytis spp.	*91.8*	*0.9*
	Sclerotinia sclerotiorum	*94.4*	*0.5*
Pea	*Ascochyta* spp.	*21.4*	*4.9*
	Botrytis spp.	*92*	*0.9*
	Sclerotinia sclerotiorum	*97.7*	*0.5*

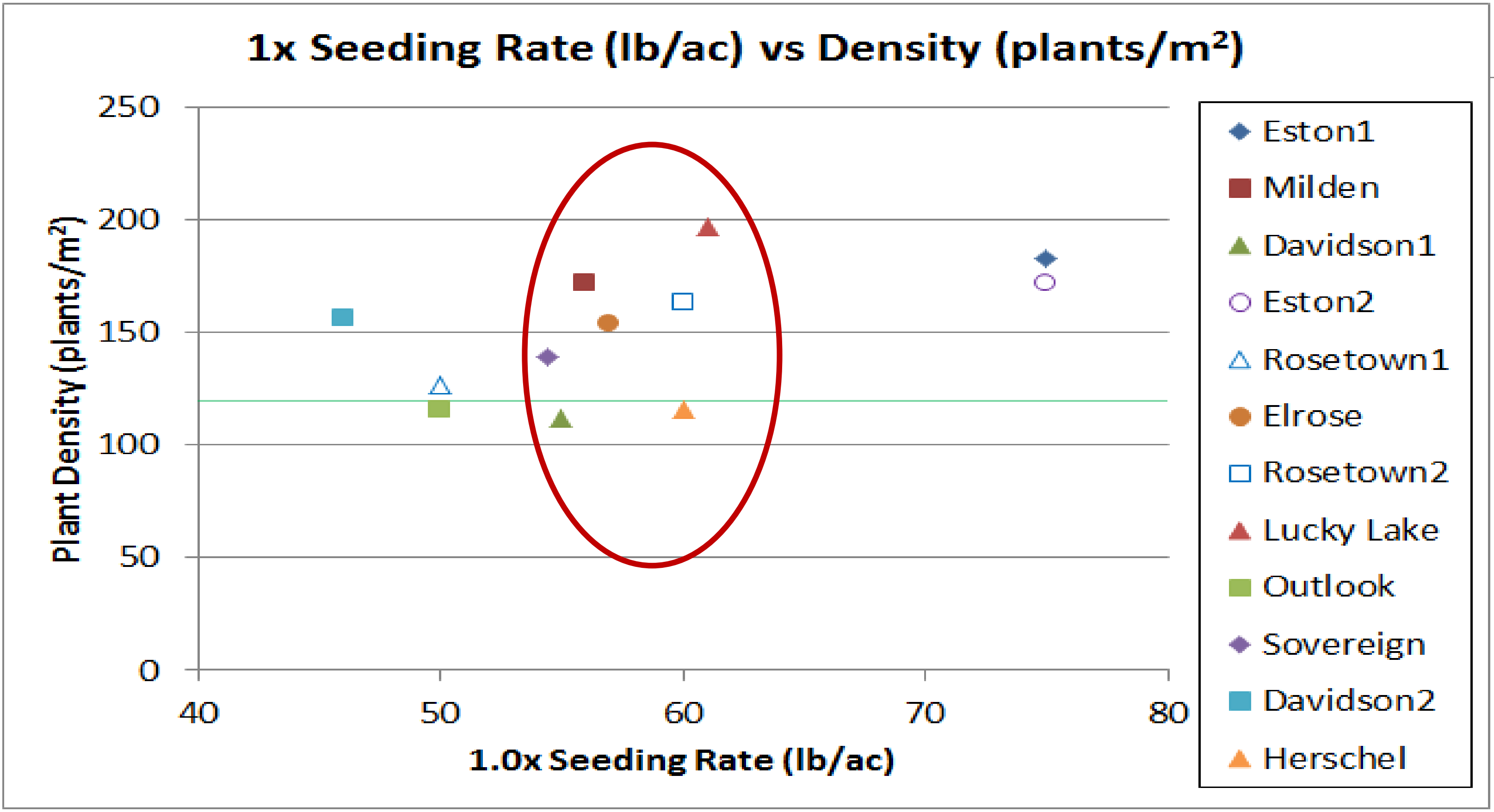
3 labs - 20/20 Seed Labs Inc., Prairie Diagnostic Seed Lab, and Discovery Seed Labs Ltd

Project Funded by
SASKATCHEWAN pulse Growers

Aschochyta % Infection on Pea Seed
2019 preliminary (>=3 samples)



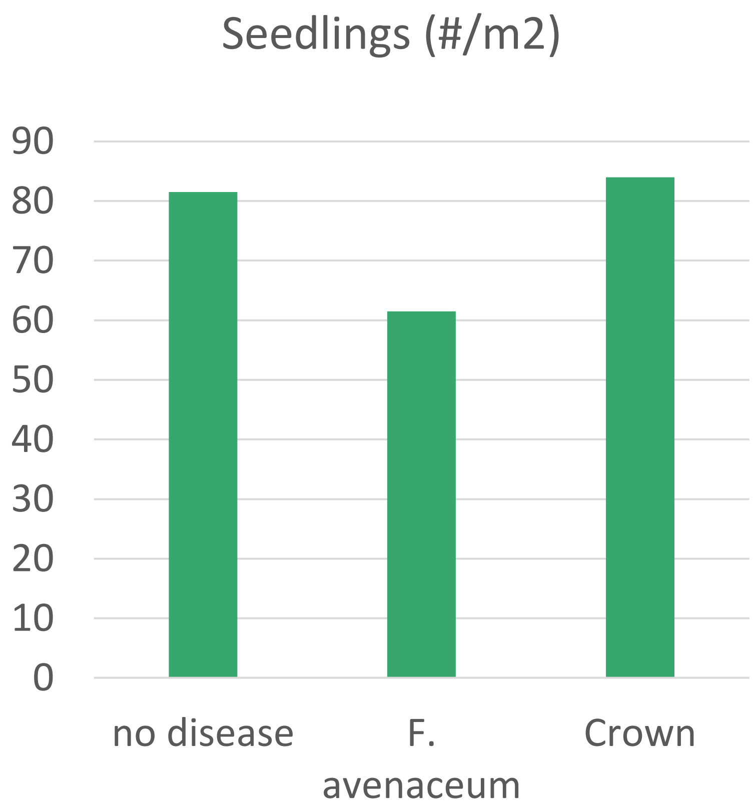
Seeding rates

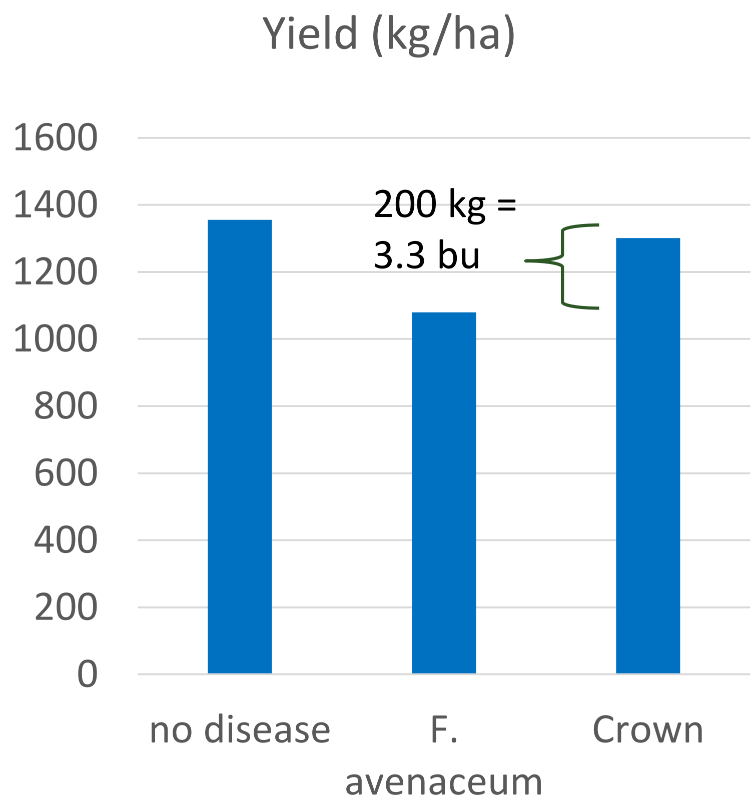


Crop	Target plant population (#/m^2)	Seed Size (TKW in g)
Lentil	120 – 130 (190-210 new)	26 – 73
Pea	75 - 85	150 – 280

$$\text{Seeding Rate (kg/ha)} = \frac{\text{Target Plant Stand x Seed Size (TKW)}}{\text{(\% Emergence)}}$$

Seed Treatment





15% YIELD INCREASE in lentils…when disease present

Source: Hwang et al, 92 & 96– Alberta Research Council

Seed Treatment

Higher Risk

- Low tannin variety
- Disease on seed
- Seeding early (cold)
- Wet soils
- History of disease
- Mechanical damage
- PLW / wireworm risk

Lower Risk

- High tannin variety
- Good seed quality
- Mid seeding date
- Warm moist soil
- No history of disease

Fertility - Phosphorous

- Pulses are good scavengers, acidify root zone, and are colonized be AM fungi (increase root surface area) *when roots are healthy!*
- Balance nutrient requirements by using removal rates
- Seed place up to 15-20 lbs/acre of P2O5 with (1” spread on 9” spacing)

Nutrient Removal Rates In Seed (lbs/bu)

	Nitrogen	Phosphorus	Potassium	Sulfur
Pea	2.3	0.7	0.7	0.3
Lentil	2.0	0.6	1.1	0.2
Canola	1.6	0.8	0.4	0.25
Wheat	1.5	0.57	0.33	0.1

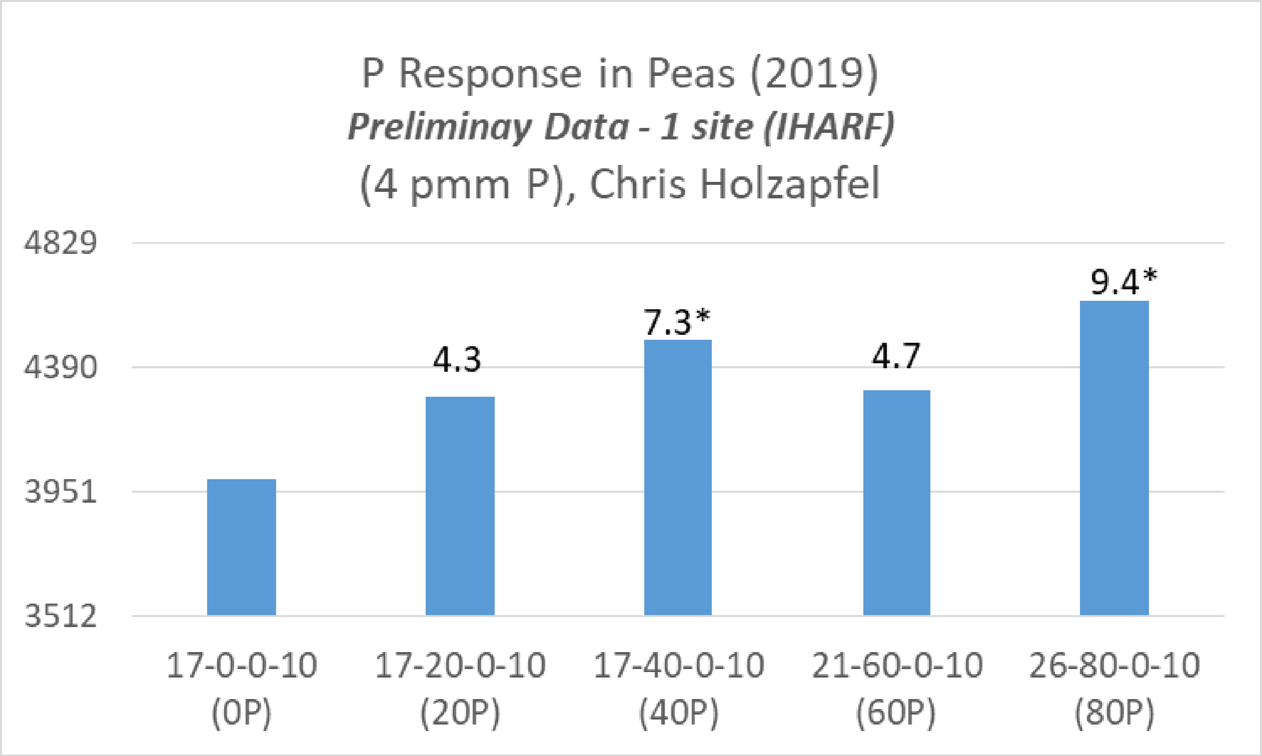
P removed in grain

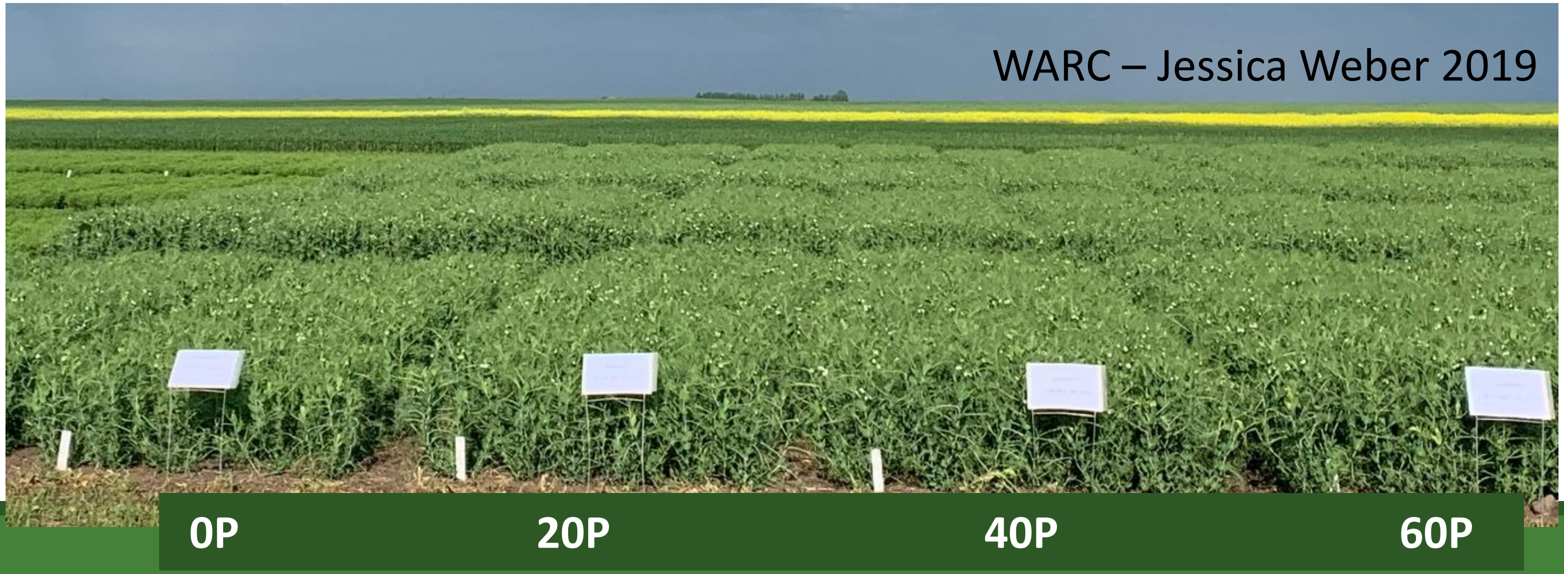
Peas @ 50 bu = 35P

Lentil @ 30 bu = 18P

Fertility Project

- 2019 (SPG funded)
- Yorkton, IH, SC, Scott, Outlook
- 5 P rates
- 3 S rates
- Various N applications
- Yield and protein
- PRELIMINARY RESULTS





Fertility - Nitrogen

- Good nodulators and fix the majority of N requirements when roots and nodules are healthy
  - Proper inoculant
  - Store safely (live organisms)
  - Apply at label rates
- In low N soils (<15 lbs/acre available) may benefit from starter N

Dr. Schoenau (2017-19) – starter N tolerance

Lentils, pea, chickpea – 10 lbs/acre

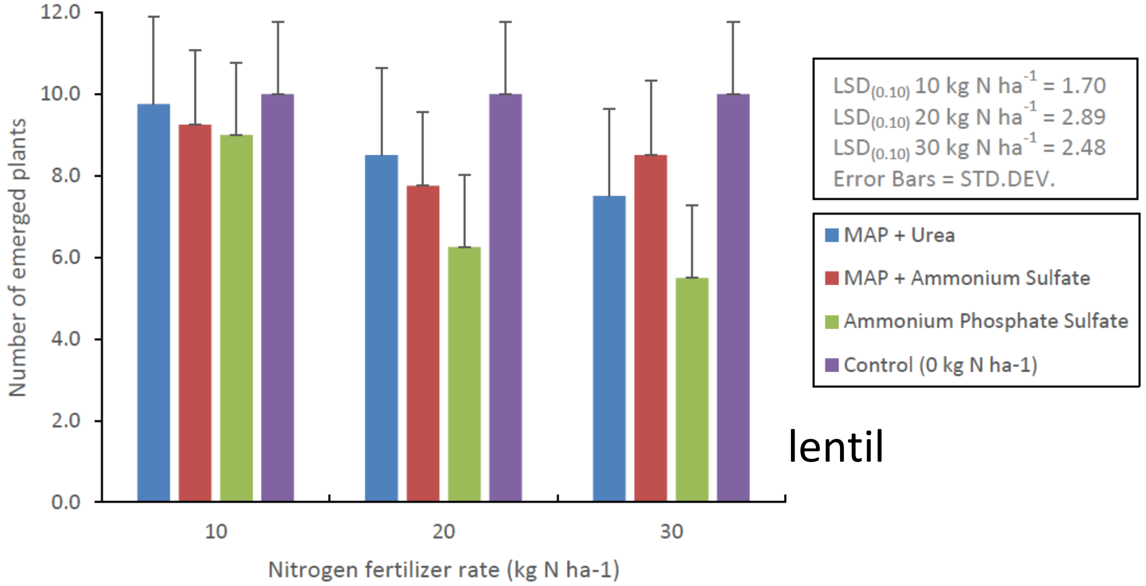
Soybeans, dry beans – 10-20 lbs/acre

Faba beans – 30 lbs/acre

Granular = peat

Peat = liquid

Granular > liquid



lentil

Why Are PULSES so Difficult to GROW??

WEEDS?   DISEASE?

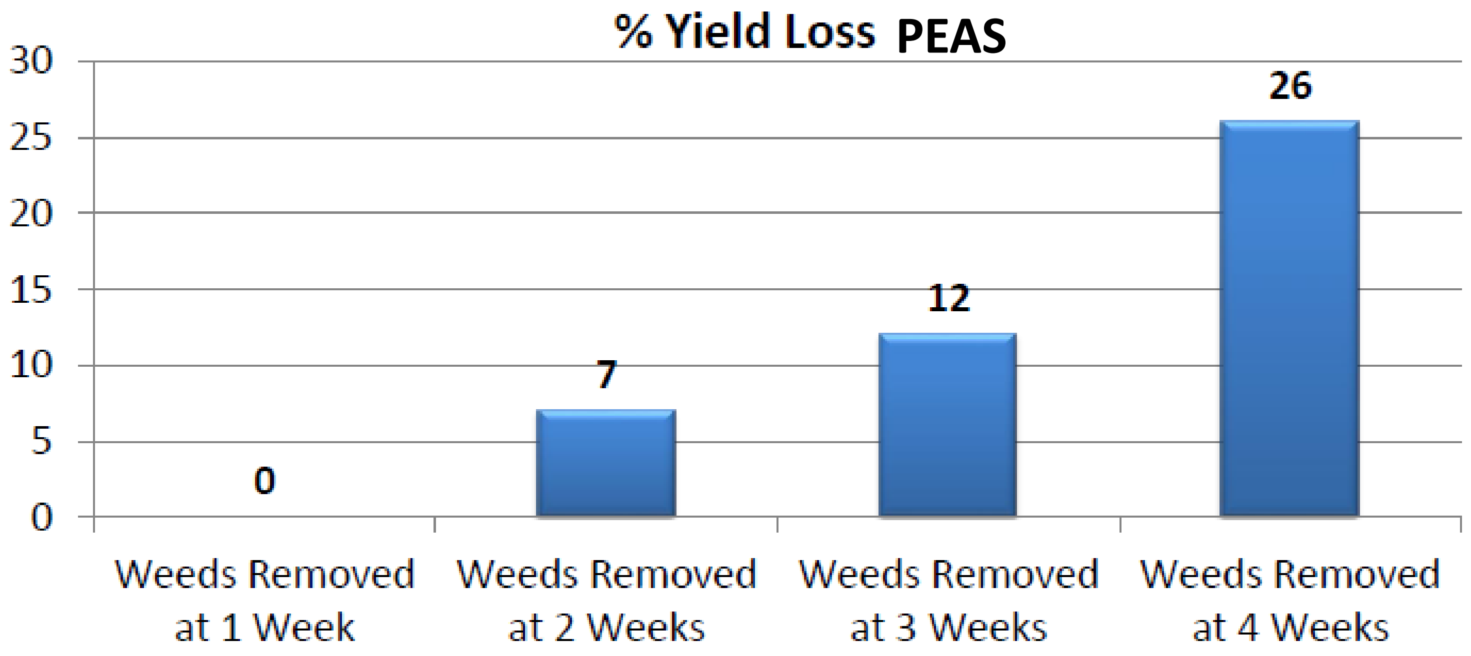
Combination of Both

Requires a combination of agronomy practices

A GLANCE at what's in the WORKS

Weed control

- Early weed removal is important with poor competitors such as peas and lentils
- 7/10 early applications > yields over later applications (AAFC AB) with PEAS
- CWFP: up to 4 weeks after emergence (peas) and up to 10 node (lentils) (5-10 node)



Source: AAFC Alberta

Weed control – Herbicide Layering

Utilizing two to three herbicides **in sequence from different herbicide groups** to tackle tough-to-control weeds and to stave off weed resistance

- Soil residual products and/or burndown options
- Early weed control
- HR management
- Soil activity provides control into growing season
- Better in crop control because weeds smaller

Soil Residual Herbicides	Group
Authority *(sulfentrazone)*	14
Authority Supreme *(sulfentrazone + pyroxasulfone)*	14 + 15
Avadex® *(triallate)*	8
Edge® Granular *(ethalfluralin)*	3
Fierce® *(flumioxazin + pyroxasulfone)*	14 + 15
Focus® *(pyroxasulfone + carfentrazone)*	14 + 15
Sencor® *(metribuzin)*	5
Heat® Complete *(saflufenacil + pyroxasulfone)*	14 + 15
Bonanza® / Rival® / Treflan® *(trifluralin)*	3
Valtera® *(flumioxazin)*	14

Burnoff Herbicides	Group
Aim® *(carfentrazone)*	14
CleanStart® *(glyphosate + carfentrazone)*	9 +14
Express® SG *(triburon)*	2
Glyphosate	9
Goldwing® *(MCPA Ester + pyraflufen-ethyl)*	4 + 14
Heat® *(Saflufenacil)*	14

Not all products registered for both peas and lentils & watch timing restriction (fall vs spring)!

Check labels!

Herbicide Layering Project

- Research conducted throughout the province lead by Dr. Christian Willenborg
  - volunteer canola, kochia and mustard

- Season long-suppression of wild mustard at Scott & Saskatoon:
  - Metribuzin spring applied
  - Edge (fall) + metribuzin spring applied
  - Pyroxasulfone (fall) + metribuzin spring applied
  - **Combined applications were most efficacious**

Western Applied Research Corporation WARC Research from our farm to yours
Growing Forward 2 A federal-provincial-territorial initiative
Canada
Government of Saskatchewan Ministry of Agriculture
Saskatchewan Pulse Growers
University of Saskatchewan
AgriARM Applied Research Management
ADOPT Agriculture Demonstration of Practices & Technology

Untreated Check

28 DAE

56 DAE

Fall Pyroxasulfone

28 DAE

56 DAE

Fall Pyroxasulfone & Spring Metribuzin

28 DAE

56 DAE

Other Options

Chemical weed control

- Weed wiping
- Precision applications

Mechanical weed control

- Inter-row harrowing
- Rotary hoe
- Clipping

Cultural/Agronomics

- Seeding date
- Seeding rate

Combinations of Inputs

- What inputs have the most impact on yields?
- Are some inputs additive?
- How can we combine inputs to be most effective?

Lentil Input Study

Collaborators: Chris Holzapfel, Michael Hall, Bryan Nybo, Garry Hnatowich, Eric Johnson, Dr. Steve Shirtliffe, and Sherrilyn Phelps

Lentil Input Study

Factor One: Seeding Rate

- 130 viable seeds/m^2 (40lb/ac ; 0.67 bu/ac)
- 190 viable seeds/m^2 (60lb/ac ; 1 bu/ac)
- 260 viable seeds/m^2 (80 lb/ac ; 1.3 bu/ac)

Factor Two: Weed Control

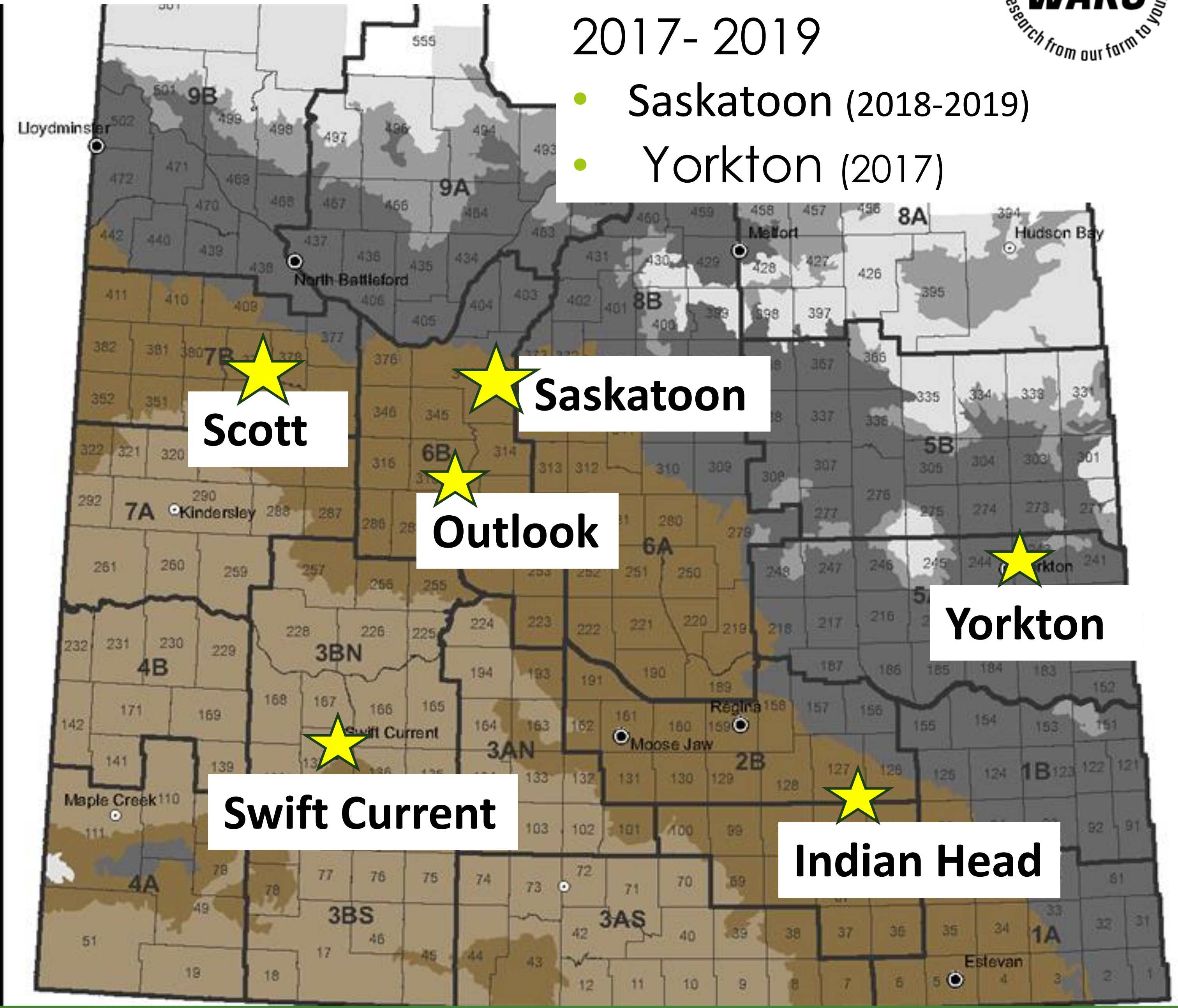
- Pre-seed burn off (glyphosate)
- Pre-seed residual (Focus)

Factor Three: Disease Control

- No Fungicide
- Single
- Dual

2017- 2019

- Saskatoon (2018-2019)
- Yorkton (2017)



% Weed control of residual herbicide relative to burnoff

*Preliminary Results

Residual herbicide was effective **71%** of the time

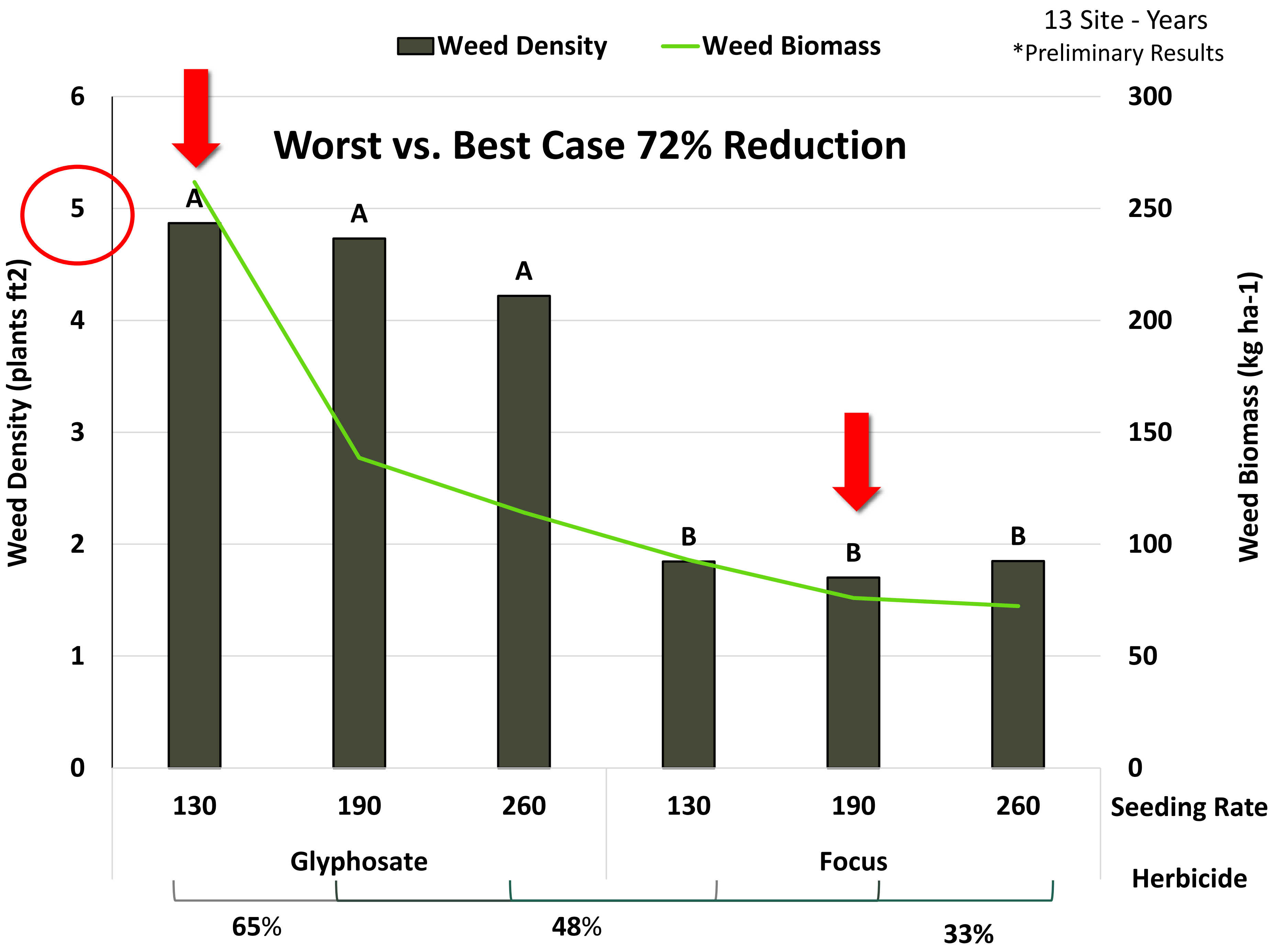
10 / 14 site years

- **66%** increase in annual weed control
  - Volunteer canola, Kochia, Cleavers
  - Wild oats, Green foxtail

Residual herbicide not effective **29%** of the time

4 / 14 site years

- Weeds not in control spectrum
- Glyphosate provided great control
- Limited secondary flushes
- Poor soil activation



Weed Density
Weed Biomass
13 Site - Years
*Preliminary Results
Worst vs. Best Case 72% Reduction
Weed Density (plants ft2)
Weed Biomass (kg ha-1)
6
5
4
3
2
1
0
300
250
200
150
100
50
0
A
A
A
B
B
B
130
190
260
130
190
260
Seeding Rate
Glyphosate
Focus
Herbicide
65%
48%
33%

5 pl/ft2

Standard (130 seeds/m2 & Glyphosate) **5% Yield Loss**

Vs.

Enhanced (190 seeds/m2 & Focus) **1% Yield Loss**

10 pl/ft2

Standard (130 seeds/m2 & Glyphosate) **9.5% Yield Loss**

Vs.

Enhanced (190 seeds/m2 & Focus) **3% Yield Loss**

15 pl/ft2

Standard (130 seeds/m2 & Glyphosate) **14% Yield Loss**

Vs.

Enhanced (190 seeds/m2 & Focus) **4% Yield Loss**

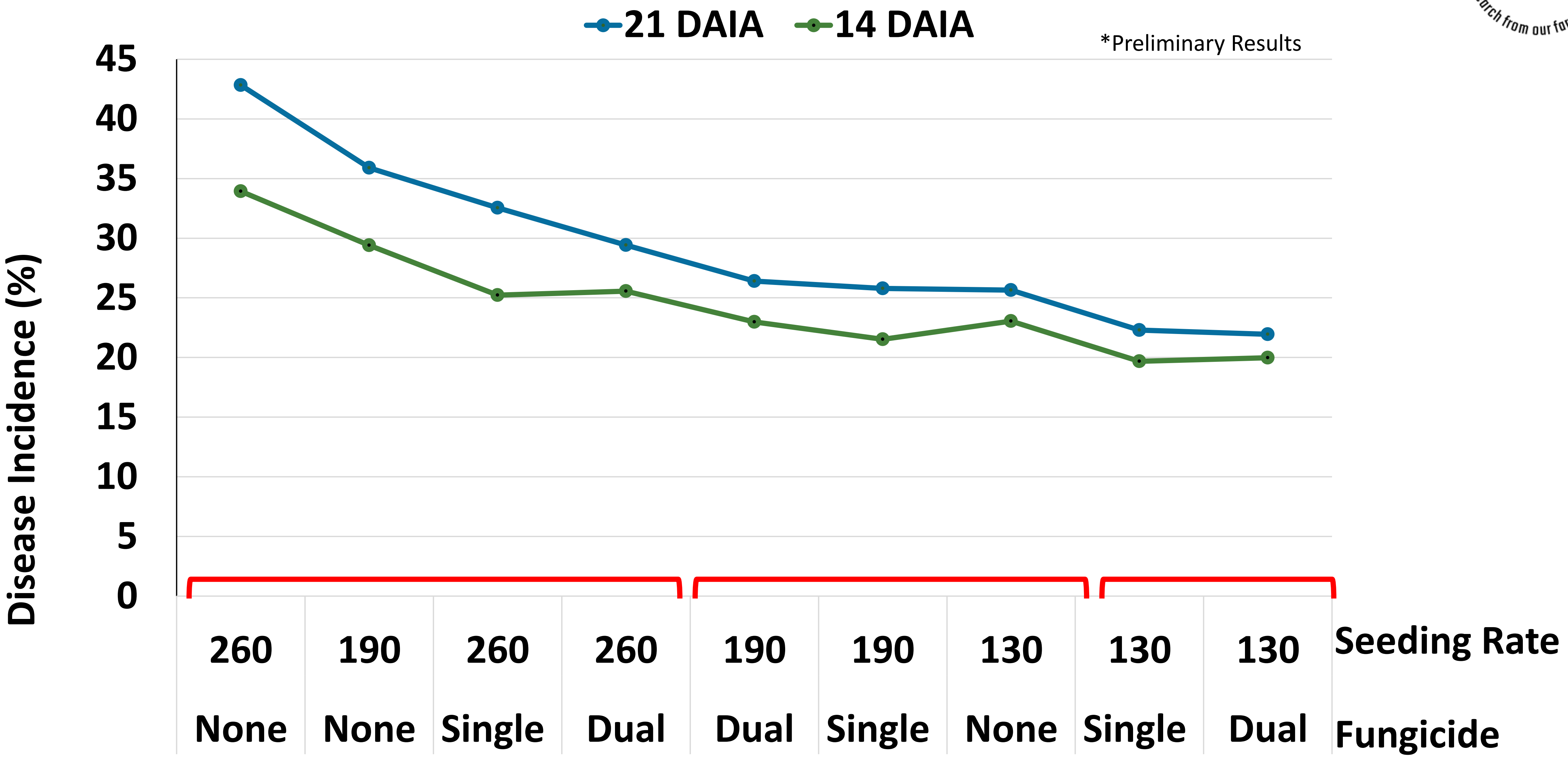
30 pl/ft2

Standard (130 seeds/m2 & Glyphosate) **28% Yield Loss**

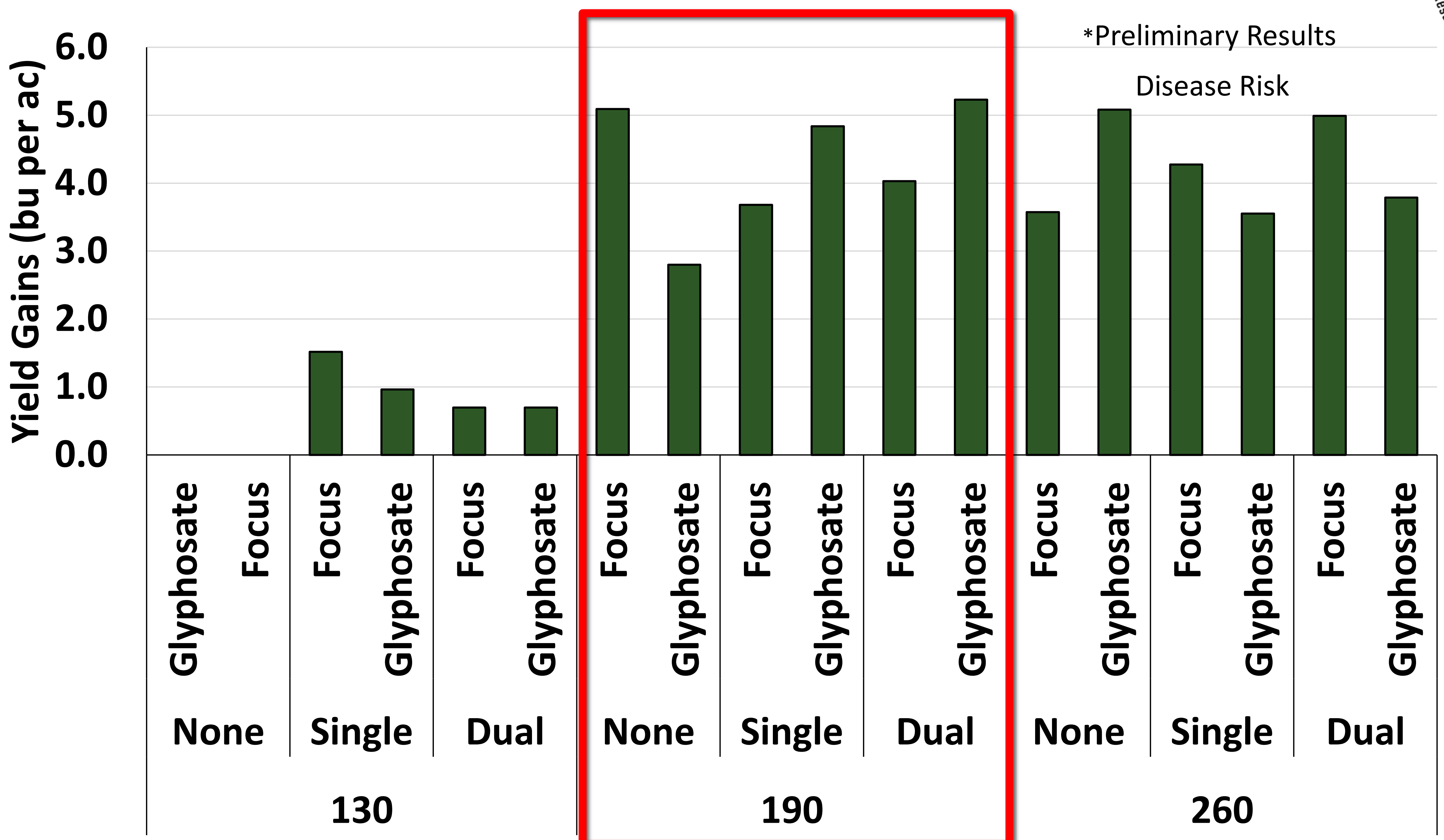
Vs.

Enhanced (190 seeds/m2 & Focus) **8% Yield Loss**

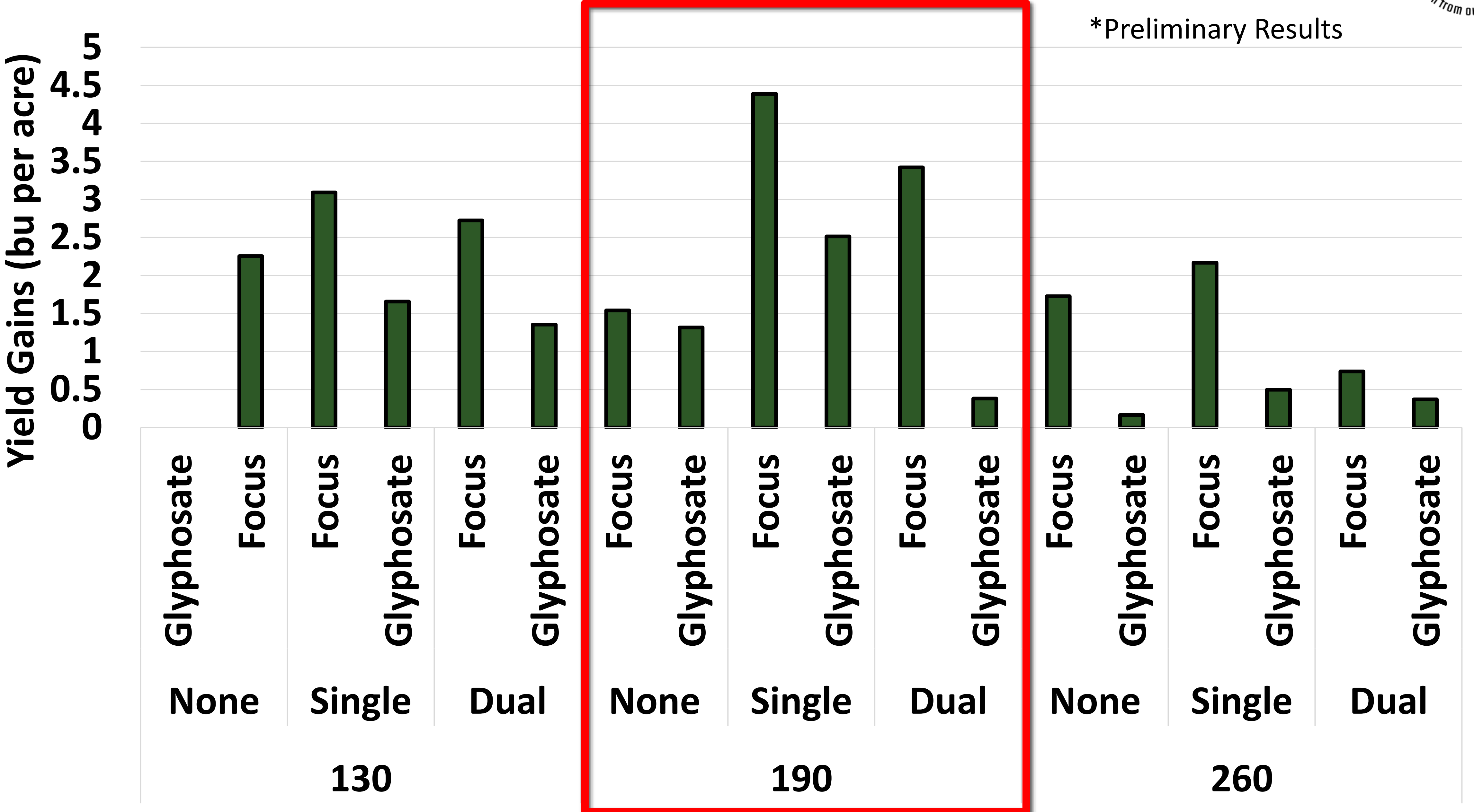
Effect of Seeding Rate & Application Timing on Disease Incidence



High Yielding (9/15 Site Years)



Low Yielding (6/15 Site Years)



Revenue (%) impact as weed populations increase

Low- Yielding Sites (6/15 Sites)

% Diff. in Revenue

Seeding Rate (seeds/m^2)	Herbicide	5 Pl/ft^2	10 Pl/ft2	15 Pl/ft^2	20 Pl/ft^2
130	Glyphosate vs Glyph. + Focus	-2.1	7.8	14.0	20.9
190	Glyphosate vs Glyph. + Focus	4.2	14.1	20.3	27.2
260	Glyphosate vs Glyph. + Focus	1.2	12.3	19.2	26.9

High- Yielding Sites (9/15 Sites)

% Diff. in Revenue

5 Pl/ft^2	10 Pl/ft2	15 Pl/ft^2	20 Pl/ft^2
-2.9	5.3	10.3	15.8
-2.7	5.5	10.5	16.1
-2.3	6.1	11.2	16.9

Small Red Lentil Best Management Practice

*Preliminary Results

Seeding Rate:

- 190 > 260 > 130 viable seeds/m^2 under "good" conditions
- 190 > 130 > 260 viable seeds/m^2 under "poor" conditions

Residual herbicides:

- was effective 71% of the time
- 65% reduction in weed establishment
- 72% reduction in weed biomass
- $$ Profit at plant densities >5 plants/ft2

Fungicide:

- 260 < 190 ≤ 130 unsprayed < 130 single/ dual
- Dry conditions: 1 pass
- Wet conditions: 2 passes ?

Overall - Increased seeding rate (190) + residual herbicide + single fungicide

Field Pea Input Study

Laryssa Grenkow, Western Applied Research Corporation

Eric Johnson, Agriculture and Agri-Food Canada

Stewart Brandt, Northeast Agricultural Research Foundation

Chris Holzapfel, Indian Head Agricultural Research Foundation

Bryan Nybo, Wheatlands Conservation Area

Anne Kirk, University of Manitoba

Sherrilyn Phelps, Saskatchewan Pulse Growers

Field Pea Input Study

- 2012-2014
- Scott, Swift Current, Melfort, Indian Head- SK ; Minto, MB

Inputs	Empty Input Package	Full Input Package
Seeding rate (SR)	60 seeds/m^2 (105 lb/ac; 1.75 bu/ac)	120 seeds/m^2 (210 lb/ac; 3.5 bu/ac)
Seed treatment (ST)	None	Apron Maxx RTA (Fludioxonil + Metalaxyl-M & S-isomer)
Inoculant type (GI)	Liquid Cell-Tech	Granular Cell-Tech
Starter N fertilizer (Fz)	None	34 kg N ha^{-1} (granular 46-0-0 side-banded)
Foliar Fungicide (Fn)	None	1st - Headline EC (pyraclostrobin) 2nd - Priaxor DS (pyraclostrobin + fluxapyroxad)

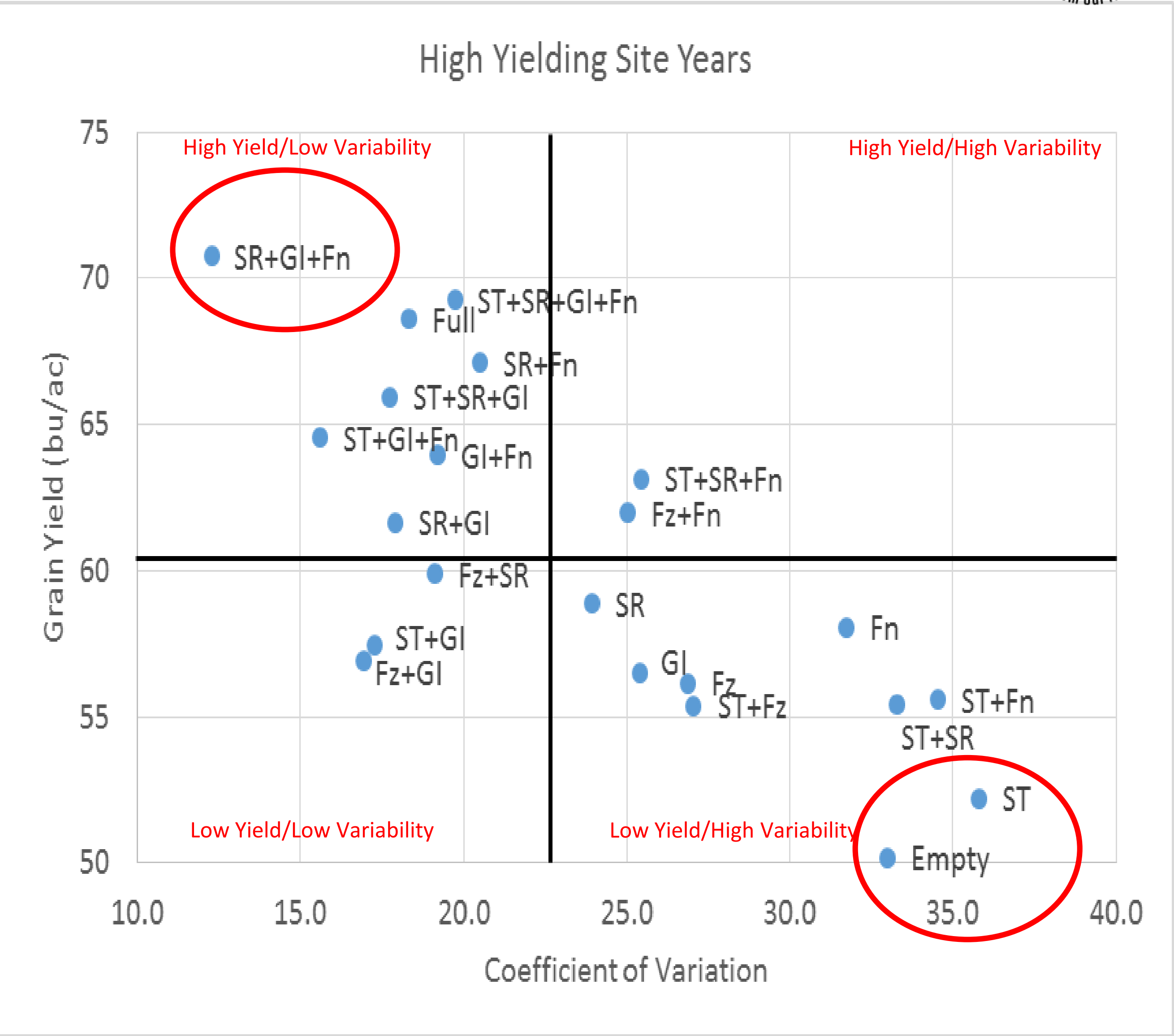
Grain Yield and Variability

Additive Effect

- Granular Inoculant
- **Seeding Rate**
- Fungicide

Add 3 > 2 > 1 Inputs Increased Yield & Decreased Variability

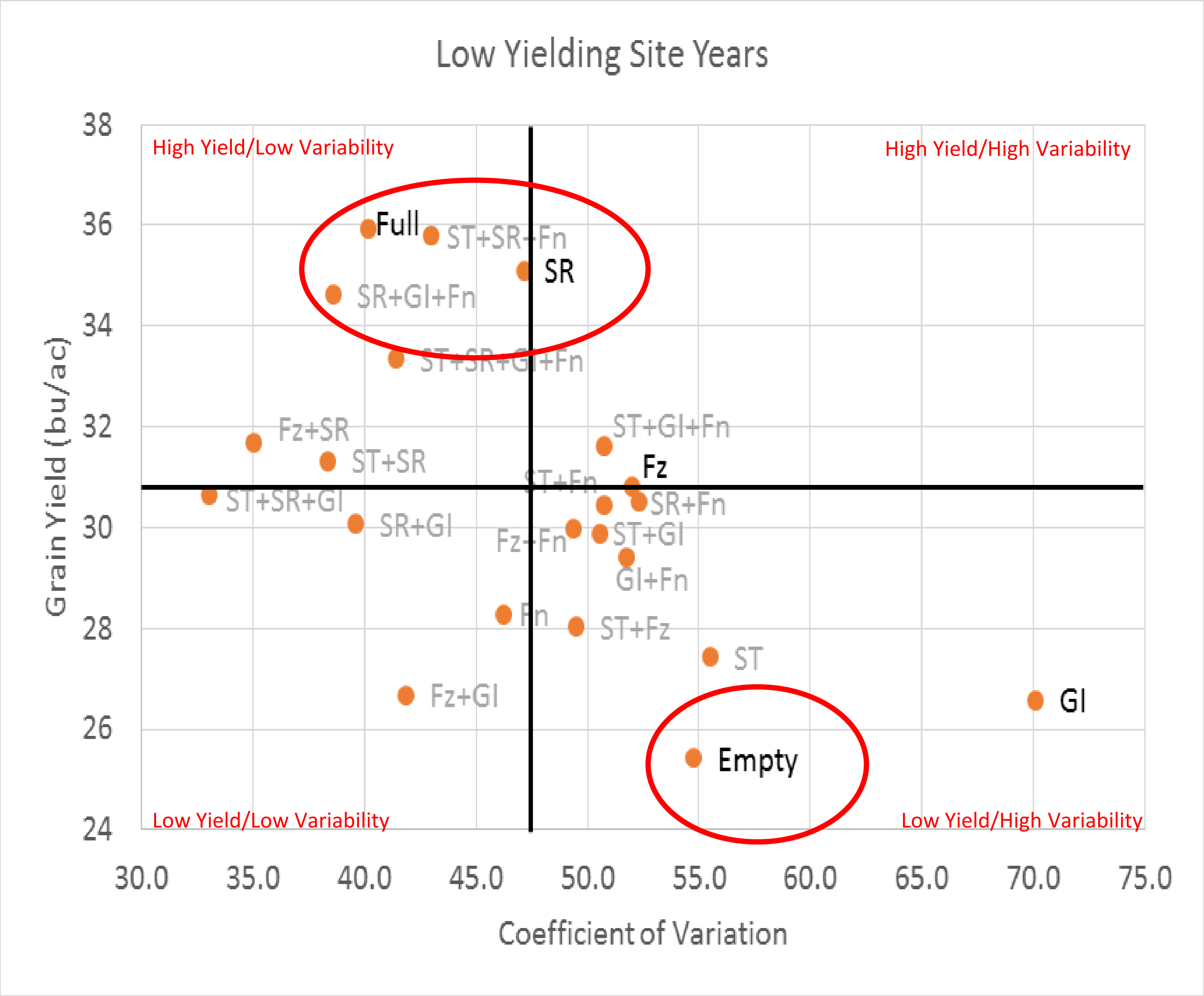
- Adding all 5 Inputs (seeding rate, fungicide, starter fertilizer, inoculant, seed treatment) did not improve yield or decrease variability
- Seed treatment in combination had no effect
- Seed treatment alone 2nd lowest yield & 2nd highest variability
- Empty lowest yield and greatest variability



ST = Seed Treatment; Fz = Starter N Fertilizer; GI = Granular Inoculant; Fn = Foliar Fungicide; SR = High Seeding Rate

Grain Yield and Variability

- Low-yielding site > variability compared to high-yielding sites
- Adding all 5 Inputs (seeding rate, fungicide, starter fertilizer, inoculant, seed treatment) **DID** improve yield and decrease variability
- Seeding rate most influential factor
- Fungicide higher response with high-yielding site
- Empty (low seeding rate & liquid inoculant) lowest yield & greatest variability



ST = Seed Treatment; Fz = Starter N Fertilizer; GI = Granular Inoculant; Fn = Foliar Fungicide; SR = High Seeding Rate

FULL INPUT PACKAGE

EMPTY INPUT PACKAGE

Net Revenue

High Yielding Sites

Top 5 MOST Profitable Input Combinations		5 LEAST Profitable Input Combinations	
Treatment	$/ac GAIN	Treatment	$/ac Gain
SR+GI+Fn	72	Fn	10
ST+SR+GI	71	ST	9
SR+GI	53	ST+SR	2
SR+Fn	50	**Empty**	0
ST+SR+GI+Fn	50	ST+Fn	-13
(No. 11) Full	31		

Low Yielding Sites

Top 5 MOST Profitable Input Combinations		5 LEAST Profitable Input Combinations	
Treatment	$/ac GAIN	Treatment	$/ac GAIN
SR	54	**Full**	-25
Fz	23	Fn	-25
ST+GI	18	Fz+Fn	-28
ST	8	ST+SR+GI+Fn	-29
ST+SR	6	SR+Fn	-33
(No. 9) Empty	0		

Field Pea Best Management Practice

Under "Good" growing conditions:

- Input combinations of **2 or 3 interacted in additive** fashion
- Generally, **yield increased** and **yield variability decreased** with each **additional input** added
- **Seeding rate, fungicide and granular inoculant** were the inputs that most **consistently increased yields and economic return**, especially when applied **all in combination**
- Seed Treatment and Starter Fertilizer provided inconsistent effects on yield

Under "Poor" growing conditions:

- Yield was **more variable** and input interactions were generally **not additive**
- Overall response to seeding rate and fungicide was significant; however, the **high cost of the fungicide** resulted in those treatments having the **lowest economic return**
- **Seeding rate** applied alone **maximized yield** and **economic return**

Do These Strategies Change in Aphanomyces Infected Soil?

Management strategies to improve field pea root health in aphanomyces contaminated soils

Evaluating combinations of various management strategies to reduce the impact

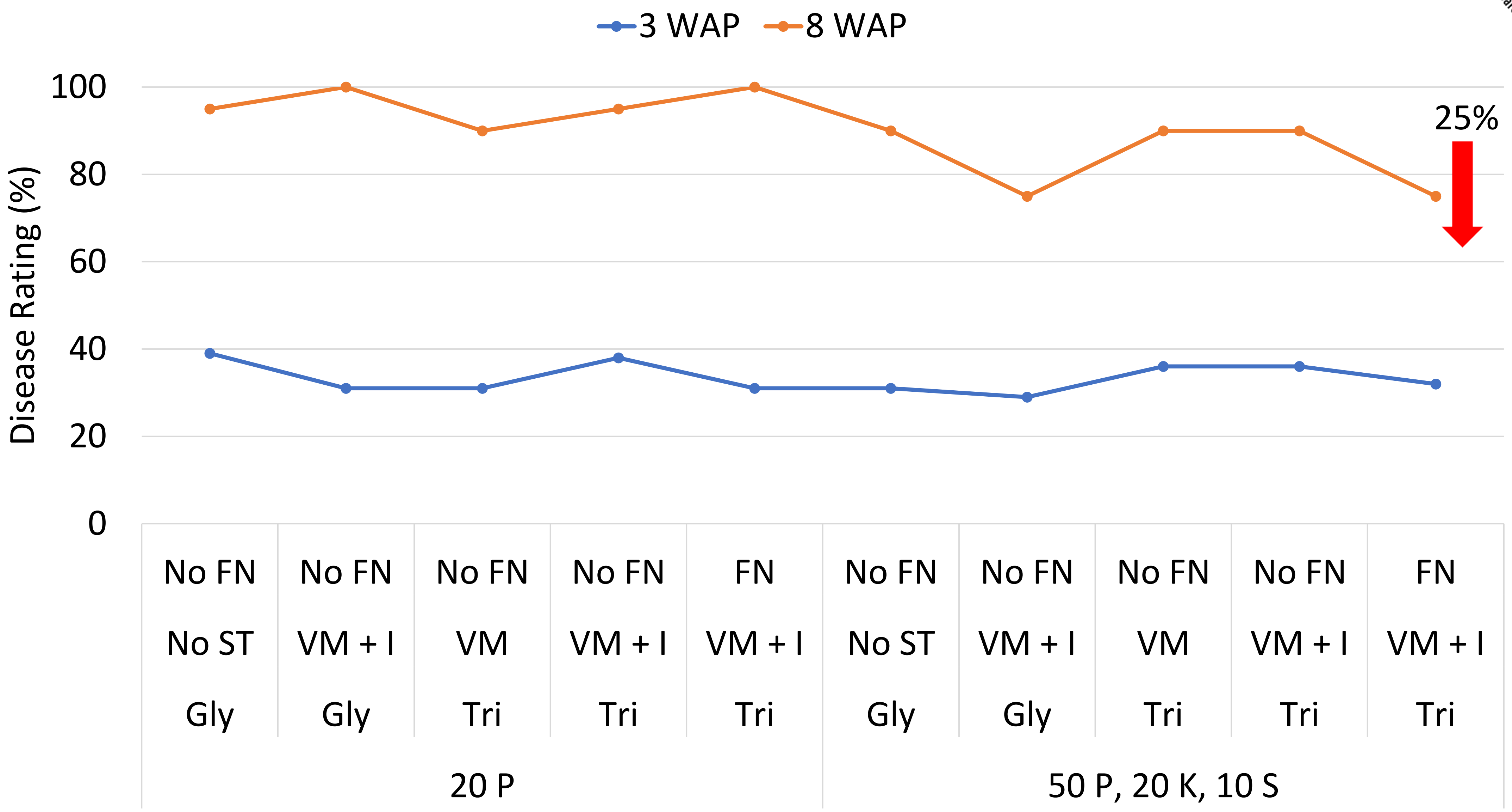
1. Pre-seed herbicides- application of a dinitroaniline herbicide inhibited the production of motile zoospores to delay infection
2. Increased available nutrients- to boost early development & improve growth through to improve tolerance
3. Seed treatments- targets root rot complexes to improve tolerance

TRT #	Herbicides	Starter Fertilizer lb/ac	Seed Treatment	Foliar nutrient
1	Glyphosate	4N,20 P	no	no
2	Glyphosate	4N,20 P	vibrance maxx + intego	no
3	Glyphosate + trifluralin	4N,20 P	vibrance maxx	no
4	Glyphosate + trifluralin	4N,20 P	vibrance maxx + intego	no
5	Glyphosate + trifluralin	4N, 20 P	vibrance maxx + intego	yes
6	Glyphosate	20 N, 50 P, 20 K, 10 S	no	no
7	Glyphosate	20 N, 50 P, 20 K, 10 S	vibrance maxx + intego	no
8	Glyphosate + trifluralin	20 N, 50 P, 20 K, 10 S	vibrance maxx	no
9	Glyphosate + trifluralin	20 N, 50 P, 20 K, 10 S	vibrance maxx + intego	no
10	Glyphosate + trifluralin	20 N, 50 P, 20 K, 10 S	vibrance maxx + intego	yes

Trifluralin = Treflan/Rival/Bonanza

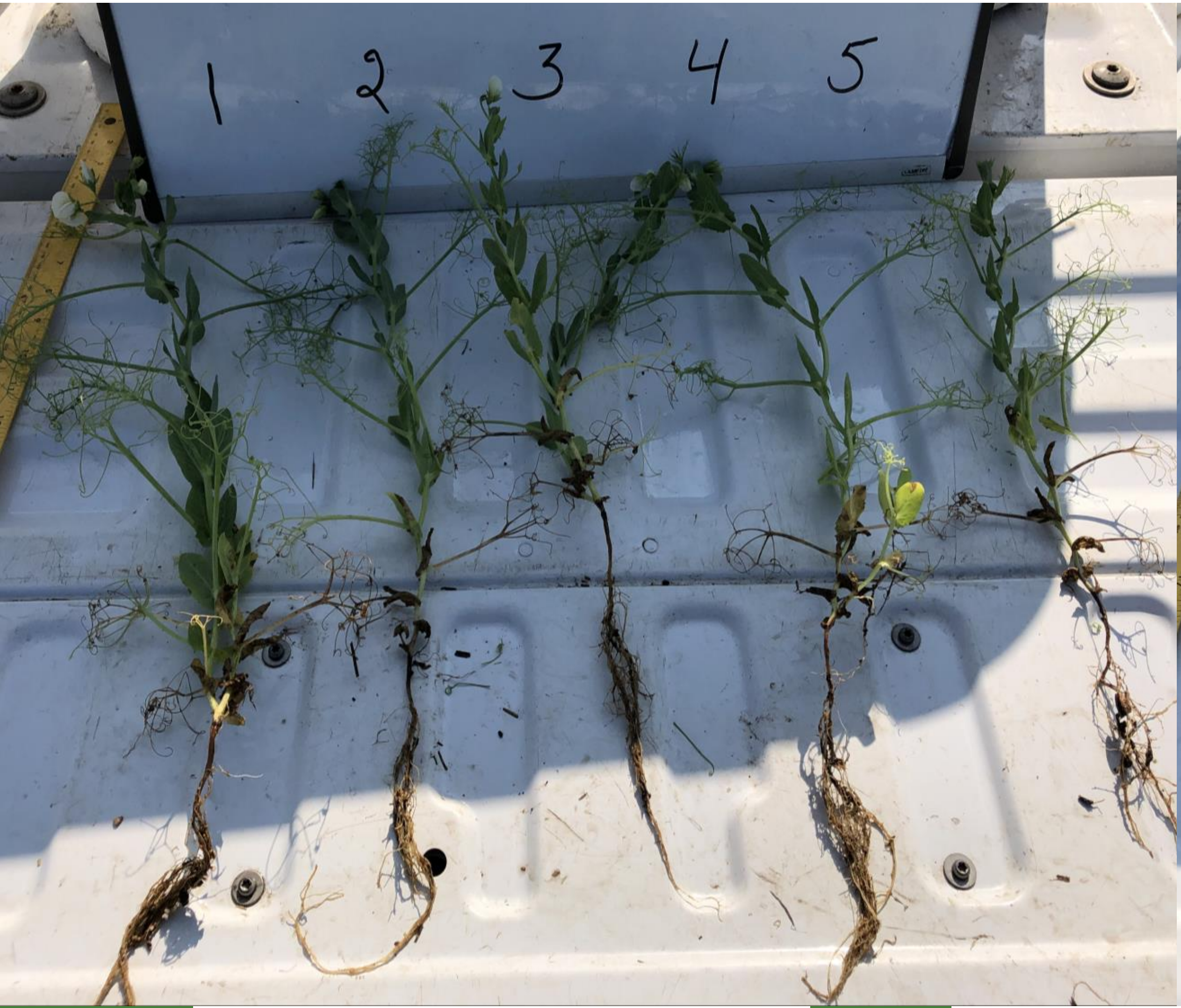
Scott, 2019

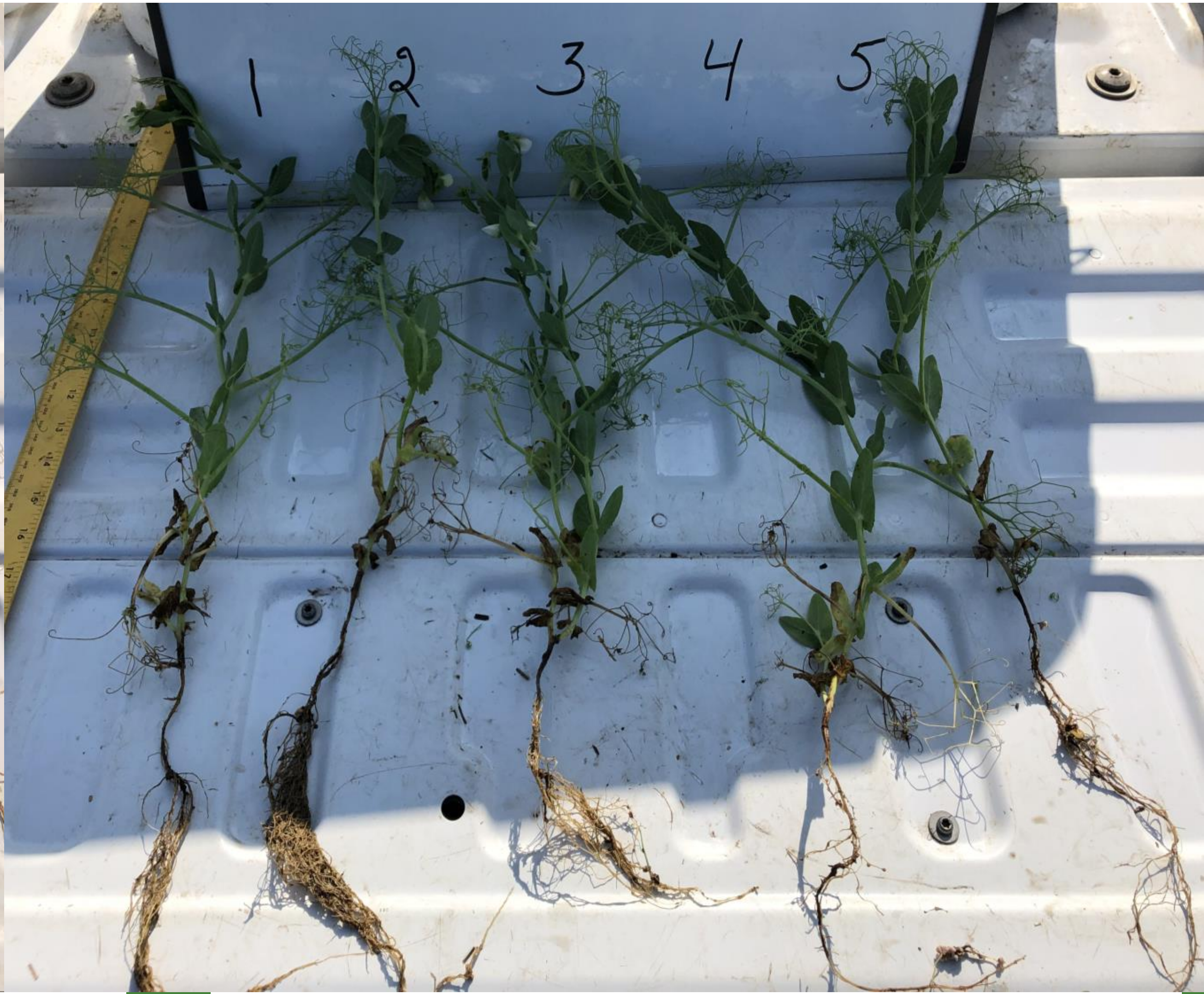
Preliminary Data



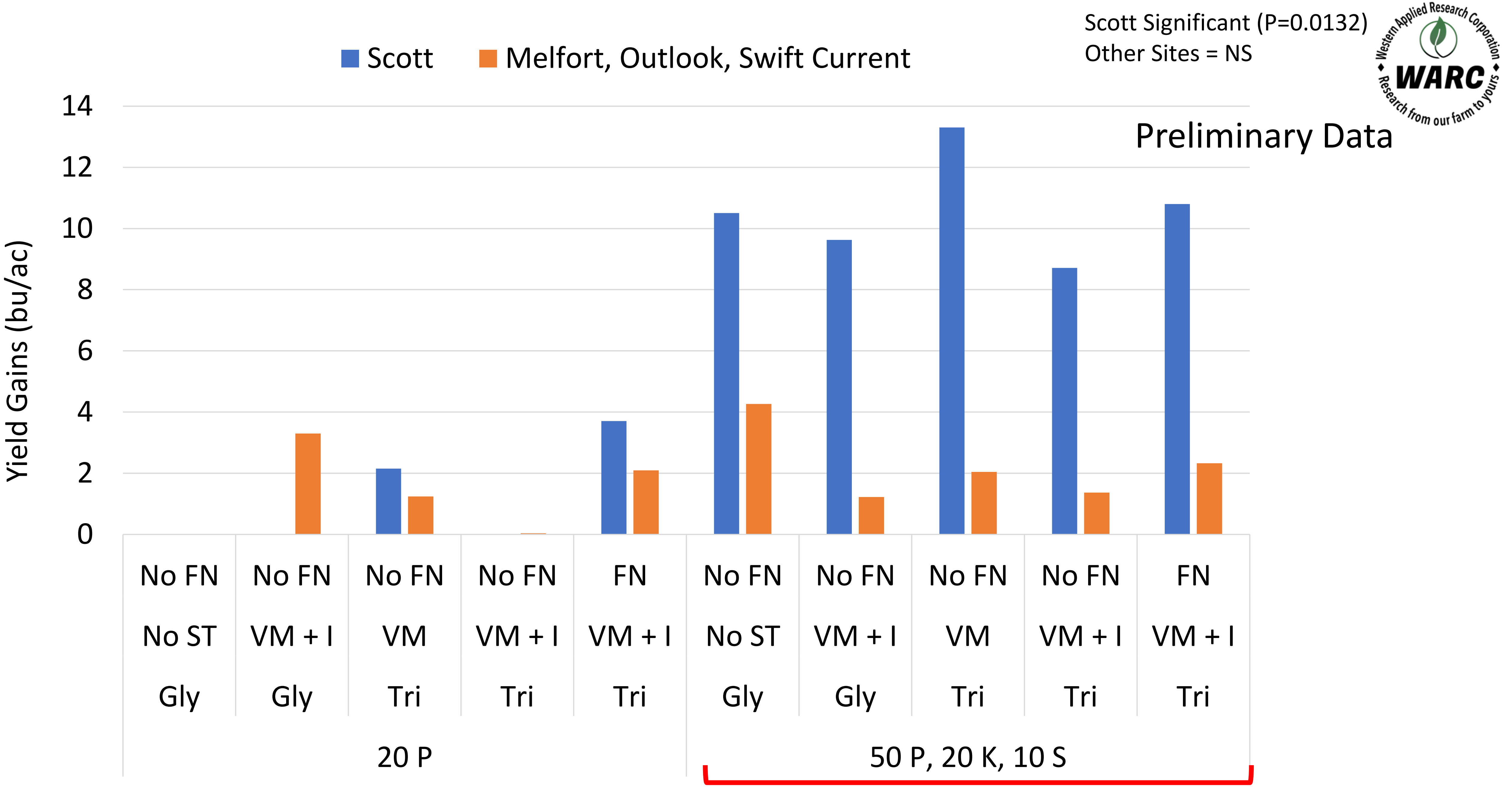
Gly= Glyphosate, Tri= Trifluralin, ST= Seed Treatment, VM= Vibrance Maxx, I= Intego, Fn= Foliar Nutrient

Scott, 2019 @ 8 Weeks After Planting





Gly + 20 P, No ST/FN vs Tri + 50 P,20K,10S, VM+ I + FN



Gly= Glyphosate, Tri= Trifluralin, ST= Seed Treatment, VM= Vibrance Maxx, I= Intego, Fn= Foliar Nutrient

Basic Strategy

- Glyphosate
- 20 P lbs/ac
- No Seed Treatment
- No Foliar Nutrients

Intensive Strategy

- Glyphosate + Trifluralin
- 20N, 50 P, 20 K, 10 S lbs/ac
- Seed Treatment (Vibrance Maxx + Intego)
- Foliar Nutrients

Management Strategies in Aphanomyces Infected Soils

Scott

Higher fertility regime tended to improve plant growth

- Yield Gains of 9 bu/ac at Scott, SK
- Tended to have less " pinching" of the roots compared to low fertility treatments
  - More developed roots increased tolerance to disease

Melfort, Outlook, Swift Current

Higher fertility regime appeared to slightly influence yield but not significant

- Very inconsistent among the different locations

SUMMARY – Recipe for Success

1) **Rotations** – longer is better, especially if root rots are an issue
2) **Plant densities** – target seeding rates based on TKW and factors influencing emergence
3) **Balance fertili**ty – in pulse year or prior to pulses (feed the crop); inoculant
4) **Manage weeds** – early weed control & herbicide layering
5) **Manage diseases** – thicker crops require closer management; consider environment
6) **Harvest management** – good quality in the bin

Combinations of inputs and more intensely managed crops are higher yielding and less variable.

No one recipe – tailored for each farm based on level of risk, environment and production practices

Thank you – questions?