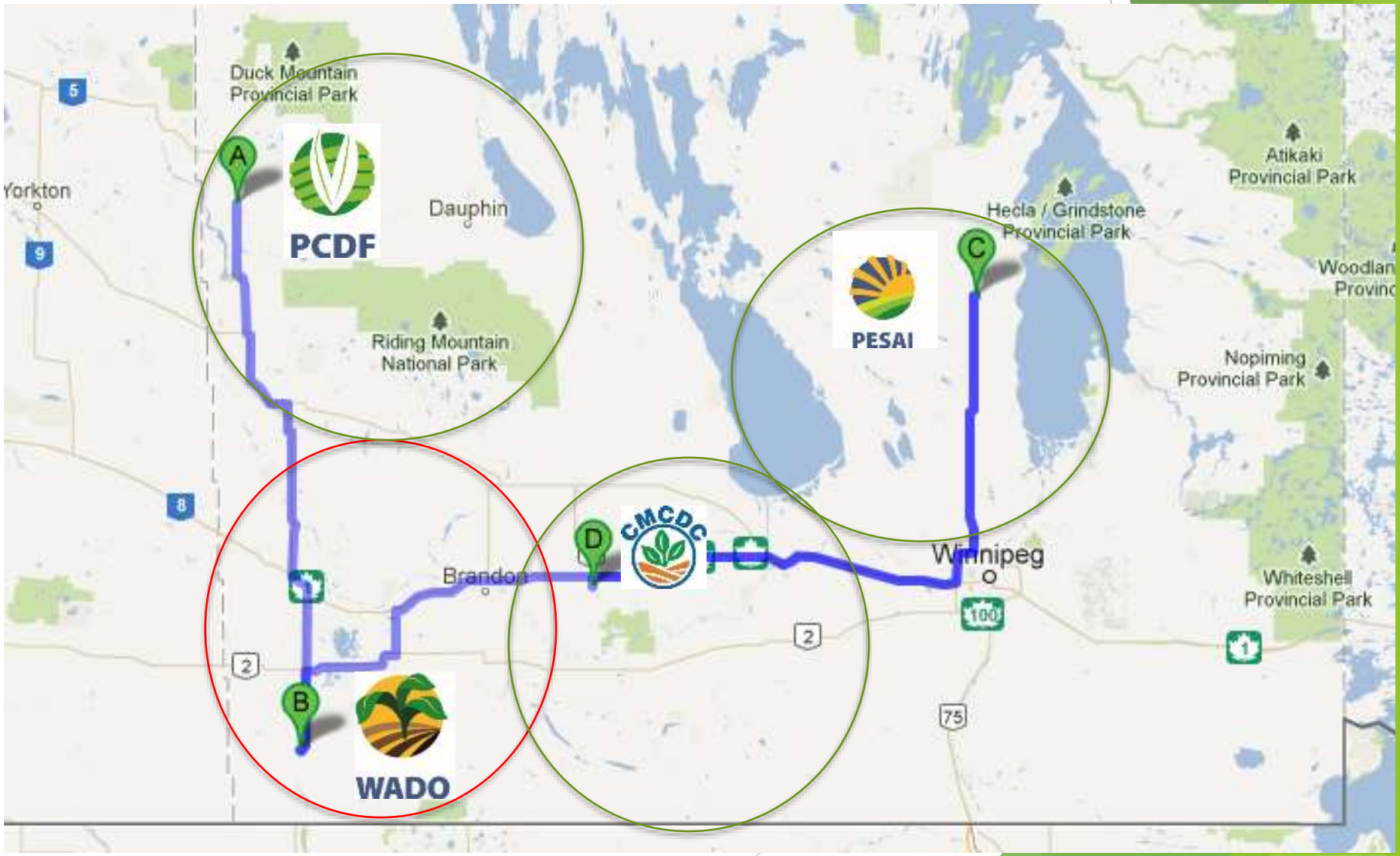
Companion Cropping in SW Manitoba

Scott Chalmers, Diversification Specialist
Manitoba Agriculture, Melita MB
Westman Agricultural Diversification Organization

WADO

Manitoba Diversification Centres

A. Roblin
B. Melita
C. Arborg
D. Carberry

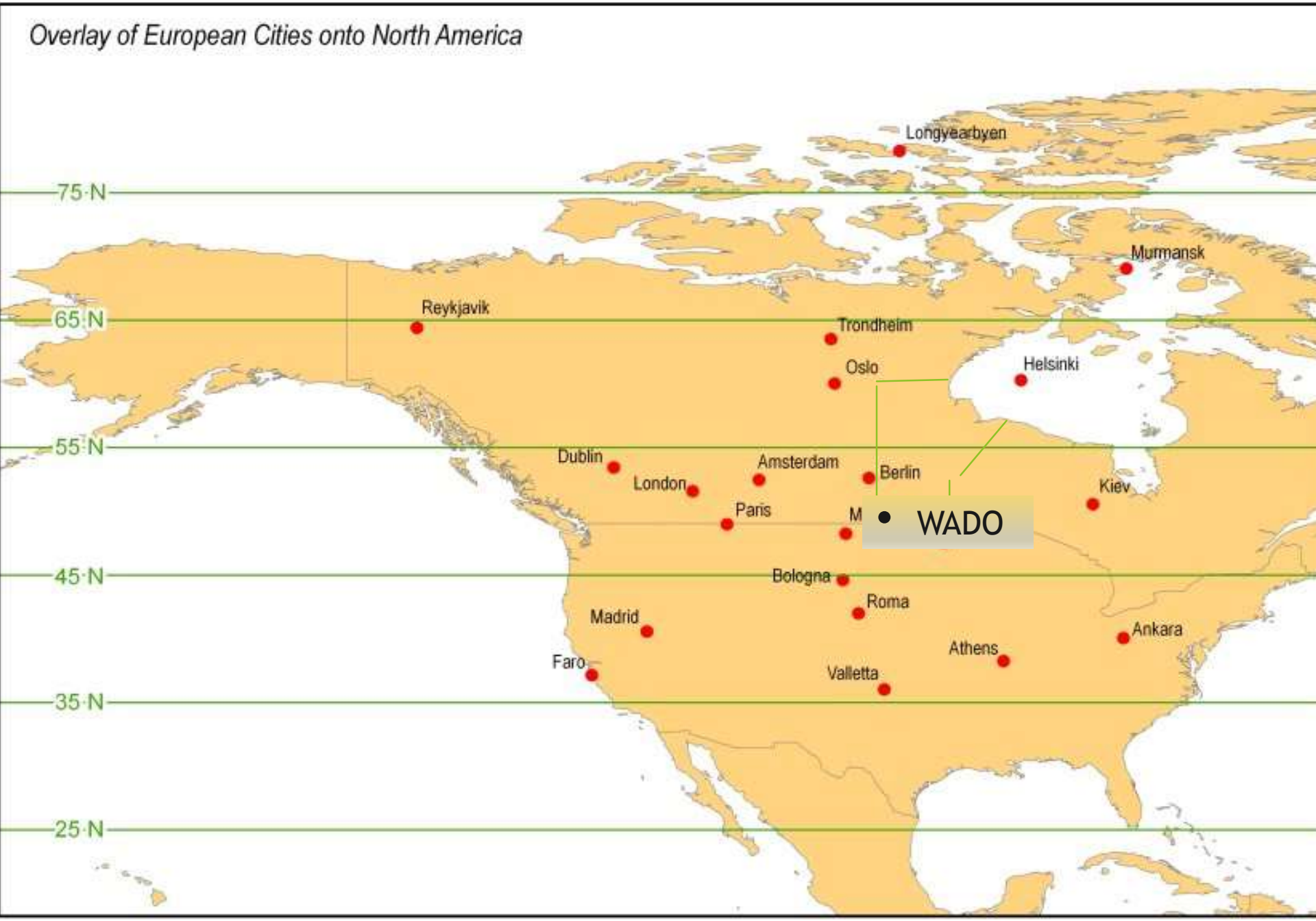


WADO STAFF

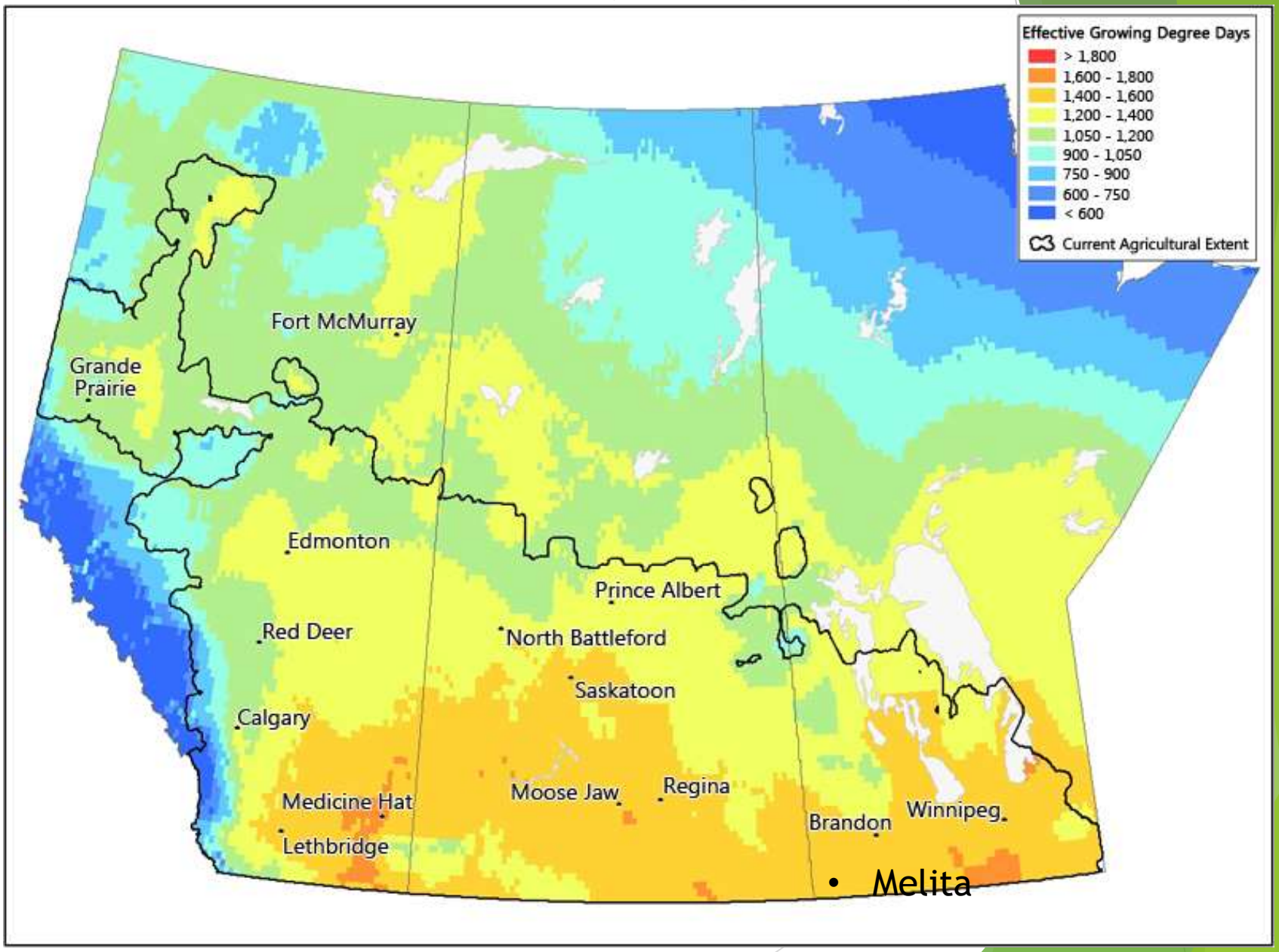
Left to Right:

Jessi Mayes Justice Zhanda Scott Boutlon Scott Chalmers Leanne Mayes Chantal Elliott

Extension Field Tours

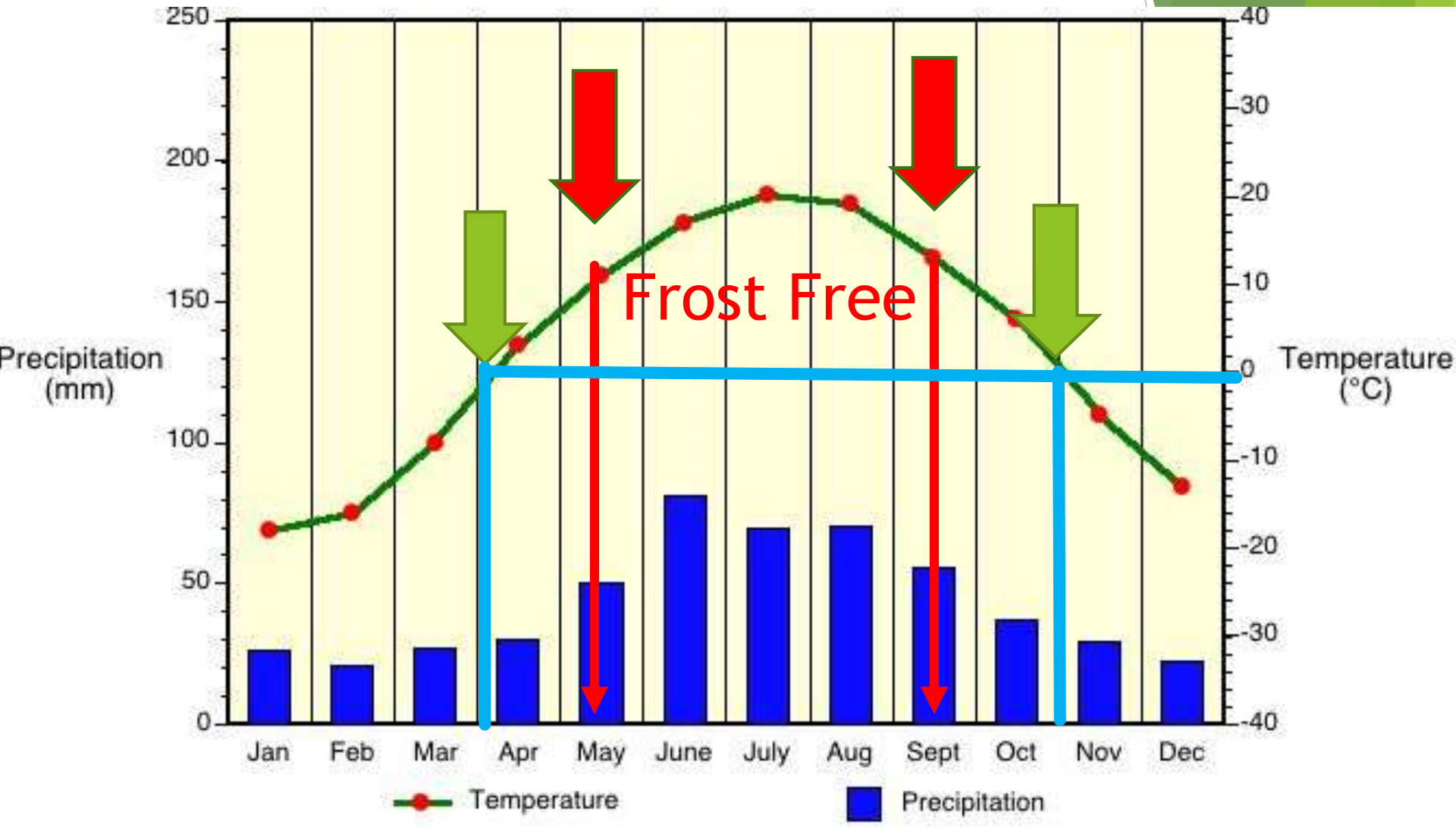

Overlay of European Cities onto North America
75 N
65 N
55 N
45 N
35 N
25 N
Longyearbyen
Murmansk
Reykjavik
Trondheim
Oslo
Helsinki
Dublin
Amsterdam
Berlin
London
Kiev
Paris
M
WADO
Bologna
Roma
Madrid
Ankara
Athens
Faro
Valletta

Growing Degree Days (Temp>5*C)



http://www.agr.gc.ca

Manitoba Climate



- 415 mm total annual
- 300 mm growing season

Crop Heat Units Before Spring Frost and After Fall Frost

Pierson Weather Station

Time/Year	2017	2016	2015	2014	2013	Mean
May 15 - Sept 1 (110 days)	2095	2365	2352	2369	2265	2289
Apr 1 - Nov 1 (214 days)	2946	3253	3368	3008	3044	3124
% CHU extra (104 days)	29%	27%	30%	21%	26%	**27%**

Modern Prairie Agriculture

Nature’s Way of Life

No Till vs Tillage Headingley MB, Feb 2018

Companion Cropping

- Growing various species together to benefit or co-exist for various reasons
- Utilizes more water, nutrients, light, time
  - Intercrops
  - Relay Crops
  - Cover Crops

Intercropping

Two or more crops growing at the same time in the same space

Peas (monocrop)

Pea + Canola (intercrop)

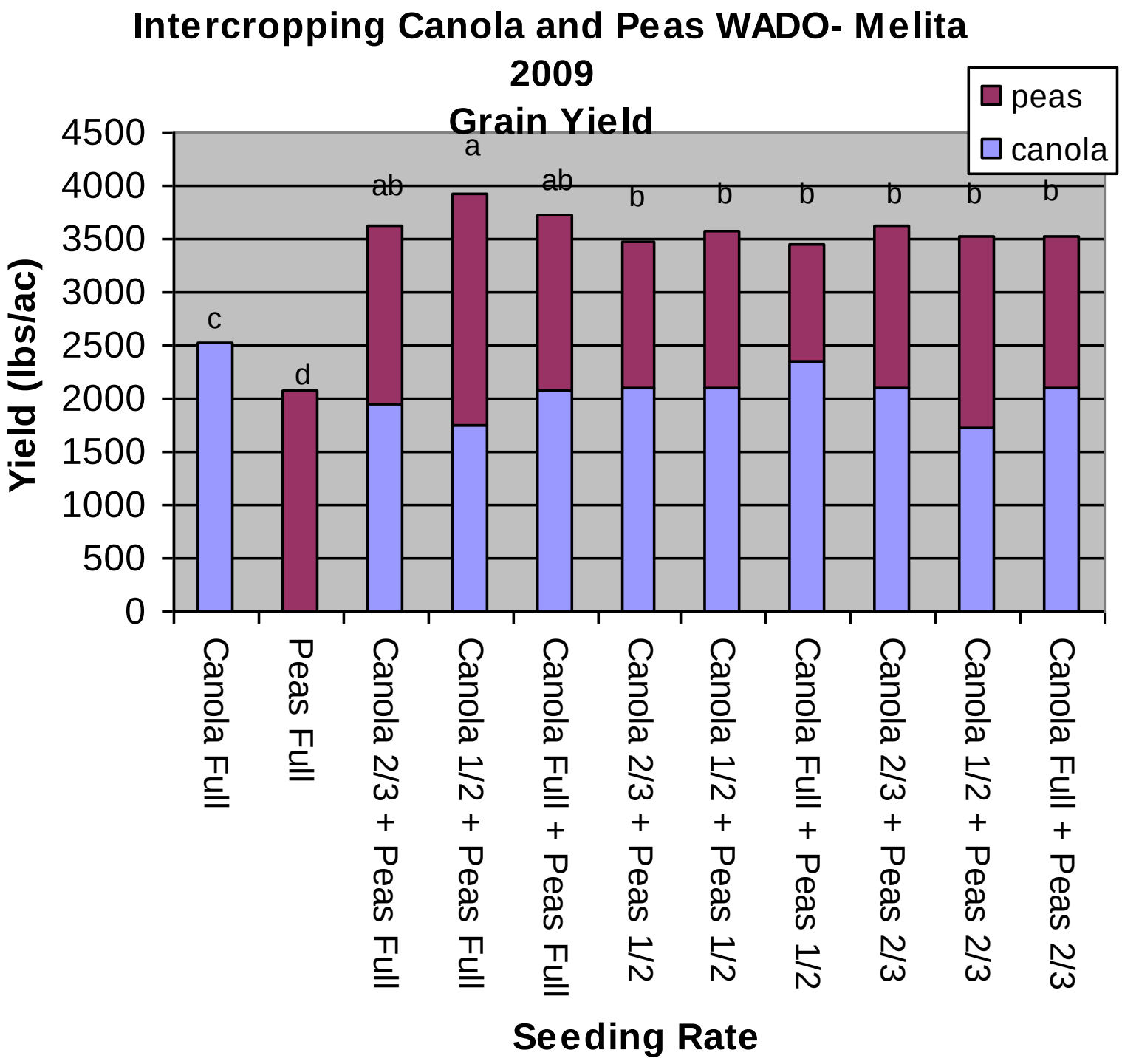
Relay Cropping

Planting of two or more crops with staggered outcomes for harvest or growth patterns

Spring Wheat and Sweet Clover

Cover Cropping

One to Many Crops usually seeded after or before harvest for ground cover or forage, soil building

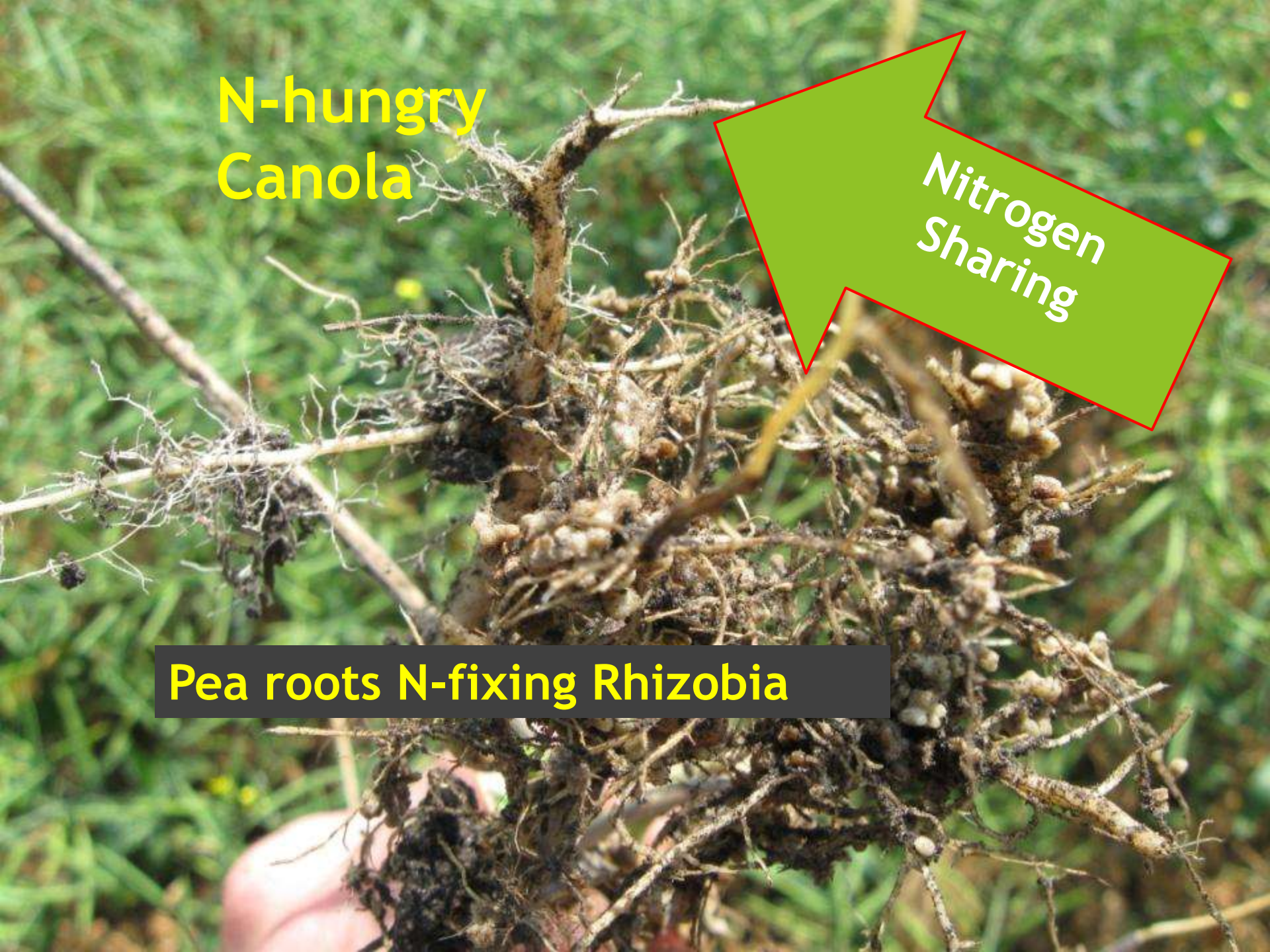

Intercropping Canola and Peas WADO- Melita
2009
Grain Yield
peas
canola
Yield (lbs/ac)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
c
d
ab
a
ab
b
b
b
b
b
b
Canola Full
Peas Full
Canola 2/3 + Peas Full
Canola 1/2 + Peas Full
Canola Full + Peas Full
Canola 2/3 + Peas 1/2
Canola 1/2 + Peas 1/2
Canola Full + Peas 1/2
Canola 2/3 + Peas 2/3
Canola 1/2 + Peas 2/3
Canola Full + Peas 2/3
Seeding Rate

Why Companion Cropping Now? (mostly natural solutions)

- More Crop to Harvest
- Increase Fertilizer Efficiency
- Increase time of growth
- Soil Health (+organic matter)
- Reduce Climate risk
- High Land Values
- Bee health
- Increase Mycorrhizae
- Better Feed Value
- Pesticide Resistance
- Multi-Crop Seeding Equipment
- Sophisticated Seed Cleaning Systems
- Greater Water Use
- Less Salinity
- Less Compaction

What's Happening with Intercrops?

- Leaky N in Peas (8-12% N fixed in soil) (Norman Sawatsky 1987, Xiao 2004)
- Light Use Efficiency (Szumigalski 2008)
- Water Use Efficiency (Szumigalski 2008, Chalmers 2014)
- Root Interactions, pH changes, N transfer, (N sharing, J. Fustec. France 2010 suggests 8-12% in Vetch & Faba > Brassica)
- Mychorrhizae (Pea-Barley 15%N transfer Johnasen 1996)
- Competition Effect (will for survival) (Chalmers 2009)
- Nutrient Efficiency (Szumigalski 2008, Nitrate "Sparing Effect")
- Maturity differences in pea-canola (extra growing days with more crops (Chalmers 2014)
- Less Pea Aphids in pea-canola (Chalmers 2017)


N-hungry
Canola
Nitrogen
Sharing
Pea roots N-fixing Rhizobia

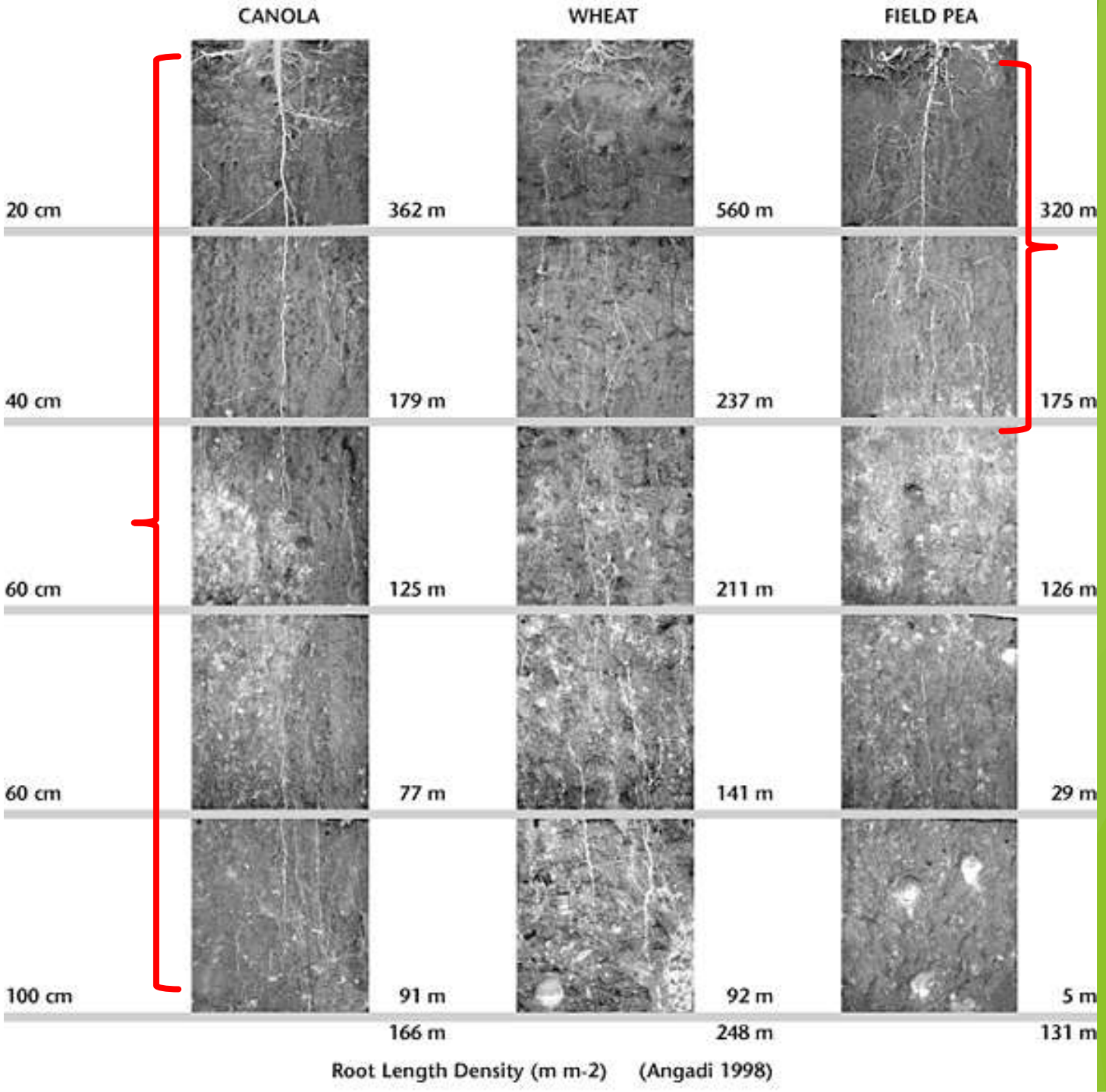
Intercropping Pea Canola: Why Now?

- Overlap seed date
- Overlap Herbicides
- Similar growth stages (flower, maturity)
- Overlap fungicides (Lance)
- Shatter tolerant canola
- Save on Fertilizer and Pesticides
- Grow better peas, harvestability, quality

Clearfield® Production System for Canola

LANCE® FUNGICIDE

Crop Water Sourcing



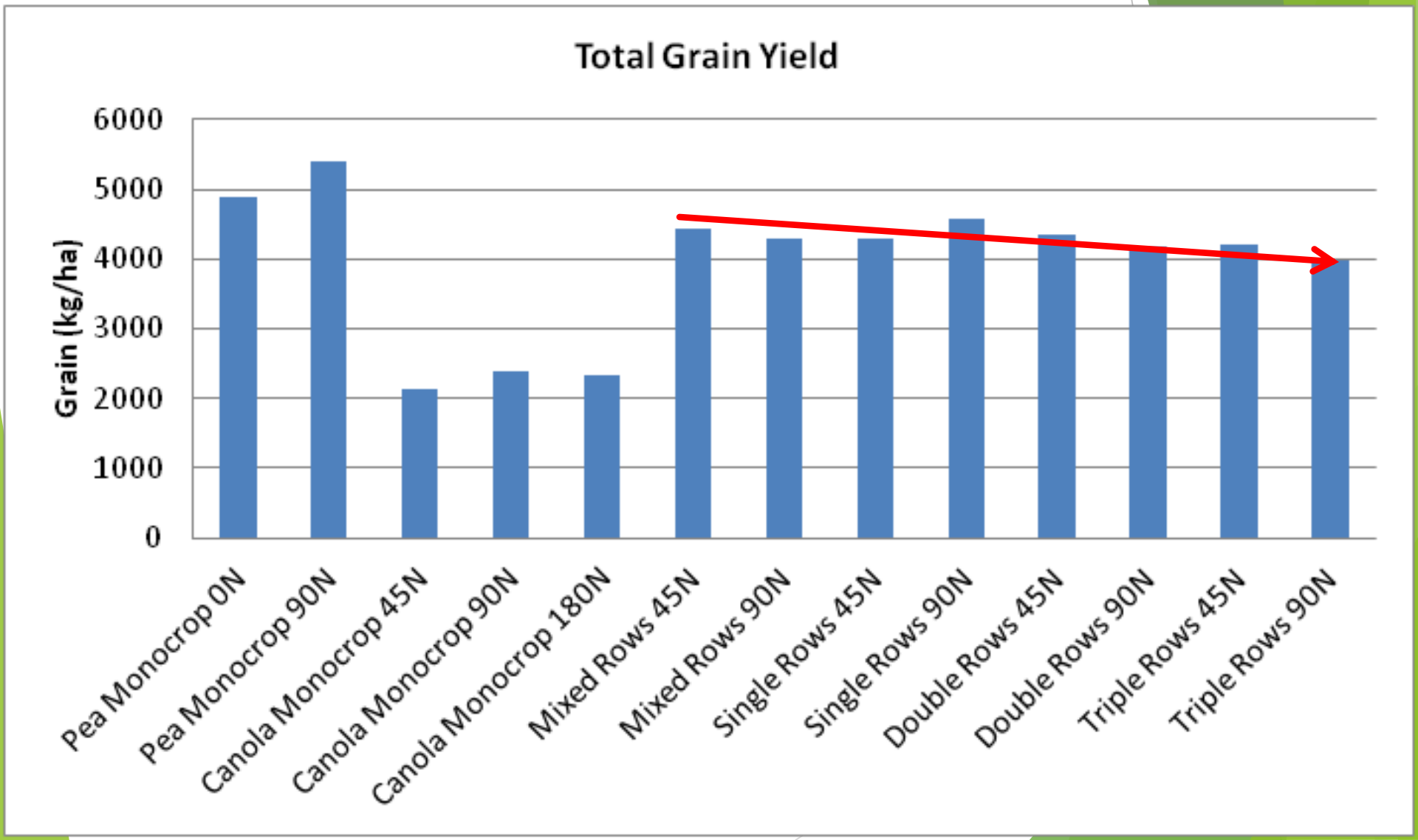
Why Not Companion Crop? (mostly human issues)

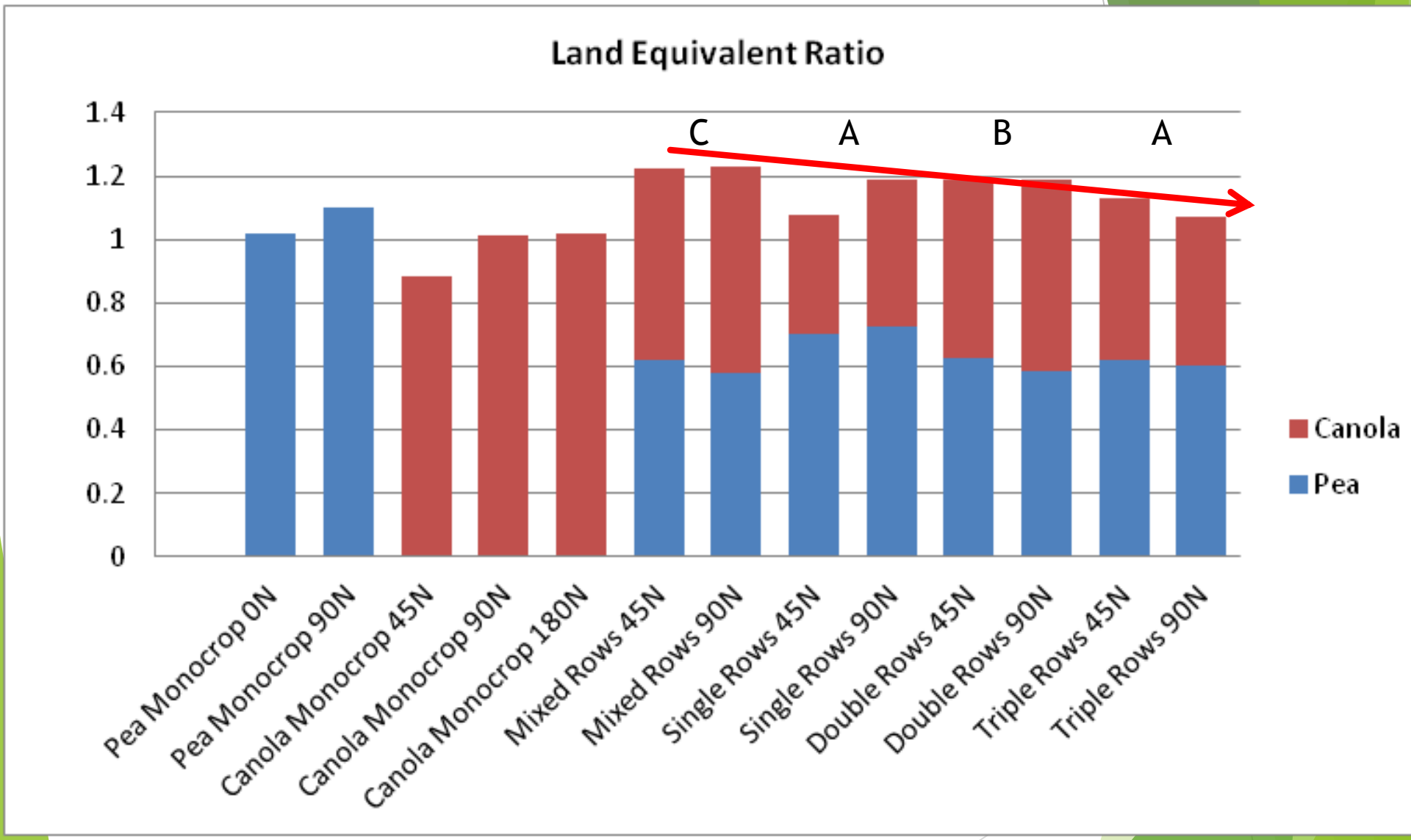
- **Market prices** may be too high or too low
- **Crop Insurance issues**
  - **Sask. Municipal Hail Insur.**
- **Too stressful at harvest**
- Equipment design issues
- Tighter rotation intercropping
  - Increase in Sclerotinia cycles
- Large Residue Issues
- Management issues (seed, chemical, physical)
- Labour (intercropping takes at least 2 people)
- Seed too expensive?
- Cleaning issues at harvest
- Lack of courage

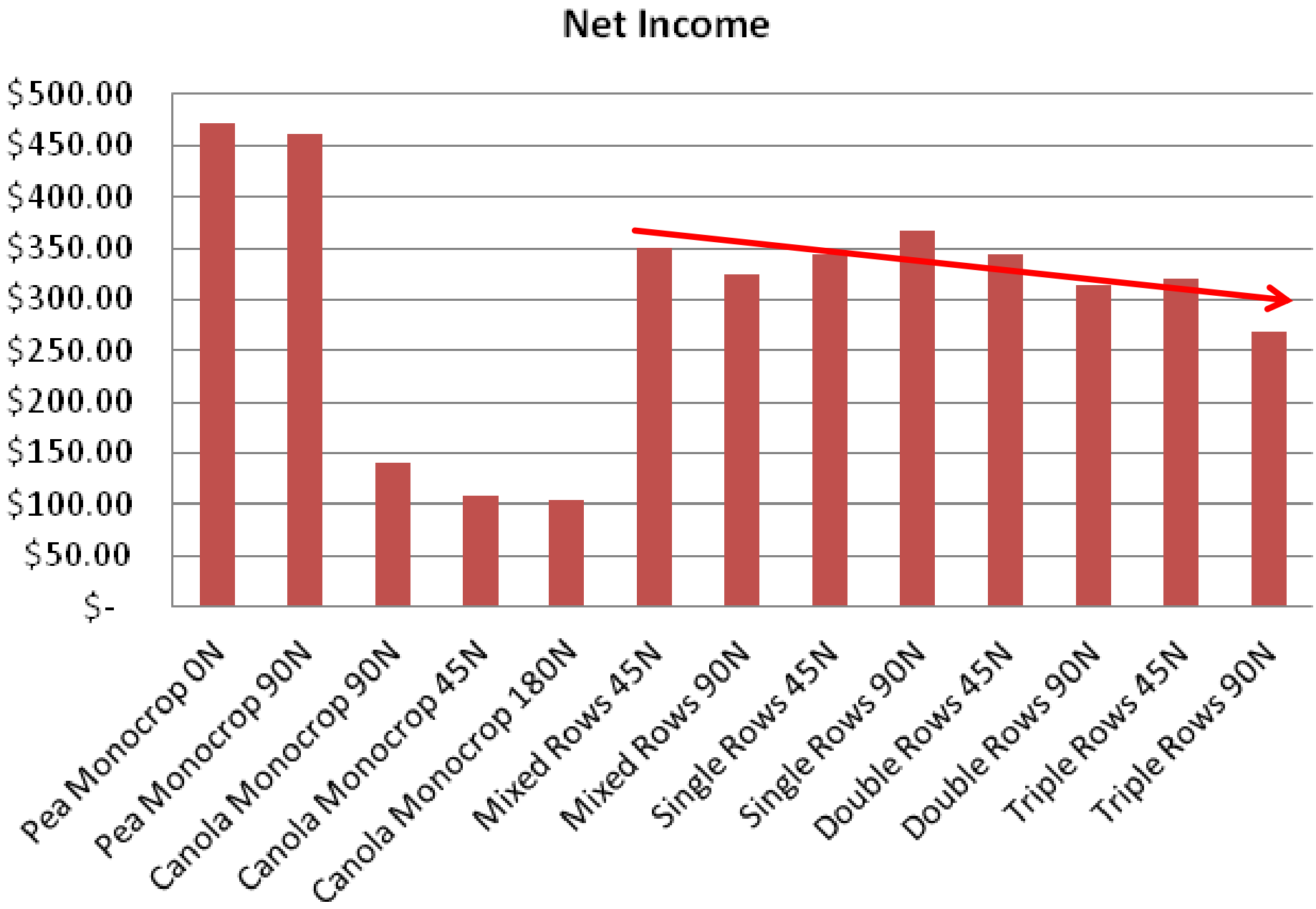
Mixed Rows @ 45 or 90 N

Single Rows @ 45 or 90 N

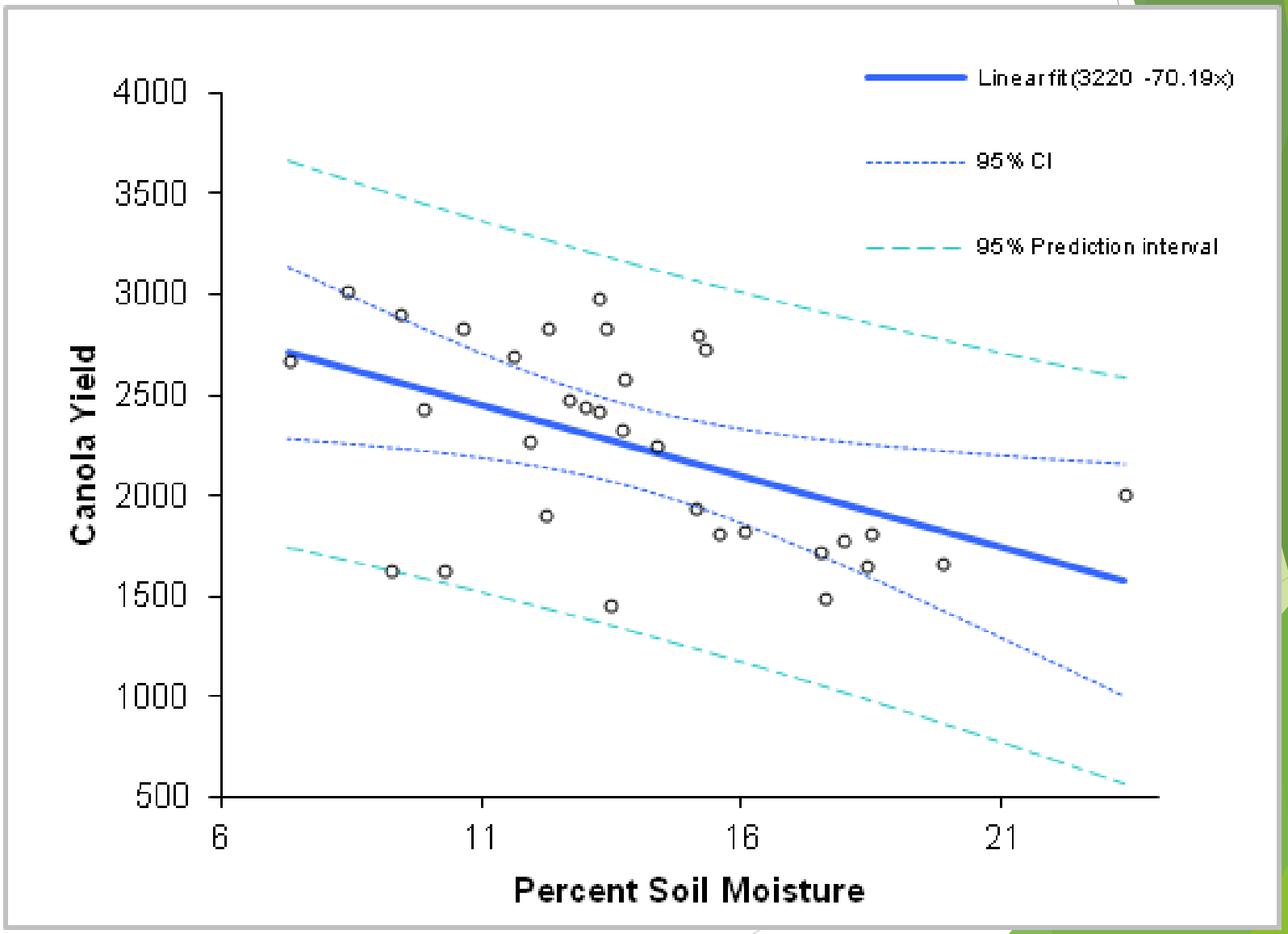
Double or Triple Rows @ 45 ot 90 N


Total Grain Yield
Grain (kg/ha)
6000
5000
4000
3000
2000
1000
0
Pea Monocrop 0N
Pea Monocrop 90N
Canola Monocrop 45N
Canola Monocrop 90N
Canola Monocrop 180N
Mixed Rows 45N
Mixed Rows 90N
Single Rows 45N
Single Rows 90N
Double Rows 45N
Double Rows 90N
Triple Rows 45N
Triple Rows 90N


Land Equivalent Ratio
1.4
1.2
1
0.8
0.6
0.4
0.2
0
C
A
B
A
Pea Monocrop 0N
Pea Monocrop 90N
Canola Monocrop 45N
Canola Monocrop 90N
Canola Monocrop 180N
Mixed Rows 45N
Mixed Rows 90N
Single Rows 45N
Single Rows 90N
Double Rows 45N
Double Rows 90N
Triple Rows 45N
Triple Rows 90N
Canola
Pea


Net Income
$500.00
$450.00
$400.00
$350.00
$300.00
$250.00
$200.00
$150.00
$100.00
$50.00
$-
Pea Monocrop 0N
Pea Monocrop 90N
Canola Monocrop 90N
Canola Monocrop 45N
Canola Monocrop 180N
Mixed Rows 45N
Mixed Rows 90N
Single Rows 45N
Single Rows 90N
Double Rows 45N
Double Rows 90N
Triple Rows 45N
Triple Rows 90N

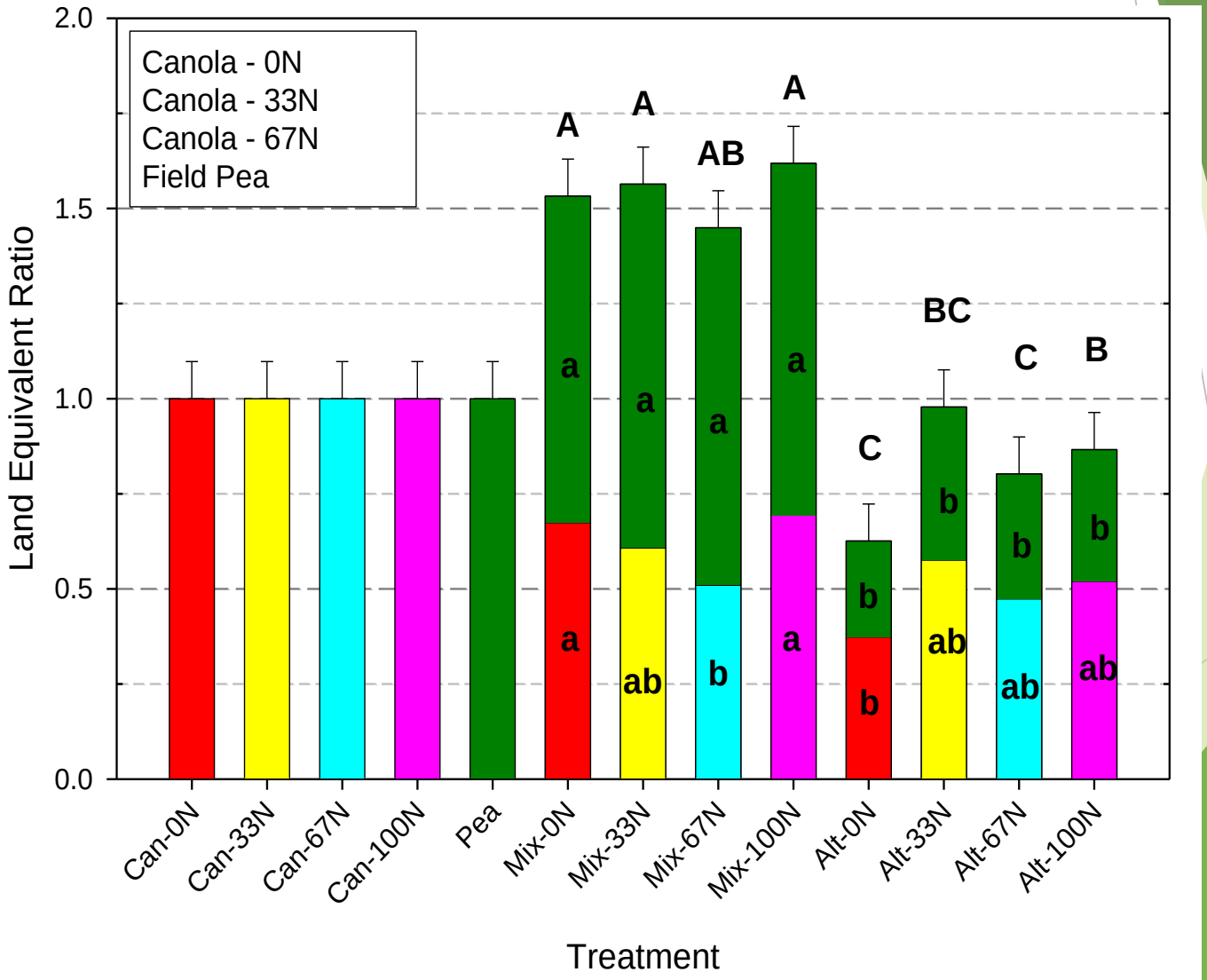
Soil Moisture is Contributing! (2013 data)



Soil Moisture is Helping!!
2013 Data Only

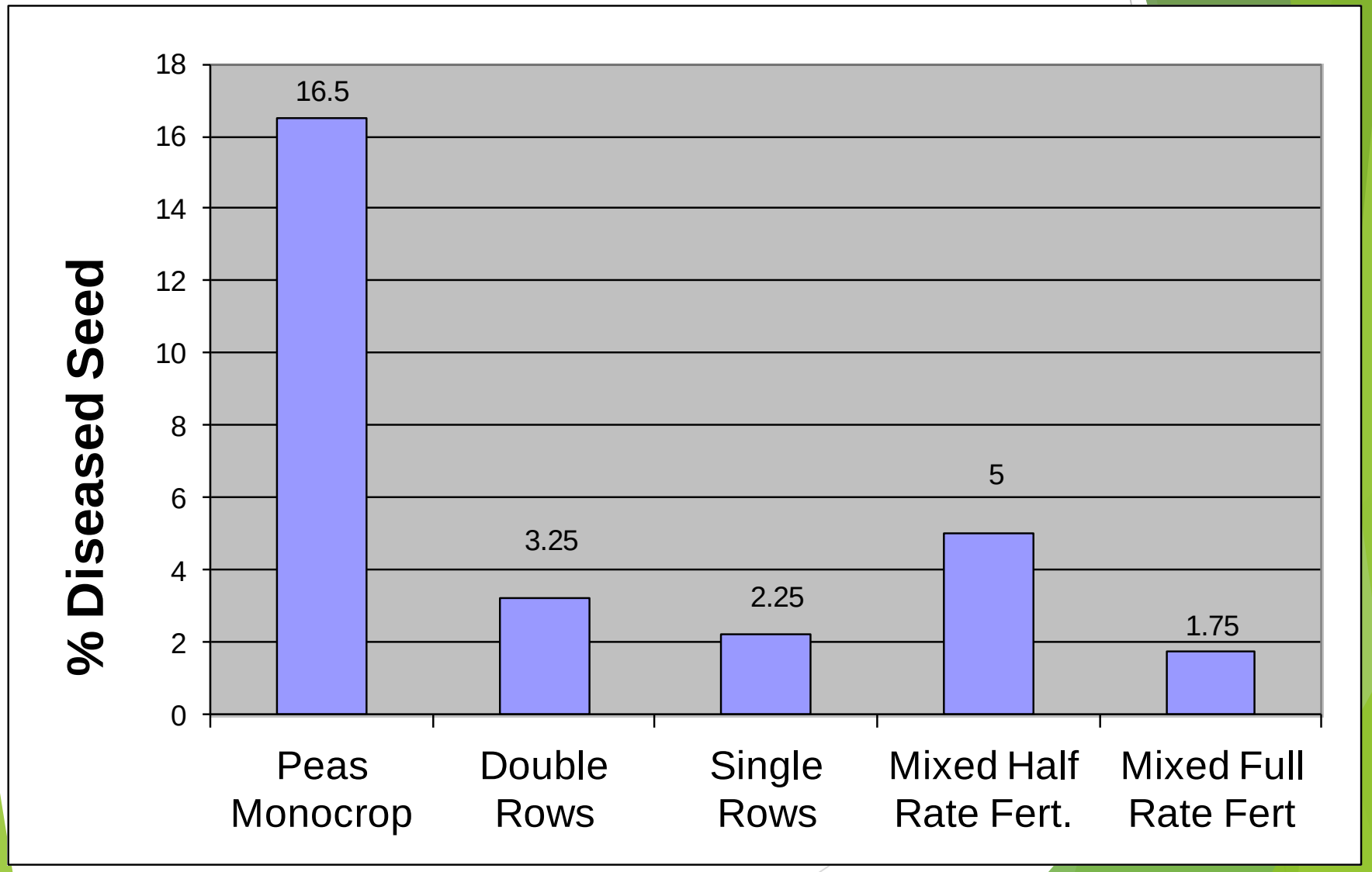
Relationship	Correlation		Regression		
	r	P value	R-squared	P value	Equation
Pea Yield x SM	0.02	0.899	0.00	0.899	PeaYD = 4812 + 5.2 (SM)
Canola Yield x SM	-0.50	**0.004**	0.25	**0.004**	CanYD = 3220 - 70 (SM)
Total Yield x SM	-0.28	0.127	0.08	0.127	TYD = 8032 - 65 (SM)
Pea LER x SM	0.14	0.437	0.02	0.437	PLER = 0.6 + 0.005 (SM)
Canola LER x SM	-0.52	**0.004**	0.28	**0.002**	CLER = 0.9 - 0.02 (SM)
Total LER x SM	-0.38	**0.033**	0.14	**0.033**	TLER = 1.4 -0.016 (SM)

2011 Peaola in Melita (wet year)




Shatter tolerance
Straight Cutting
Seed Born Diseases

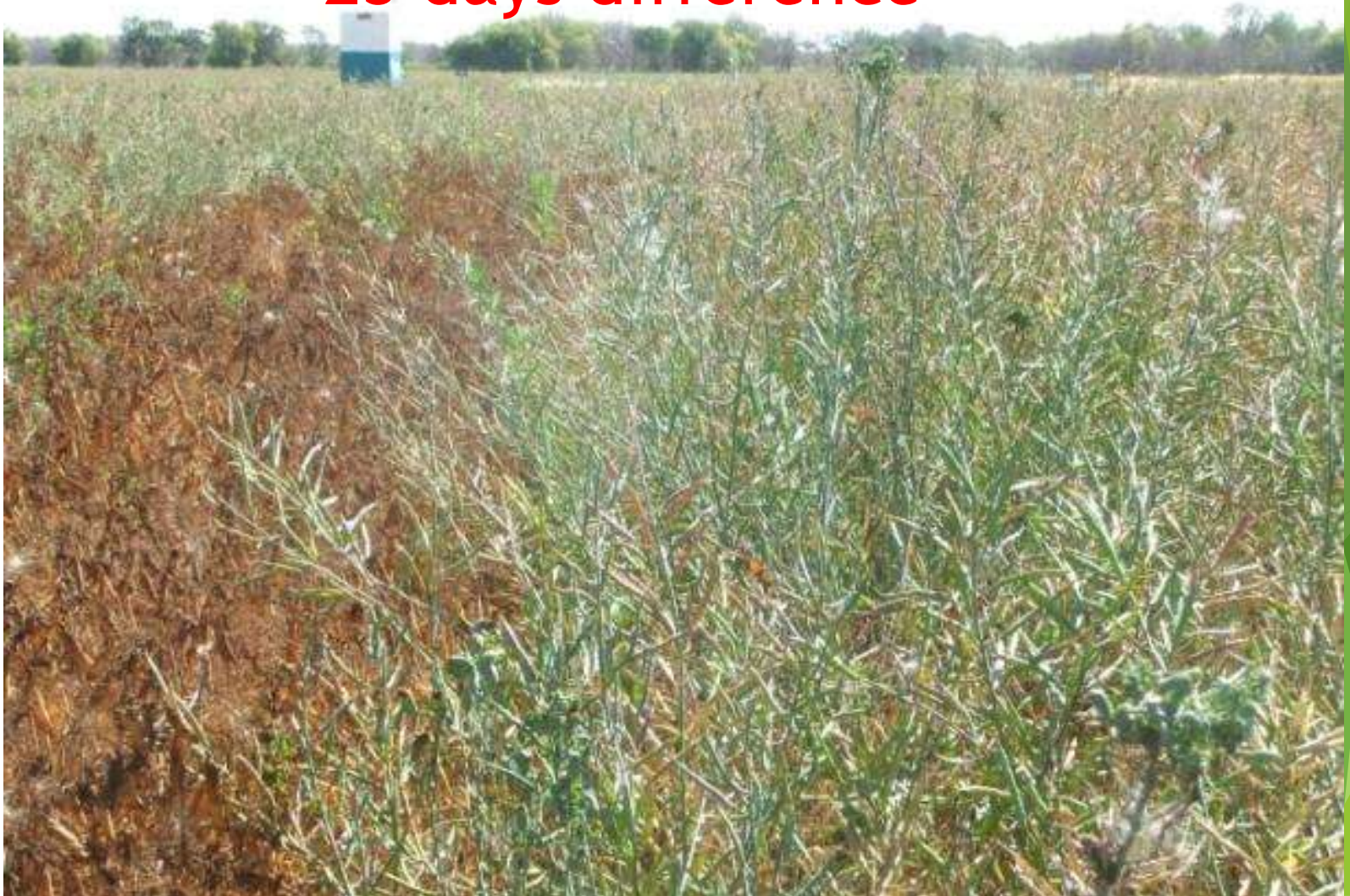
Intercrop Pea Seed Ascochyta with Canola



Time to Maturity

Photo taken Aug 7, 2012
Maturity: CDC Meadow Peas July 23, 71-40CL Canola Aug 17

25 days difference



Frost tolerance in Pea

- Darren Peters Pea Canola photo
- After May Long Weekend hard frost in 2015

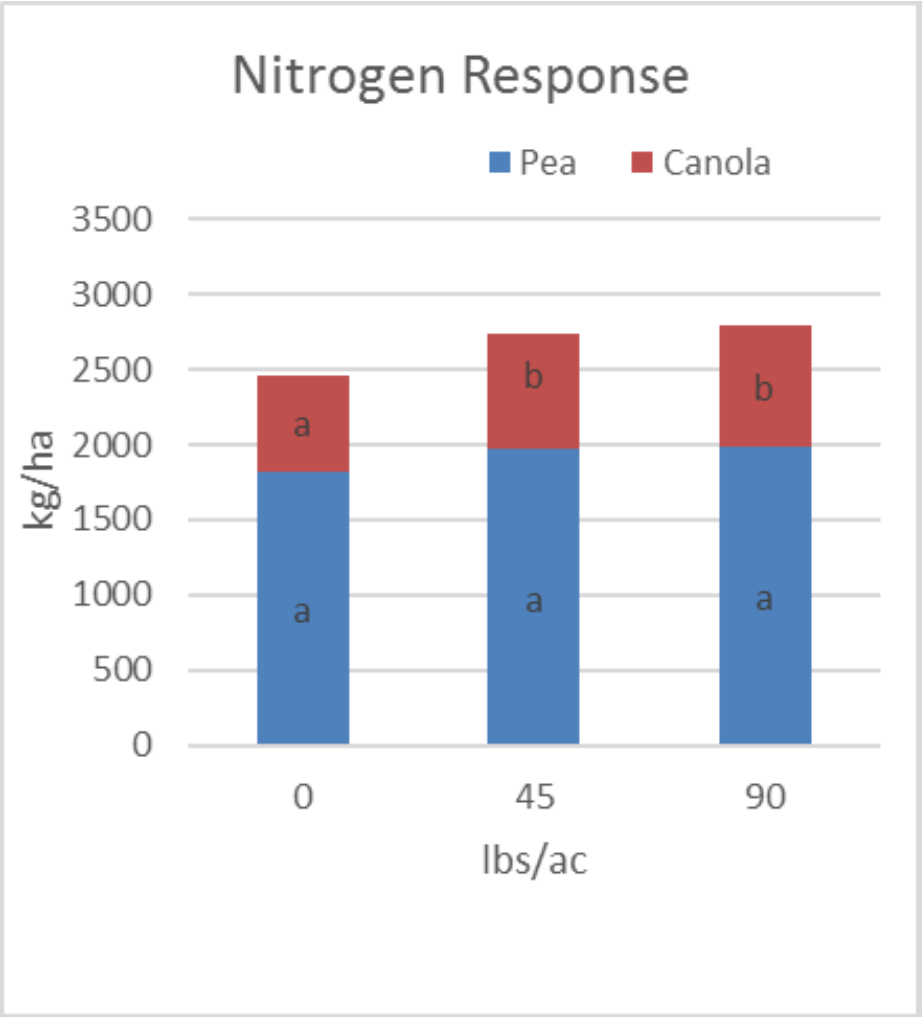
St. Leone, MB
25#N/ac, 25#P/ac
1.5# canola, 3 bu/ac Pea

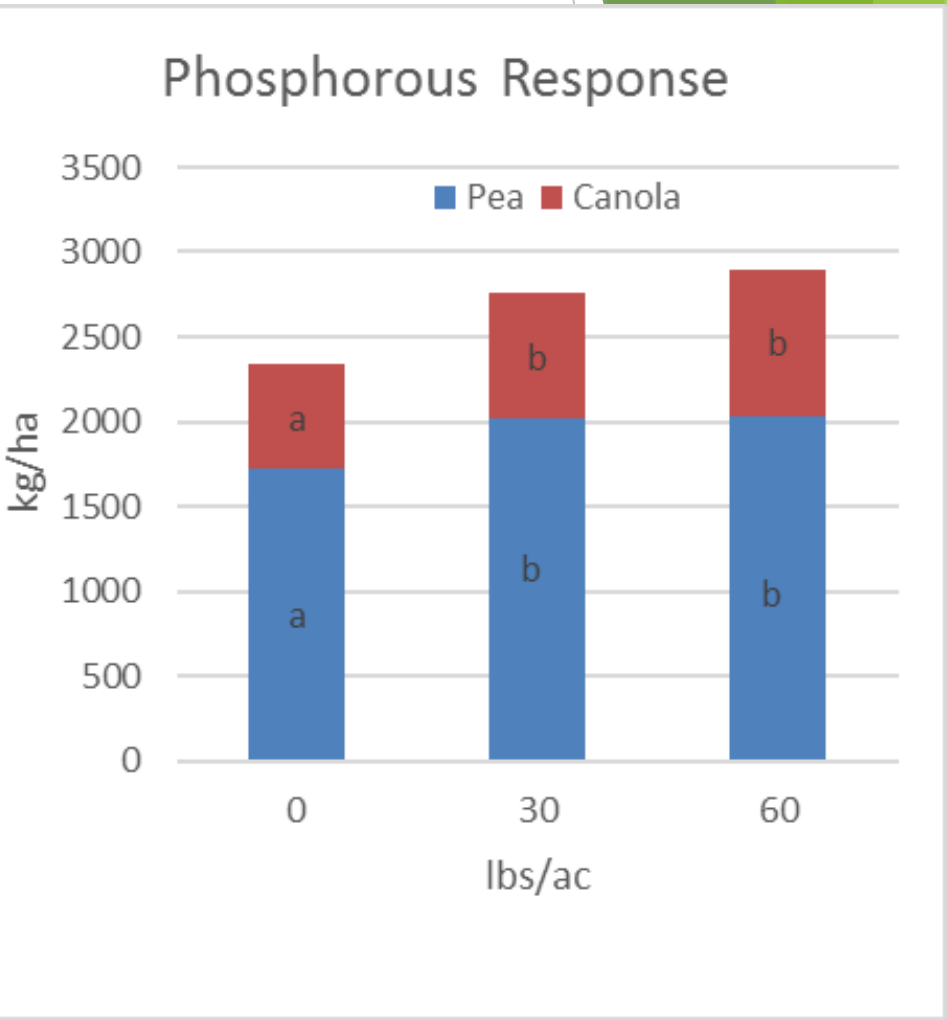
2012 (photo, 155 acres)
6.5 bu/ac canola (30 local ave.)
41 bu/ac pea (45 local ave.)
LER = 1.13

2011 (13 acres, same inputs)
30 bu/ac Peas (49 local ave)
30 bu/ac Canola (34 local ave.)
LER= 1.49

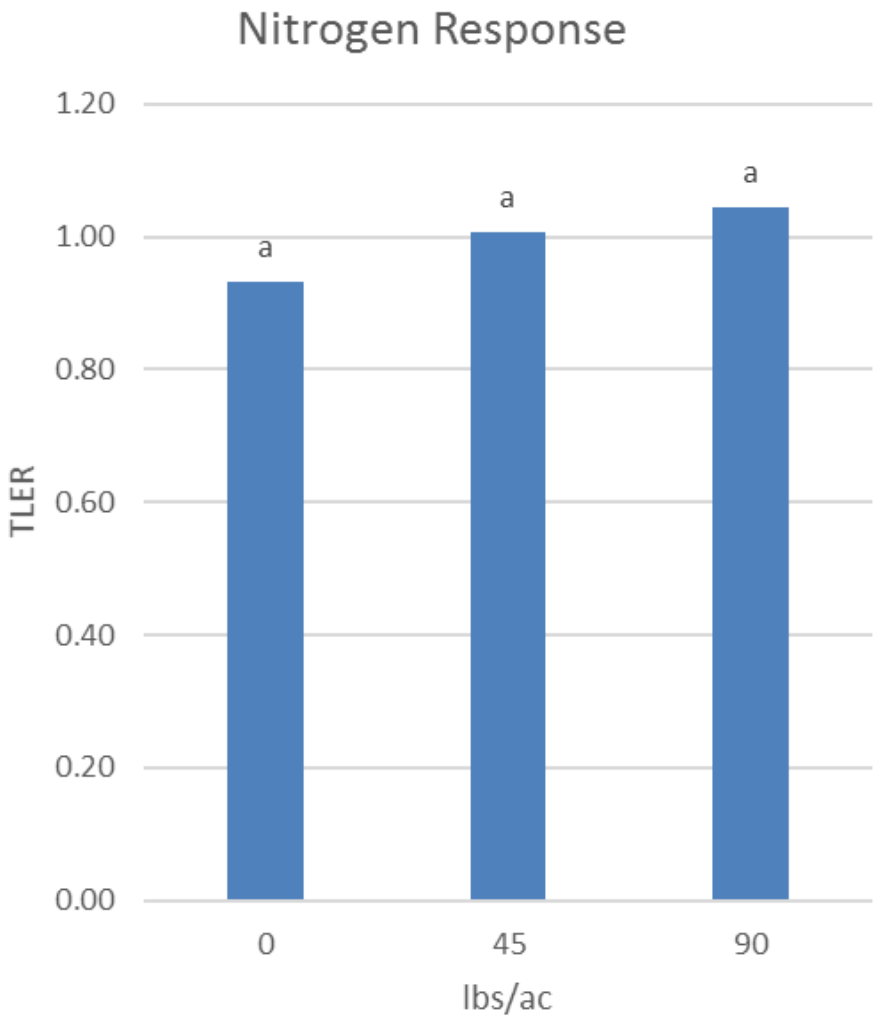
Pea and Canola
More Yield = More Phosphorous?

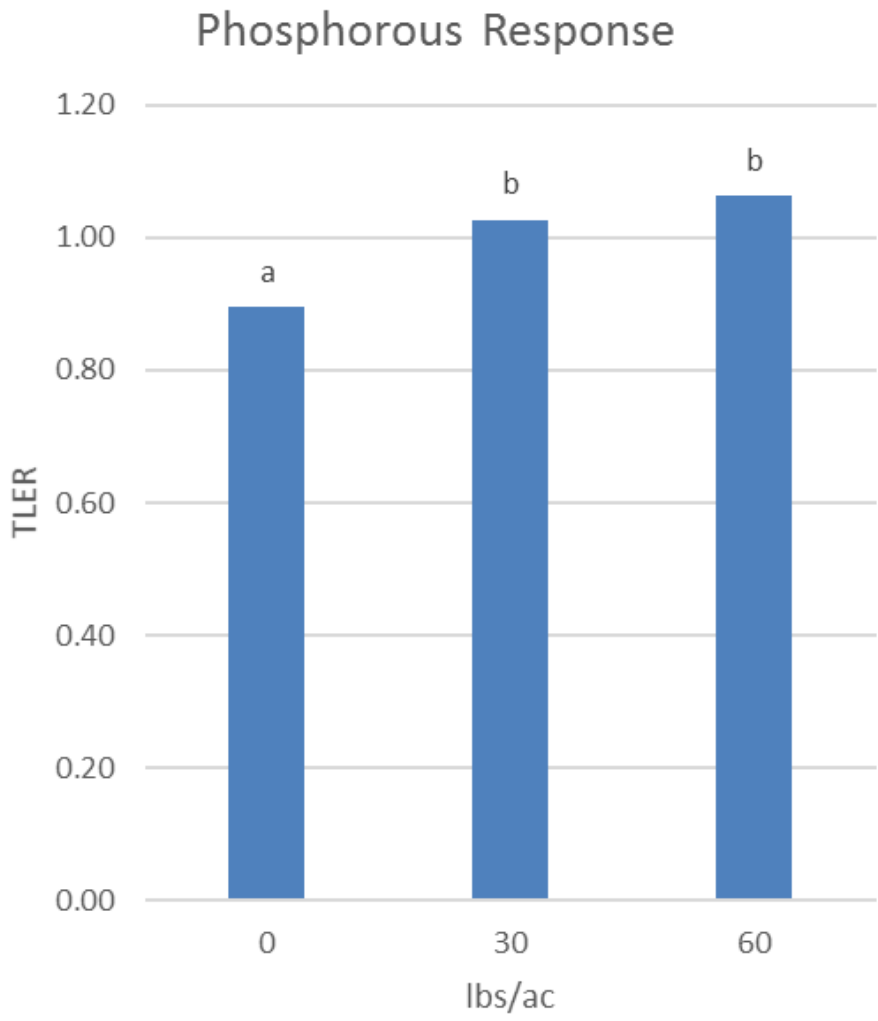
2016 & 2017 Pea-canola N vs. P Yield



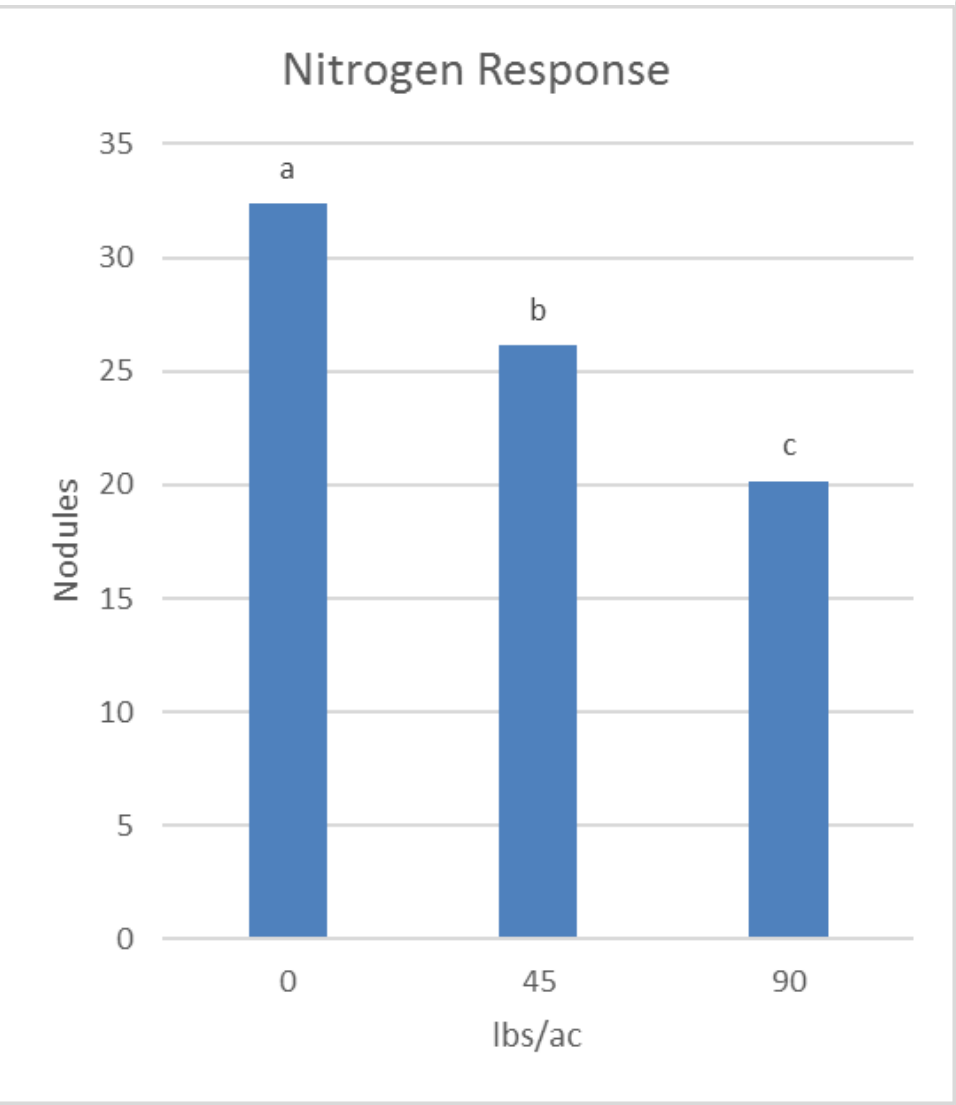


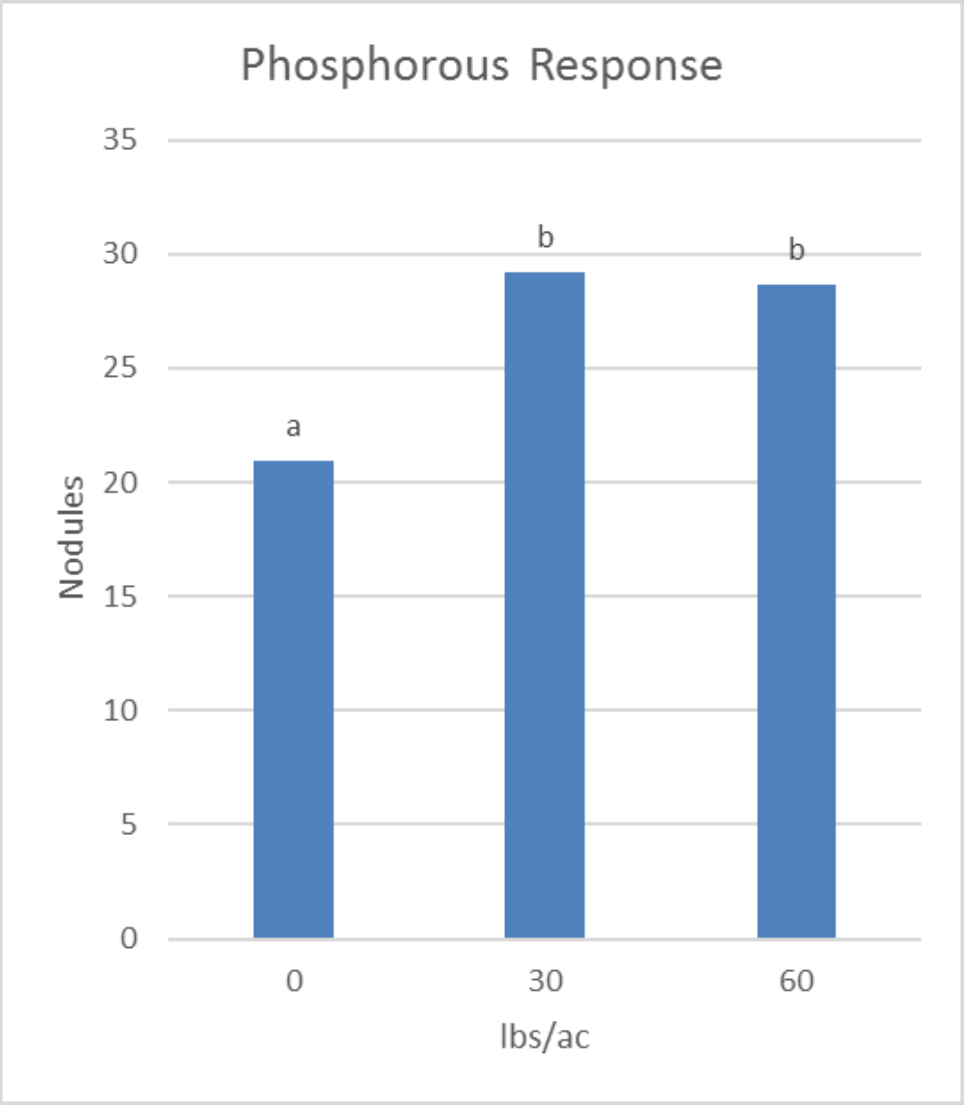
2016 & 2017 Pea-Canola N vs. P Total LER



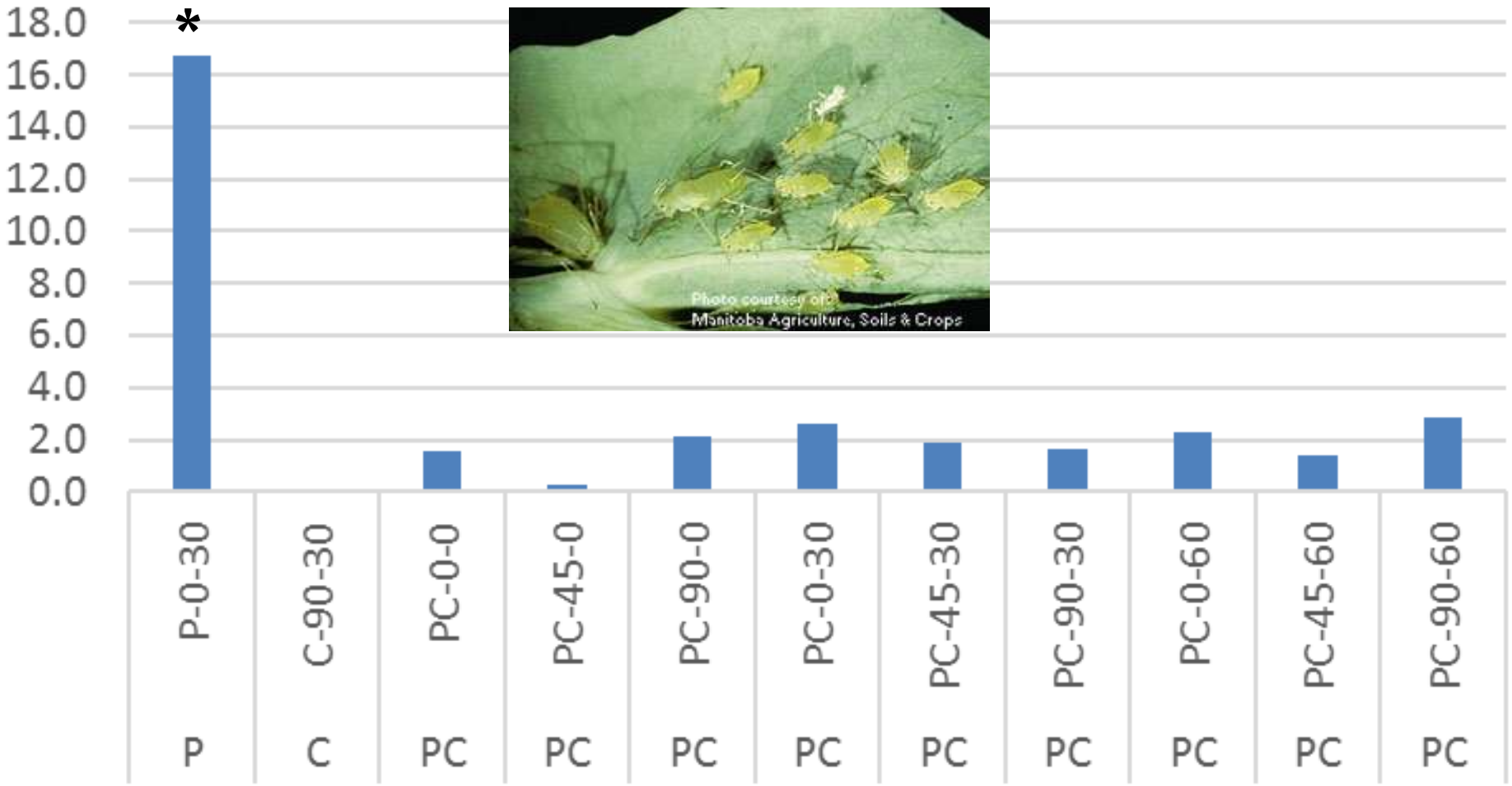


2016 & 2017 Pea Nodules
N vs. P Response





Aphids Per Plant 2017



2018 Peaola Alfalfa x Fungicide

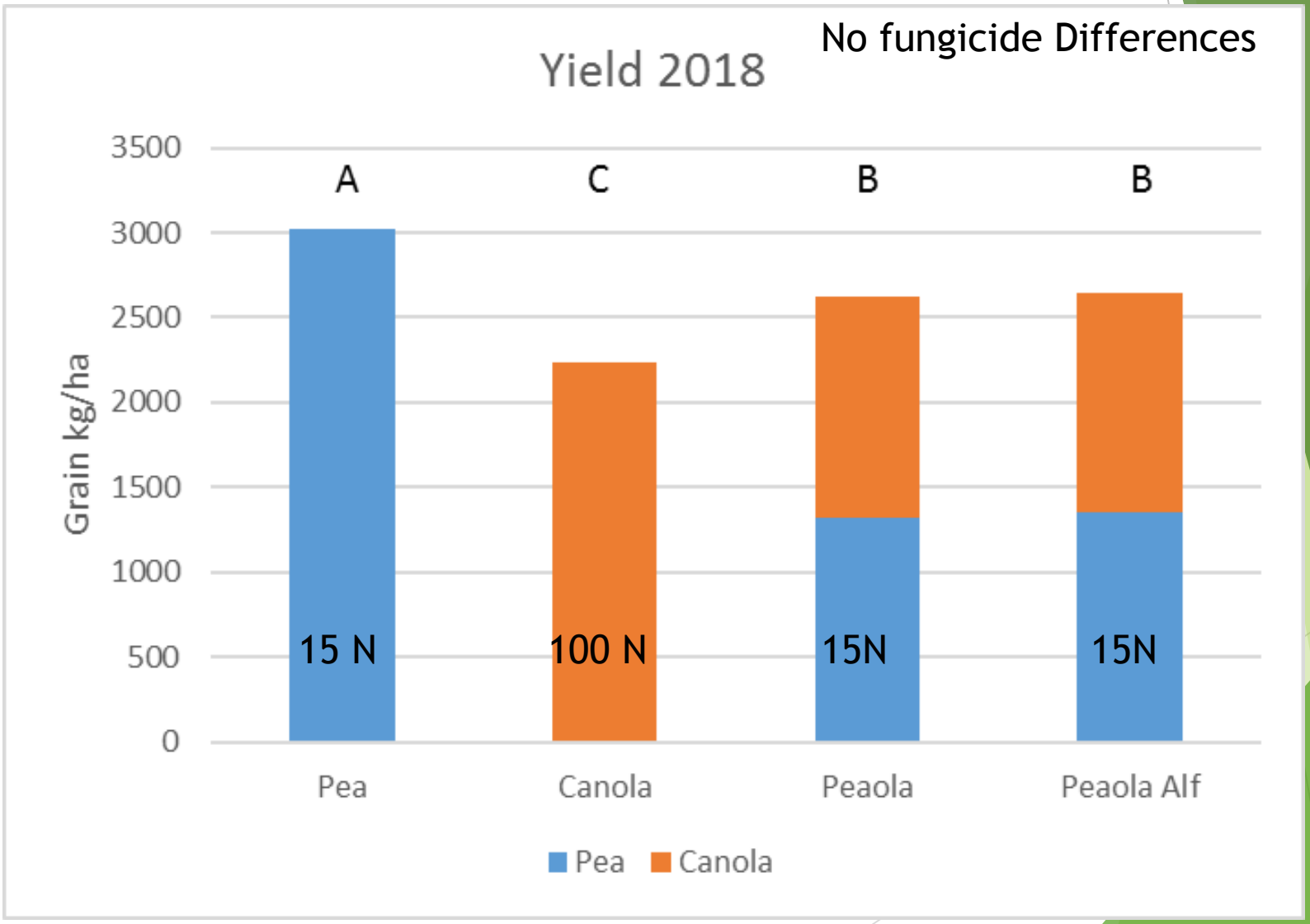
Spring Broadcast alfalfa 8 lbs/ac

Final Fall Alfalfa Stand: 52 ppm^2

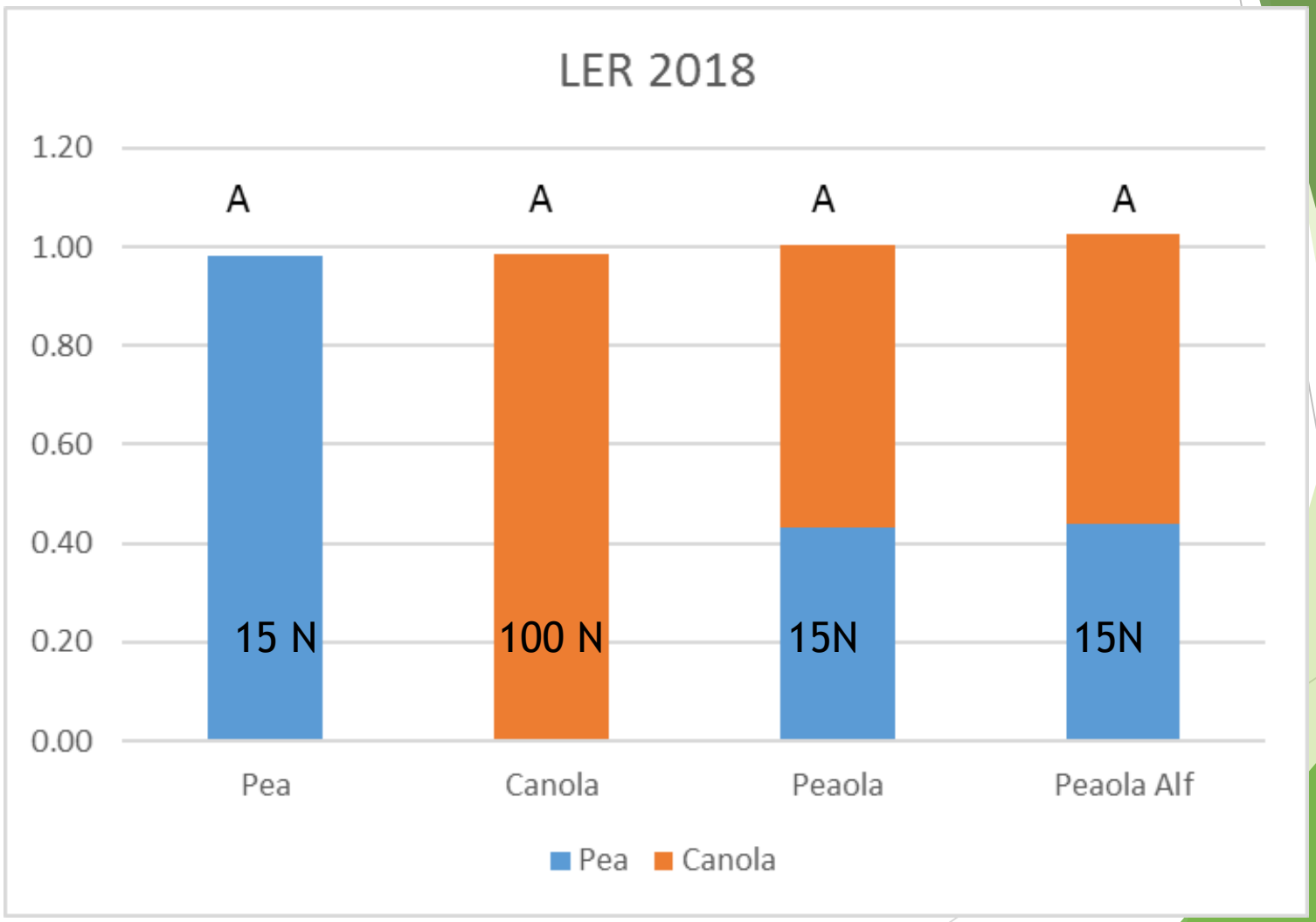
Split Fungicide App : Lance

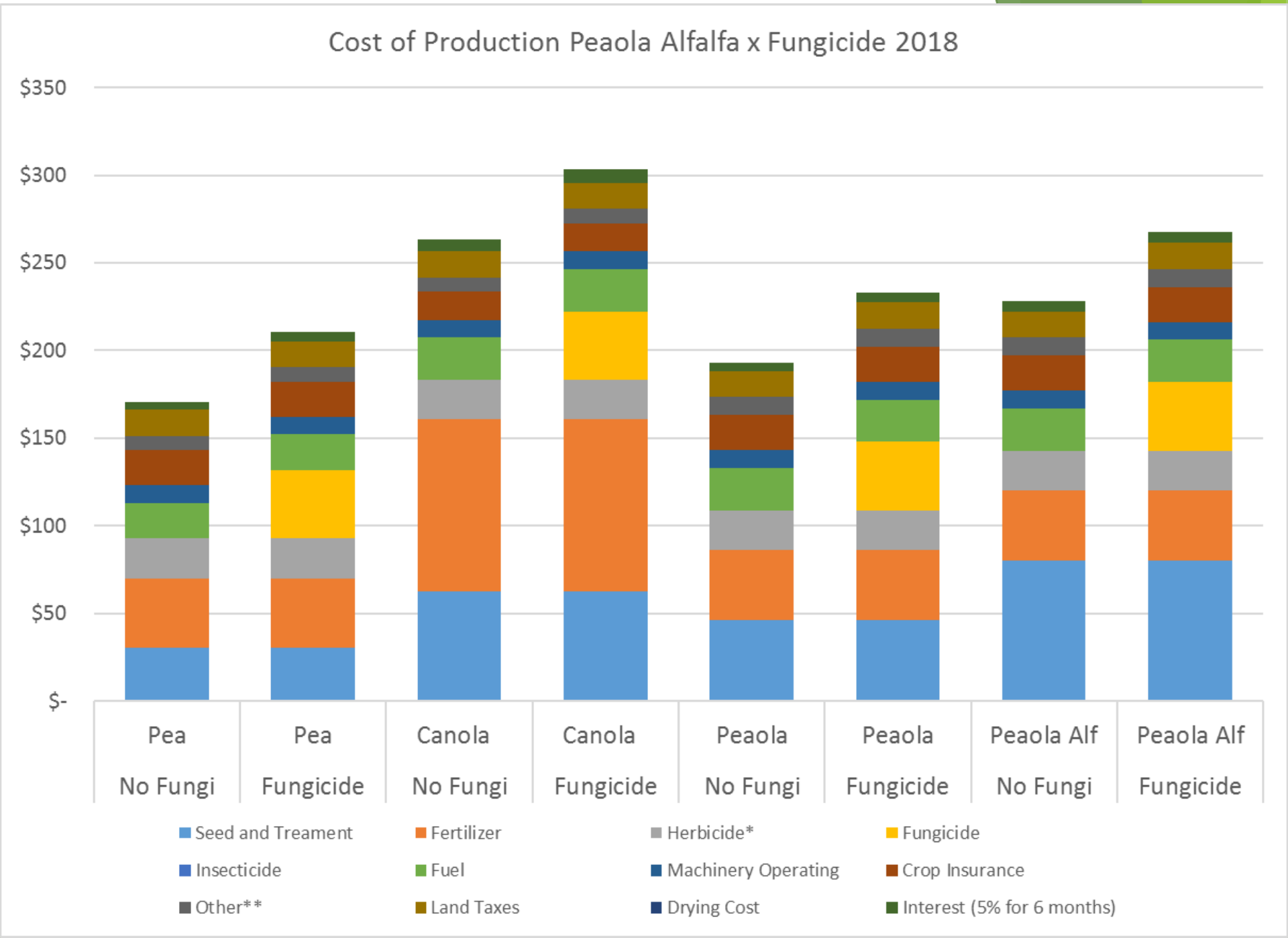
LANCE FUNGICIDE

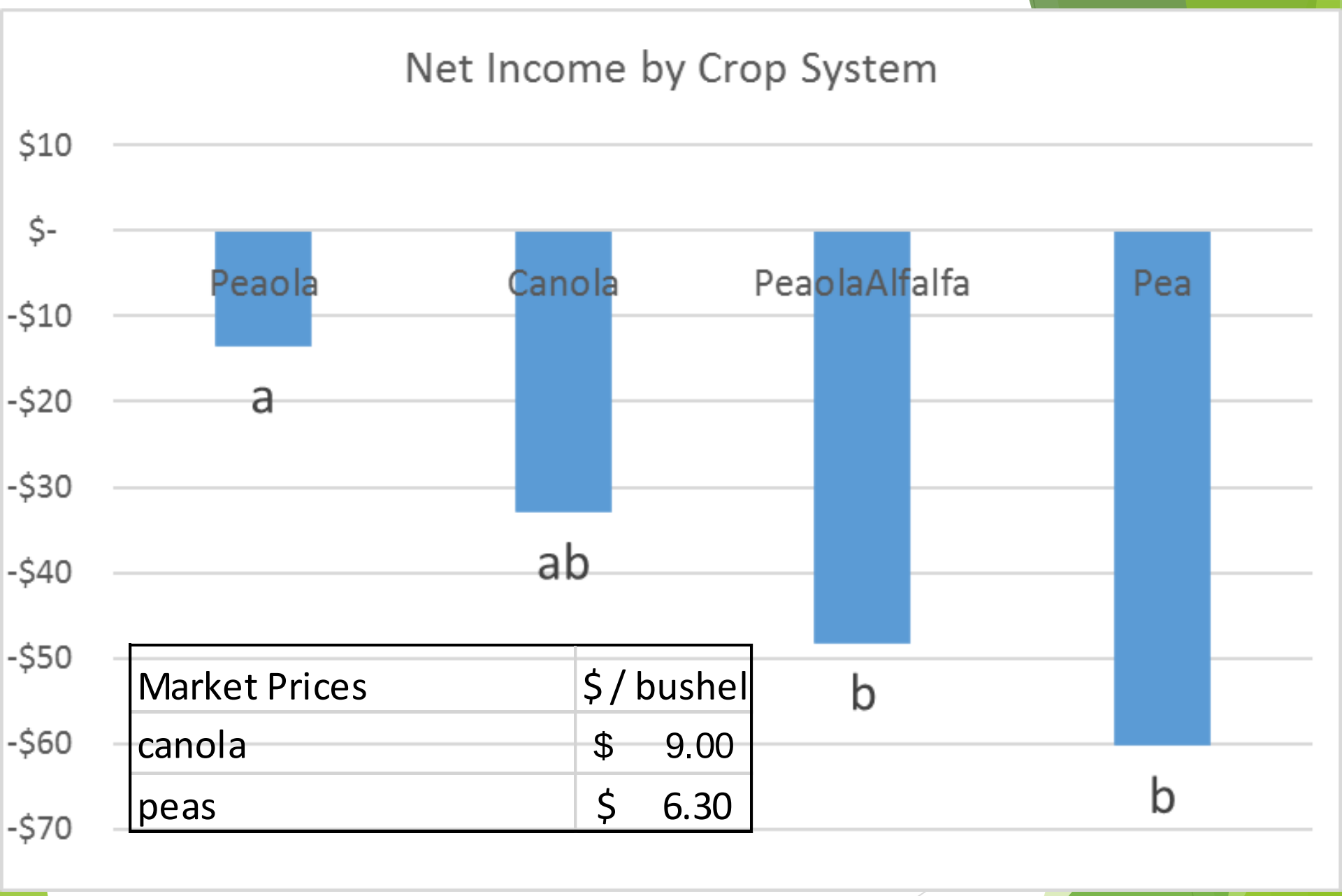
Peaola – Alfalfa x Fungicide 2018



Peaola – Alfalfa x Fungicide 2018




Cost of Production Peaola Alfalfa x Fungicide 2018
$350
$300
$250
$200
$150
$100
$50
$-
Pea No Fungi
Pea Fungicide
Canola No Fungi
Canola Fungicide
Peaola No Fungi
Peaola Fungicide
Peaola Alf No Fungi
Peaola Alf Fungicide
Seed and Treament
Fertilizer
Herbicide*
Fungicide
Insecticide
Fuel
Machinery Operating
Crop Insurance
Other**
Land Taxes
Drying Cost
Interest (5% for 6 months)



Market Prices	$ / bushel
canola	$ 9.00
peas	$ 6.30

Pea Canola Conclusions

- ✓ More yield per acre by 0-60% LER (20% ave.)
- ✓ More Rain the more effect there is
- ✓ Mixed row orientation better
- ✓ Uses more soil moisture
- ✓ Reduces *Mycosphaerella* disease in pea seed, plants
- ✓ Improves canola shatter tolerance
- ✓ Uses more soil nutrients (P)
- ✓ Likely improves N-fixation efficiency
- ✓ Reduced Pea –Aphids by more than 50%
- ✓ Increases Pea standability/harvestability
- ✓ Can effectively establish alfalfa stands
- ✗ Nitrogen reduces pea nodules
- ✗ Requires swath or desiccation operation

Hairy Vetch Seed Production in Winter Wheat

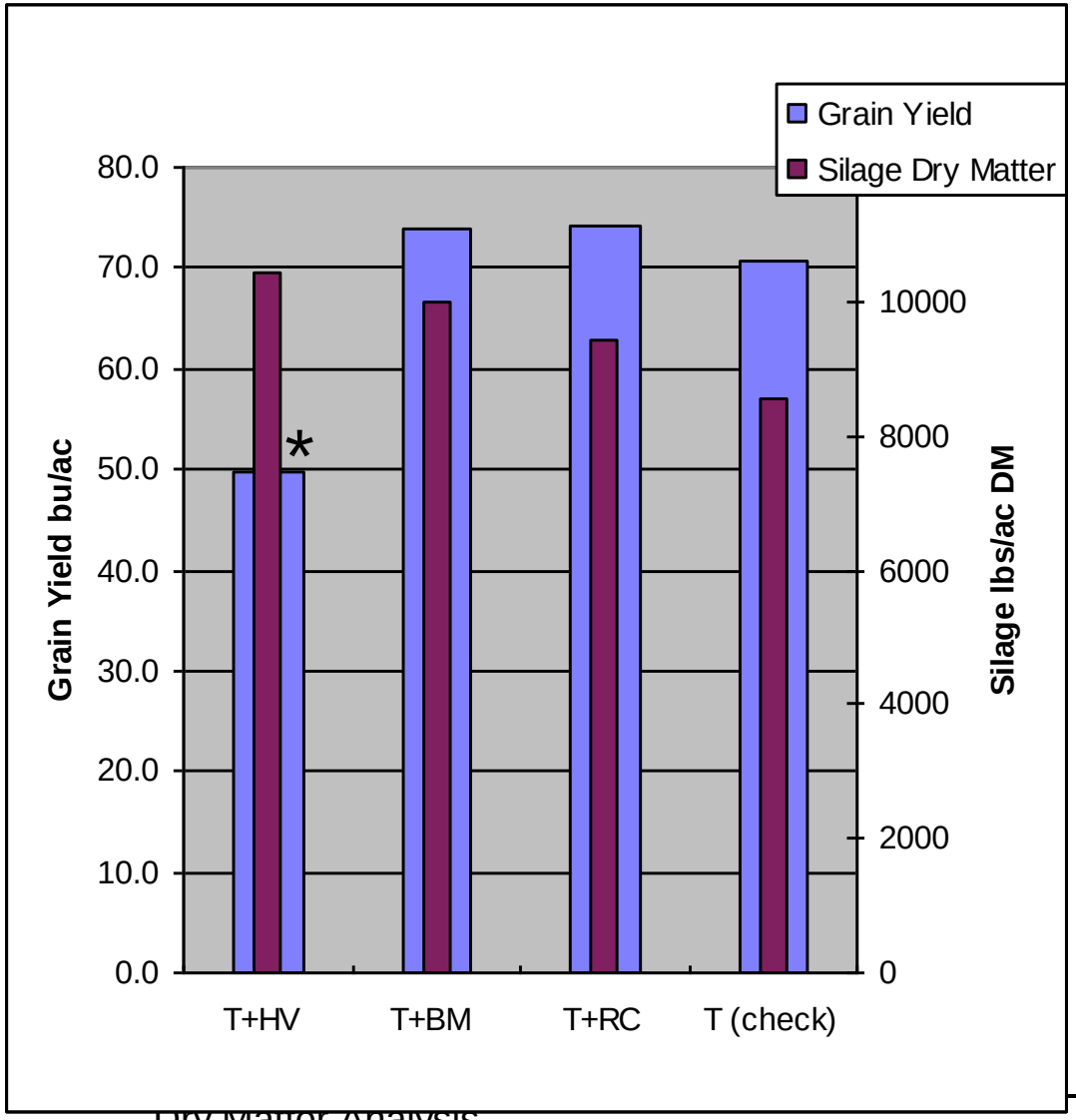
277 lbs/ac H. Vetch
33 bu/ac W. Wheat
Organic

Winter Wheat/Rye and Hairy Vetch – for seed


2012/07/10 12:04 PM


2012/07/27 03:40 PM

Treatment	Hairy Vetch	Wheat	Hairy Vetch	Wheat	Total	Gross	Net	COP*
	Spring Emergence (p/m$^{2)}$)		Yield (kg/ha)			Income ($/ha)		$/ha
Hairy Vetch	31	-	758	-	758	$ 4,167.39	$ 3,233.34	$424.57
Wheat	-	56	-	3924	3924	$ 1,338.14	$ 565.87	$351.03
Hairy Vetch & Wheat	14	47	438	2405	2843	$ 3,229.58	$ 2,190.55	$472.96
CV%	14	19	37	25	25	32	46	
LSD (p<0.05; 0.1)	8	NS	NS	1417	1417	$ 2,101.31	$ 1,134.70	
Grand Mean	22	51	3164	2508	2508	$ 2,911.70	$ 1,996.58	
P value	**0.020**	0.368	0.220	**0.008**	**0.008**	**0.047**	**0.057**	
Significant?	Yes	No	No	Yes	Yes	Yes	Yes	



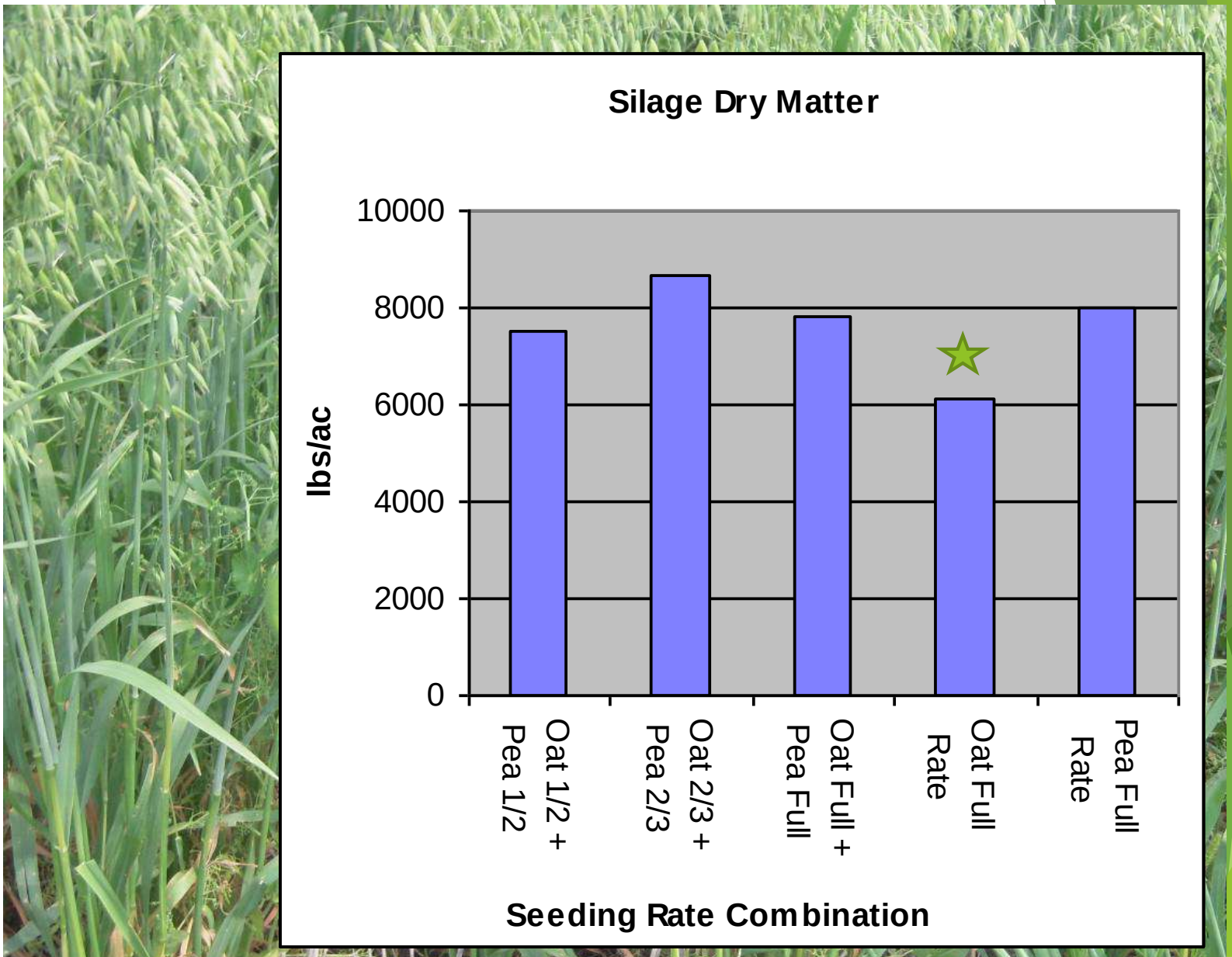
Spring Triticale and Relay Legumes

- Black medic
- Red Clover
- Hairy Vetch

Dry Matter Analysis

Treatment	CP %	Ca %	P %	Mg %	K %	Na %	ADF %	NDF %	NFCarb %	TDN %	NetE Gain Mcal/kg	RFV
T+HV	9.09	0.40	0.21	0.12	2.04	0.08	40.57	60.89	19.22	57.90	0.67	88
T+BM	7.95	0.26	0.25	0.10	1.20	0.08	36.28	57.29	23.95	60.04	0.73	98
T+RC	8.14	0.18	0.24	0.11	1.13	0.11	35.97	57.14	23.92	60.20	0.74	99
T (check)	7.70	0.18	0.14	0.16	1.09	0.03	37.40	56.91	24.59	59.48	0.72	98

Peas and Oats



Pea and Oat Feed Quality

Seed Rate Treatment	CP %	Ca %	P %	Mg %	K %	Na %	NaCl %	ADF %	NDF %	NonFiber Carb %	TDN %	NEG Mcal/kg	RFV
Oat 1/2 + Pea 1/2	9.37	0.47	0.21	0.22	1.97	0.28	0.70	41.16	58.57	21.26	57.6	0.66	90
Oat 2/3 + Pea 2/3	7.78	0.37	0.19	0.21	1.93	0.08	0.21	35.76	56.09	25.33	60.3	0.74	101
Oat Full + Pea Full	8.66	0.51	0.16	0.23	2.26	0.20	0.08	38.76	59.10	21.44	58.8	0.70	92
Oat Full Rate	6.34	0.22	0.18	0.16	1.94	0.18	0.07	39.97	59.88	22.98	58.2	0.68	90
Pea Full Rate	11.62	1.00	0.18	0.28	1.41	0.05	0.12	39.39	50.01	27.58	58.5	0.69	108

2015

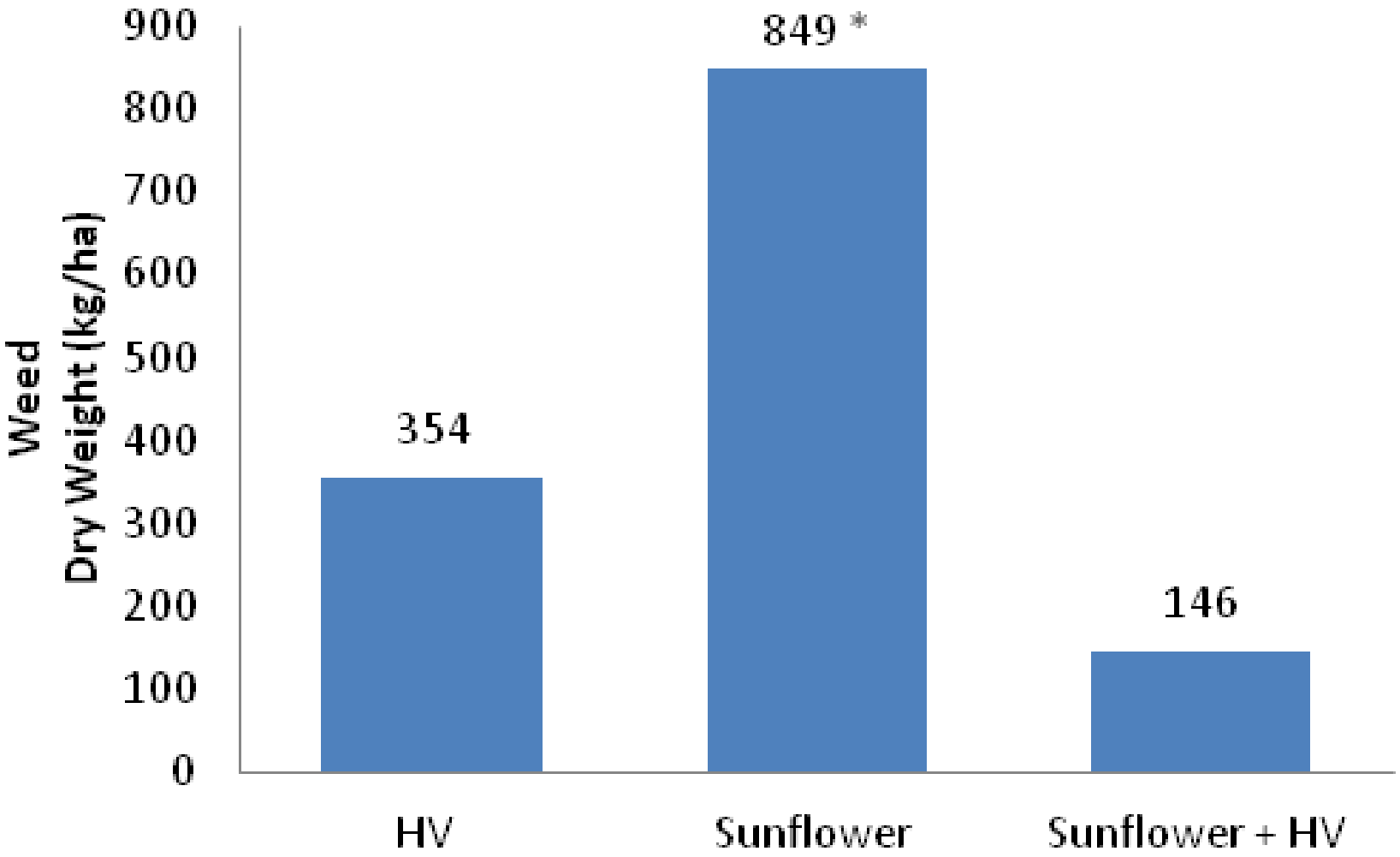
Sunflower & Hairy Vetch 2014 Results

Treatment	SPAD	HV Biomass	Crude Protein HV	N Biomass Residues	Test Wt	Sunflower Seed Yield
	Mean	kg/ha	%	kg/ha	g/0.5L	kg/ha
Sunflower	31.2	-	-	-	120.8	2234
Sunflower + HV	29.7	5091	18.2	147	115.9	1743
HV	-	7602	21.7	266	-	-
Grand Mean	30.4	6347	20.0	206	118	1989
P value (two-tailed)	**0.013**	0.065	**0.044**	**0.027**	0.354	0.269
Standard Error	0.4	1113	1.4	41	5	403

	Nitrogen lbs/ac				$ /ac	
Treatment	0-6"	6-24"	0-24"	Biomass + Soil N	Total System N Value	Gross Income
HV	19	17	36	272 c	$ 149.83 c	$ 149.83 a
Sunflower	11	11	21	21 a	$ 11.55 a	$ 648.28 b
Sunflower + HV	15	11	26	157 b	$ 86.39 b	$ 583.26 b
CV%	29	23	24	22	22	27
LSD (p<0.05)	NS	NS	NS	58	$ 31.71	$ 214.29
LSD (p<0.1)	6	4	9	-	-	-
Grand Mean	15	13	28	150	$ 82.59	$ 460.46
P value	0.079	0.055	0.0503	**0.0001**	**0.0001**	**0.002**

Thick Thatch!

H. Vetch Weed Suppression 2014



Sunflower and Hairy Vetch Deloraine 2016

2300 lbs/ac Sunflower
500 lbs/ac H. Vetch!

Sunflower and H. Vetch Conclusions

- ✓ No yield difference in sunflower
- ✓ Increases in SOM by 0.25%
- ✓ 2 ton/ac available forage
- ✓ 59 – 136 lbs/ac N credit from residues

Similar incomes even with Nitrogen credit

- ✓ Reduces weeds by 80%
- × Volunteer vetch seed
- × Issues combining, on reel and chopping
- × Sclerotinia, Puccinia Rust

Corn and Hairy Vetch
Pierson, MB- 2016

$0.40/lbs gain/cow/day SAVINGS

Planted May 15, 136 lbs/ac N, 20 lbs/ac H.Vetch Broadcast
Corn Emerged May 29
1.5 L/ac REL Glyphosate + 0.4 L/ac Bromoxynil, June 29
Photo (July 5)

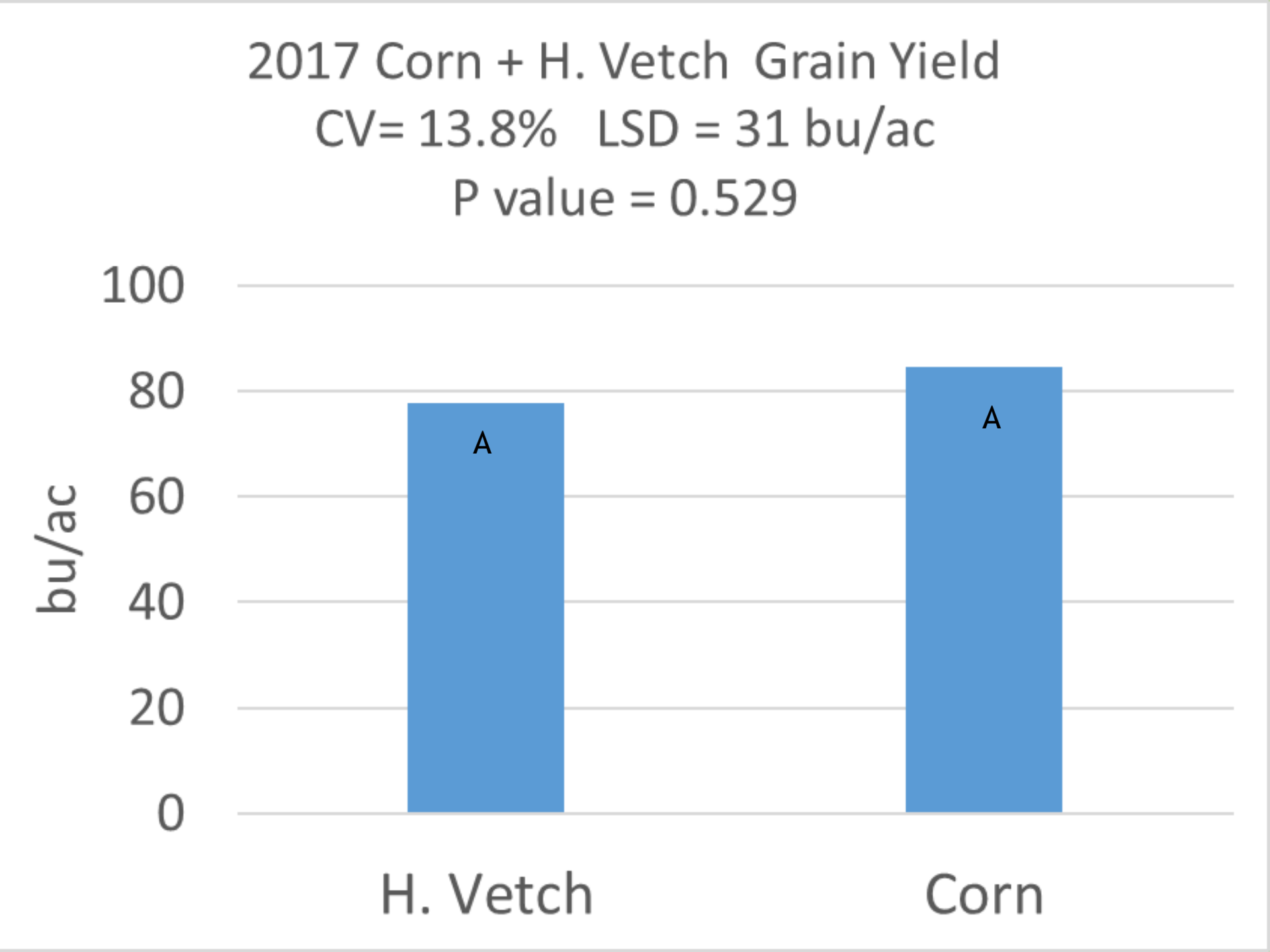
August 15

October 15

Hairy Vetch
~1/2 ton/ac Dry Matter
~ 25 lbs/ac N

= $13 N/ac
or
$55/ac feed

Harvest
October 21


2017 Corn + H. Vetch Grain Yield
CV= 13.8% LSD = 31 bu/ac
P value = 0.529
100
80
60
40
20
0
bu/ac
A
A
H. Vetch
Corn

Corn and H. Vetch

- No grain corn yield loss
- Suppress in-season weeds
- Fix nitrogen
- Provides some forage for livestock
- Provides some soil micro-organism habitat
- May assist in corn residue breakdown (from increased N credit)
- 0.5L/ac REL glyphosate works best
- May cause volunteer vetch seed
- May shelter cutworms

Oat and Forage Peas (Napinka 2015)

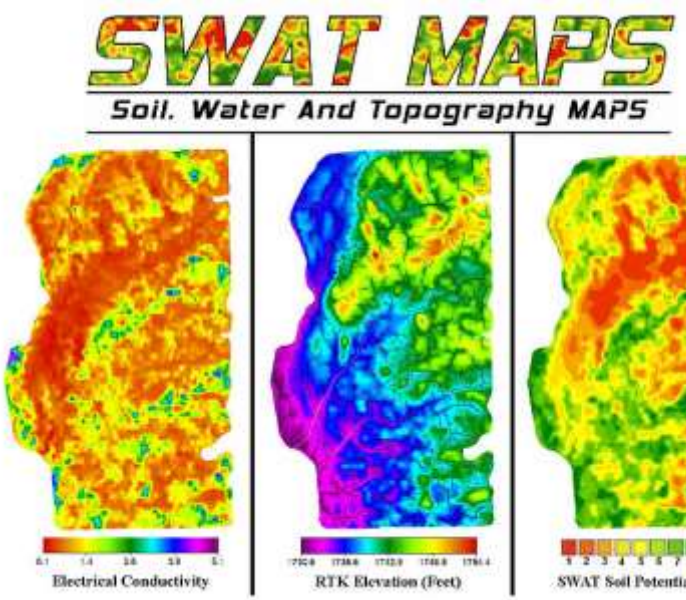
- 2/3 pea yield = $15/bu
- 1/3 oats = $5/bu
- @ 75 bu/ac total * ($15*2/3)+($5*1/3) =

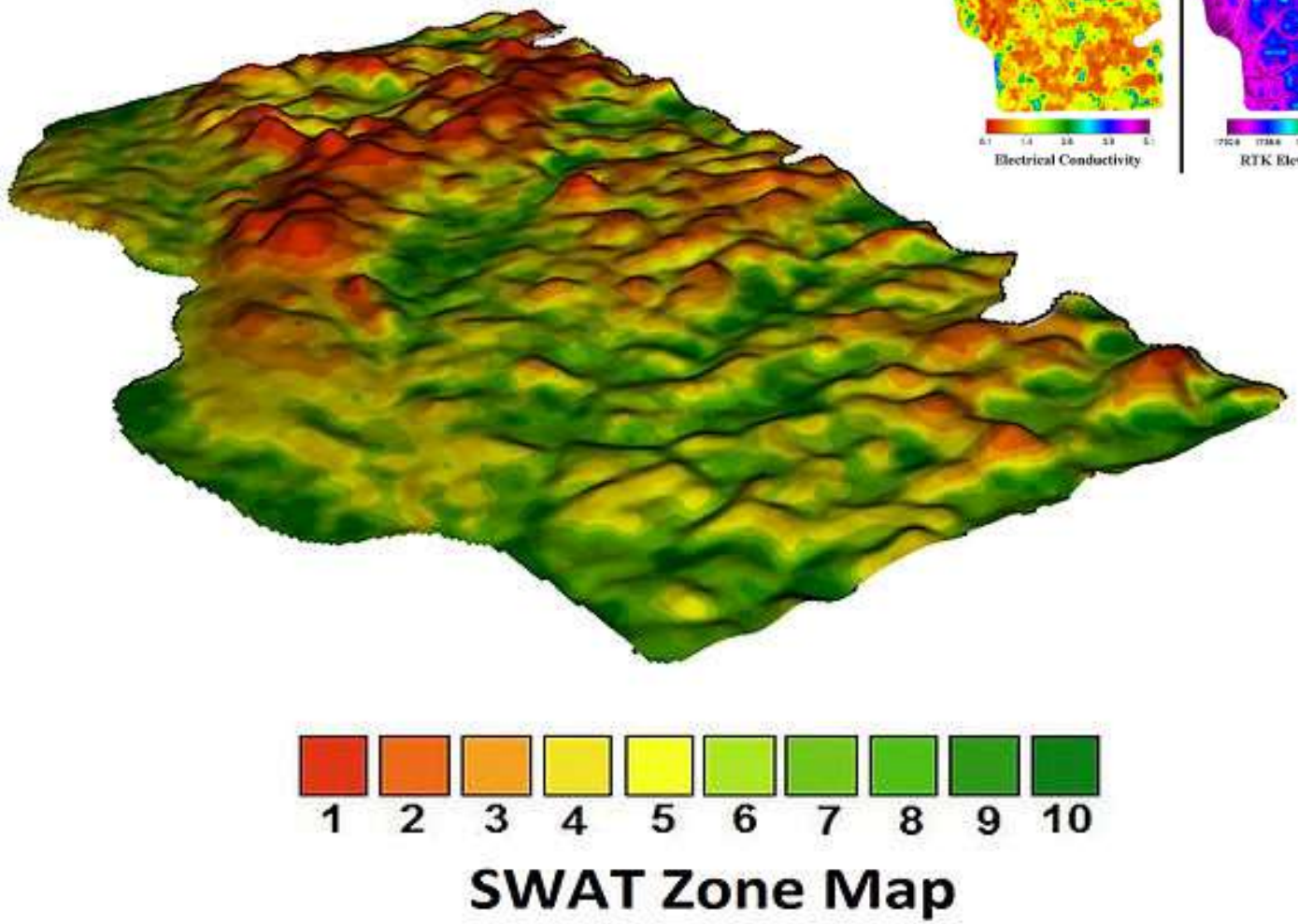
$850/ac Organic!

- ✓ Provide standability for Forage Pea
- ✓ Provide some N credit
- ✓ Zonal benefits in field


Zonal Intercropping
Pea-Oat-Mustard mix
Nesbitt, MB (organic)

S.W.A.T. Maps
Soil Water And Topography





Variable Rate – Sectional Control Seeding Systems > Intercropping?

Spring Wheat and Sweet Clover (organic)

- Wheat Yield 40 bu/ac, Organic $18/bushel = $720/ac
- Sweet Clover 5#/ac, Pottinger Seeder
- Midrow bander broadcast clover

Zonal Variation Production

- ✓ Salinity reclamation
- ✓ Increase Water Use
- ✓ Compaction Mitigation

2017

2017

Salinity Reclamation
July 5, 2017

Sweet Clover
July 5, 2017

1.2 meters tall

No Weeds

Spring Wheat + Sweet Clover Benefits

- ✓ Reduced salinity/compaction
- ✓ Weed competition
- ✓ Greater Water Use
- ✓ Choices to keep or terminate (less risk)
- ✓ Clover Seed Source
- ✓ Nitrogen Credits (green manure w/ silage harvester?)
- ✓ Green over fall-winter-spring
- ✓ Bee forage, Beef forage (if ensiled or hayed)

RR Canola into Glyphosate Suppressed Alfalfa (2009)

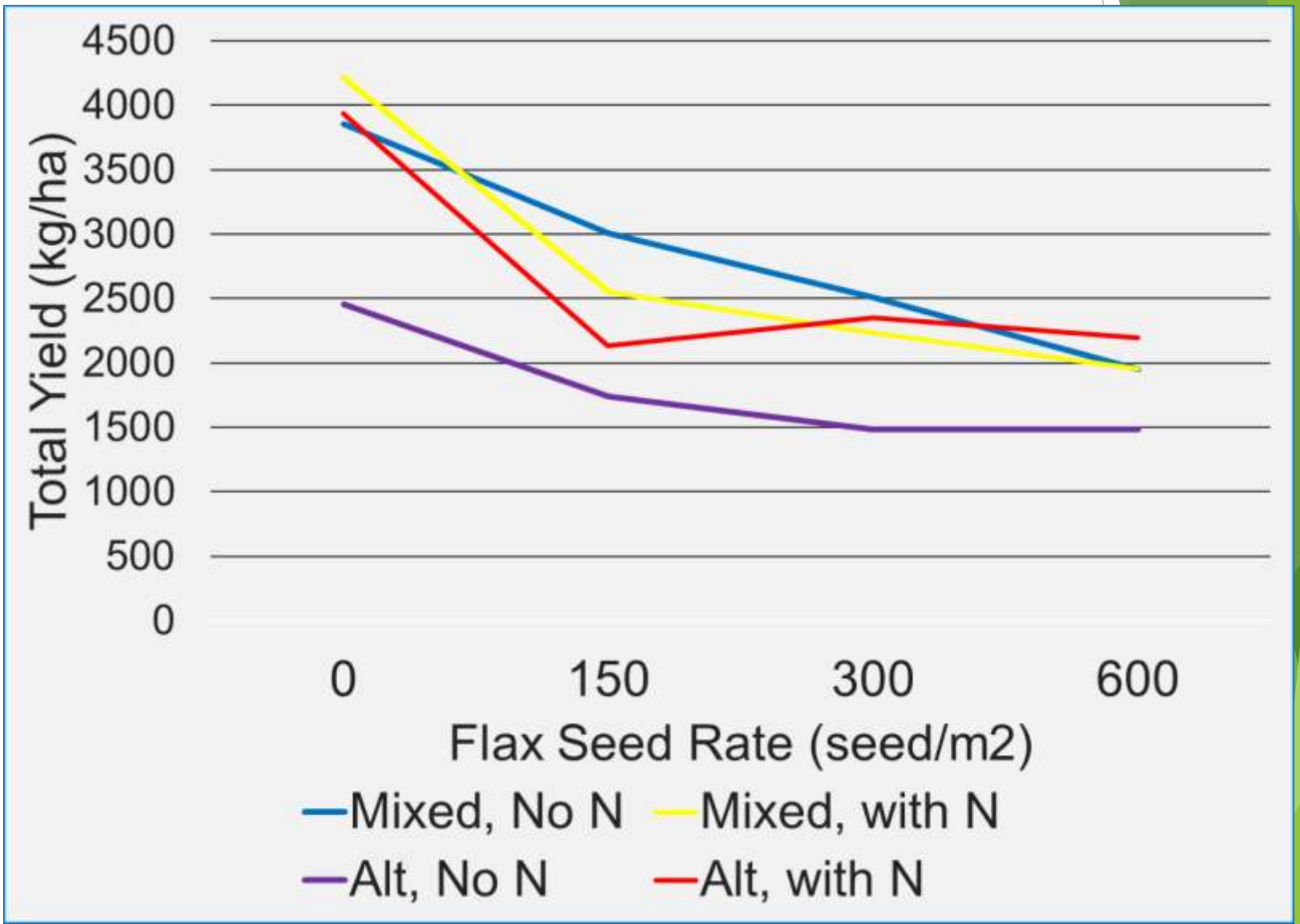
Glyphosate -Alfalfa Suppression

- Fall tillage provides huge nutrient flush
- Fall tillage better than spring tillage for moisture conservation
- Fall application better than spring apps for canola yields
- Fall apps more potent than spring apps
- Preseed Spring apps are too late for moisture conservation and efficacy in alfalfa
- Combinations or split apps may offer optimum results
  - 0.5L/ac REL fall + 1 L/ac preseed

Chickpea Flax – SERF, Redvers SK

Sept 2, 2017
Monocrop chickpeas still flowering
Intercrop ripening well beside

Chickpea & Flax Intercrop 2017 Redvers, SK



Chickpea & Flax Intercrop

- South East Research Farm, Saskatchewan
- LER of 1.7 to 3.9
  - Less Disease, Competition factor b/w Flax and chickpea
- N^{15} isotope tracing (U of S)
- Disease Severity of *Aschochyta*
  - 51% monocrop
  - 17% in intercrop

Advice

- Target monocrop chickpea density
- Flax rate 10-25 lb/ac (preliminary), do strip trials
- Seed chickpeas deeper than flax

- Chickpeas thresh the flax bolls
- Intercrop compensates, lowers risk
- Maturity is generally better in intercrop

Chickpeas & Flax

Derek Axten
Minton, SK

Oct 2016 Harvest

Chickpea Flax – Deloraine 2018

Aug 10 Above photo
July 22, left photo

Mustard-Lentil Intercrop – Redvers SK

- Replicated 2016, 2017 at Redvers (ADOPT, SPG funded)
- Why?
  - Reduce lodging, improve harvest standability
  - Could reduce disease pressure
  - Possible overyielding, higher value
  - Better weed competition

Large Green Lentil – Yellow Mustard

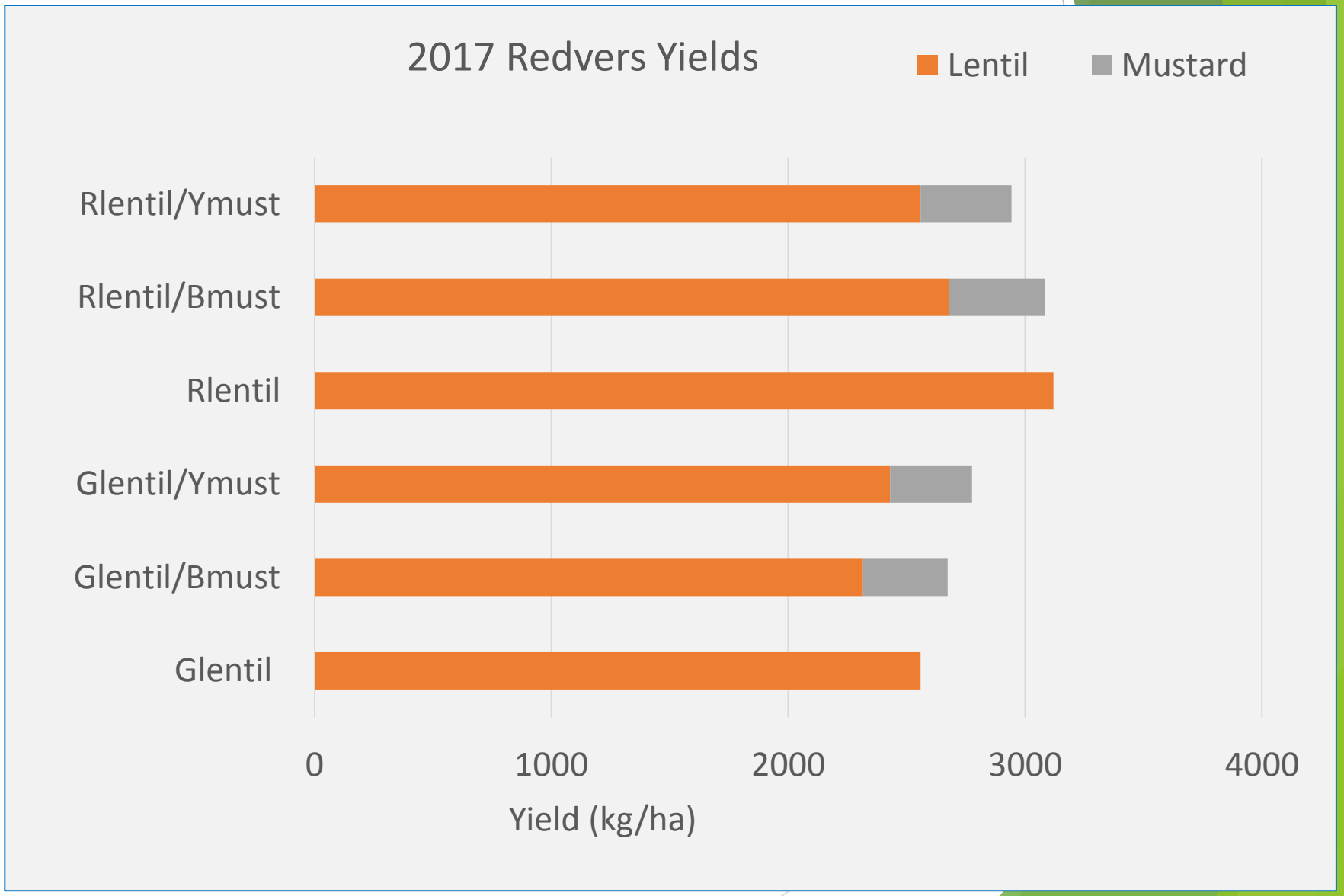
Not Lodged

Green Lentil – Mustard

- 2017 Redvers Trial
  - 2200 lb/ac Green Lentils

    (95% of monocrop Green Lentil yield)
  - 300 lb/ac bonus mustard
  - More crop value
  - Easier to harvest, taller

Lentil – Mustard Intercrop



Winter Wheat and Soybean

May 19, 2017 – RTK guidance

Winter Wheat & Soybean WADO – 2017 Yield Results

Winter Wheat	Soybean	WW Intercrop	Soy Intercrop
3087 kg/ha	945 kg/ha	2108 kg/ha LER = 0.68	388 kg/ha LER 0.41
		2496 kg/ha TLER = 1.09	

New Trial in effect for 2019 Season

Soybean-Flax Pros and Cons

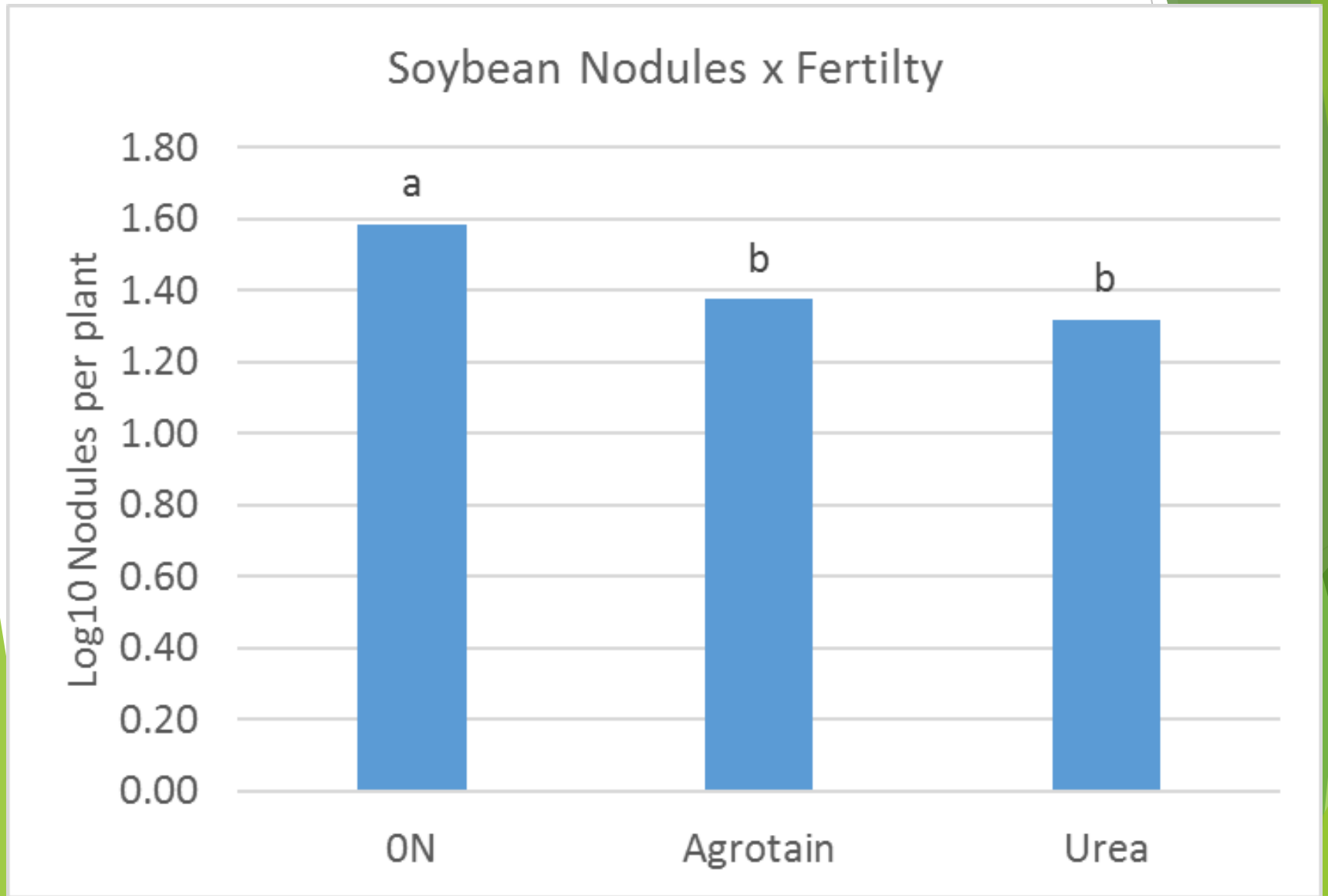
- Similar seed depth
- Authority Herbicide, Group 1 grassy
- Mycorrhizae activity in both
- Similar harvest time
- Maybe a spatial advantage
  - Diseases in flax
  - Shape of flax stand vs soybean spread
- Harvest Smashing in Soybean
- Conventional Soybean

2018 Concept Soy-Flax

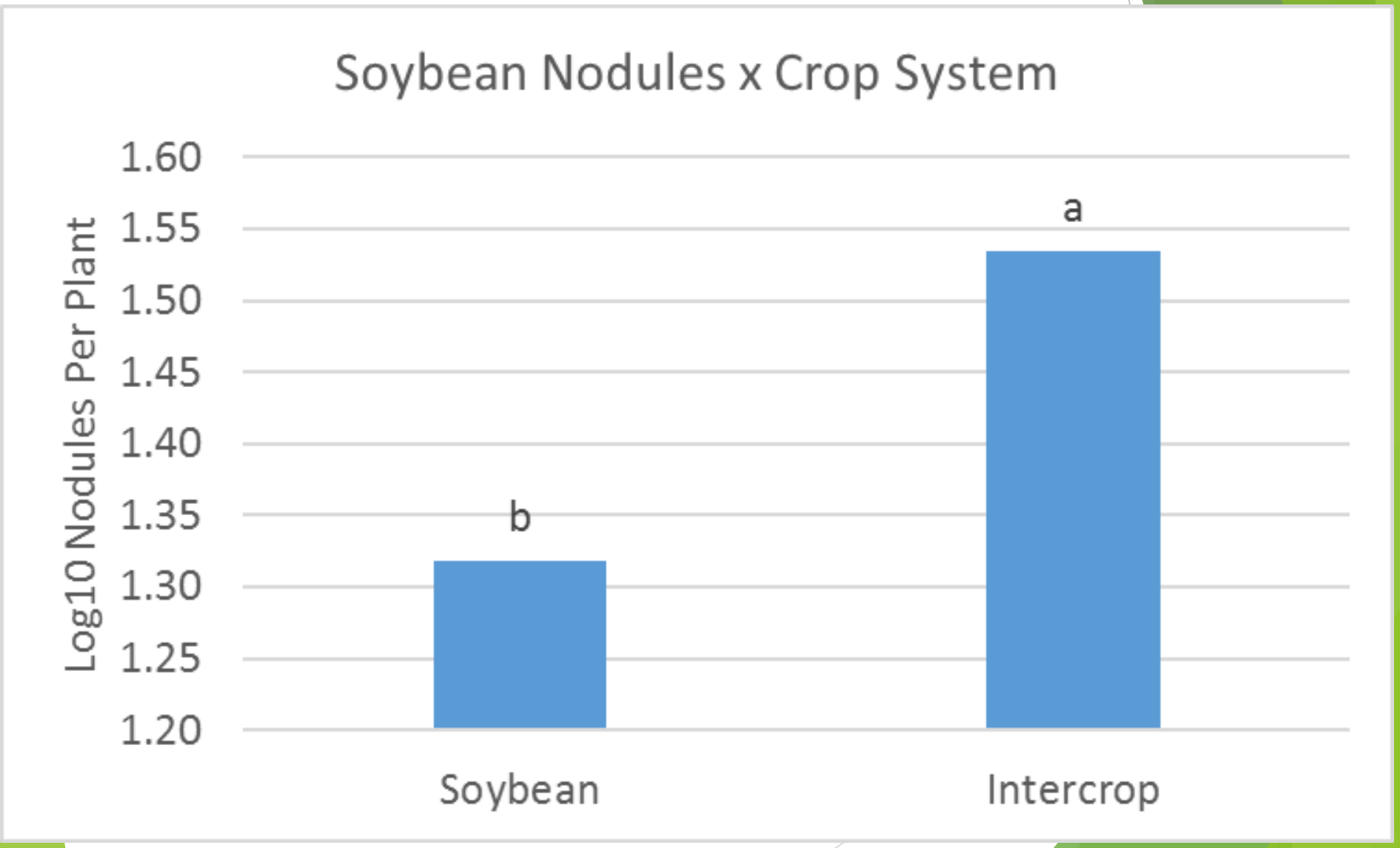
- Double Row intercrop
- 70 lbs/ac flax row equivalent
- 210,000 ppa soybean (row equivalent)
- Fertility:
  - Zero N check
  - 60 lb/ac N Urea (flax row only)
  - 60 lbs/ac Agrotain (flax row only)

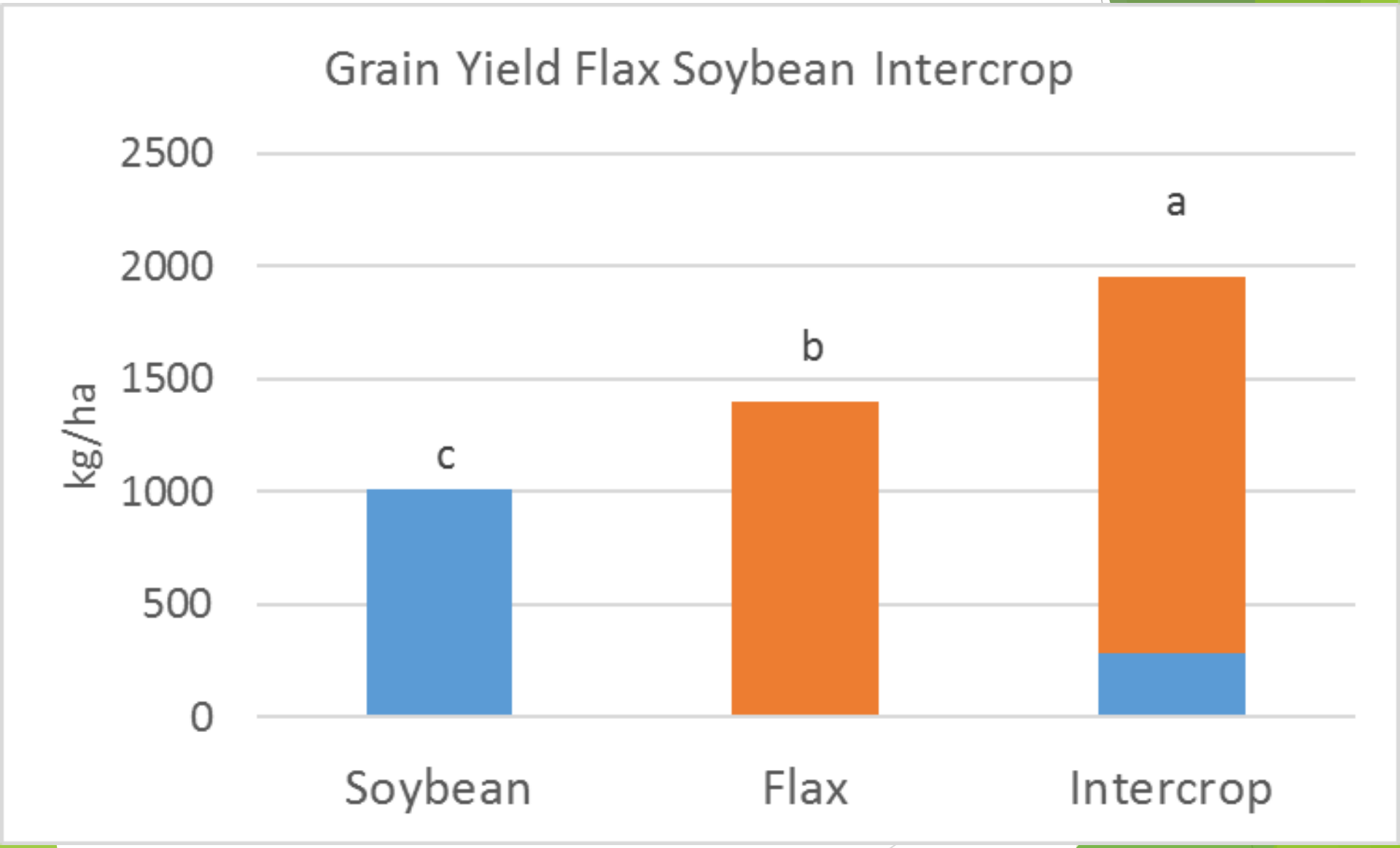
2018 Flax Soy - Aug 1 Photo

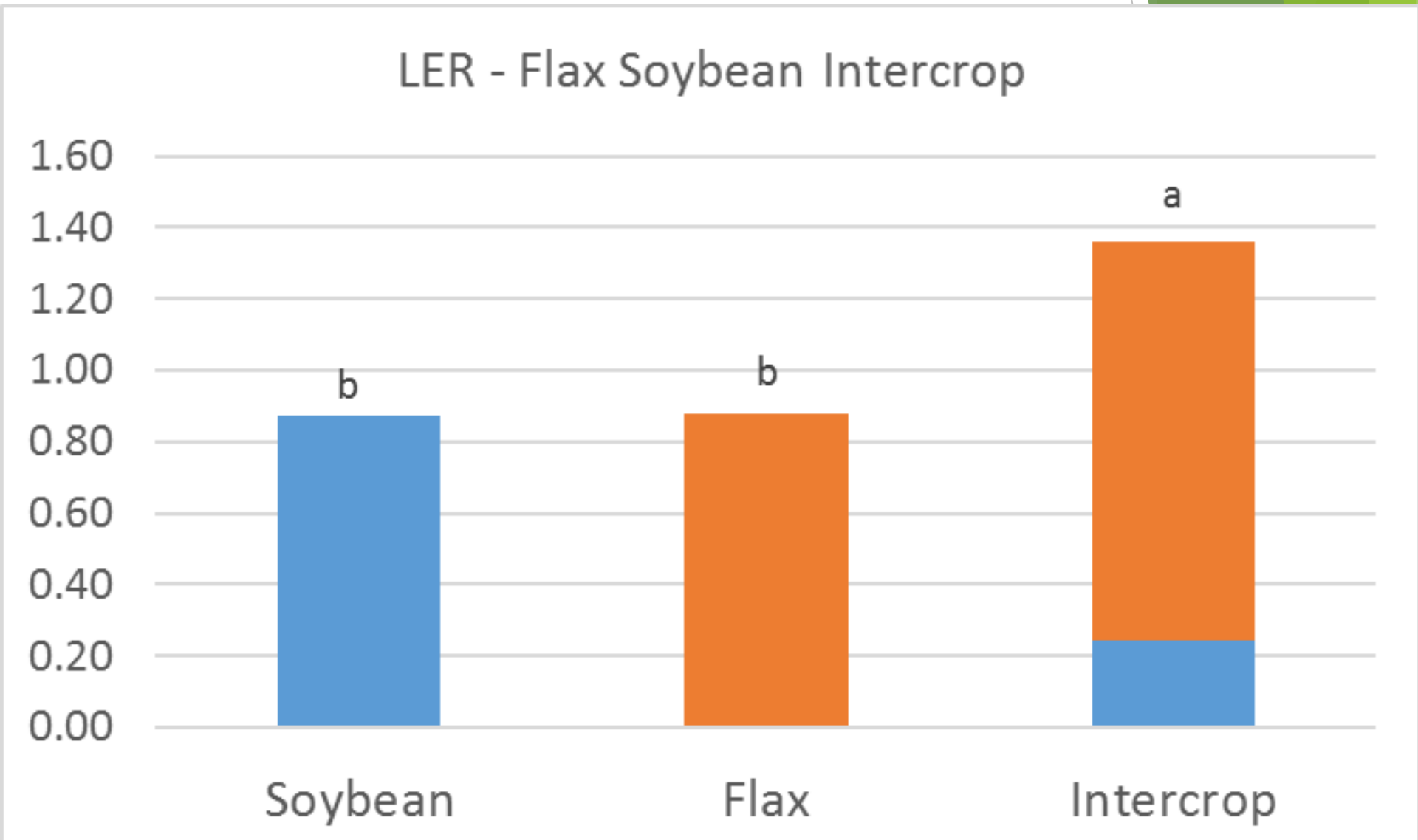
Soy-Flax Intercrop 2018



Soy-Flax Intercrop 2018




Grain Yield Flax Soybean Intercrop
2500
2000
1500
1000
500
0
kg/ha
c
b
a
Soybean
Flax
Intercrop


LER - Flax Soybean Intercrop
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
b
b
a
Soybean
Flax
Intercrop

Soybean Flax Intercrop Conclusions

- Intercropping increases nodulation in soybean
- Nitrogen forms effect nodulation
- Significant yield increase in total yield and LER intercropping
- Greater soil moisture use in intercrop
- Excessive moisture stress in soybean
- Shorter soybean crop height in intercrop
- Cost of soybean seed may outweigh economic gains on intercropping benefit
- Hoping for a wet year to compare data

Hemp Companion Cropping 2017

Concepts, Questions, Goals

- Relay legumes may counter balance N economy
- Grazing after harvest
- Fall Rye as a controllable but competitive weed
- Use more water per acre (good or bad?)
- Produce more grain (hemp + peas)
- Provide continual green cover year around
  - Soil building, reduce compaction, fertility boost
- Hemp roots shallow

Experiment

TRT		Description	Variety	Target (lbs/ac)
1		Hemp (Check)	Katani	25
2	*	Sweet Clover + Hemp	Norgold	5
3	*	Alfalfa + Hemp	Rangelander	8
4	*	Red Clover + Hemp	Altaswede	5
5	*	Hairy Vetch + Hemp	WADO	25
6		Pea (seeded) + Hemp	CDC Meadow	80
7	*	Fall rye + Hemp	Danko	20
		* all but peas are broadcast prior to seeding hemp		

Burnoff: Glyphosate0.5L/ac + Liberty at 0.75L/ac MAY 23
RCBD: 3 replications
Fertility 126-35-25-10 NPKS lbs/ac

Yellow Peas

Hairy Vetch

Sweet Clover

Alfalfa

Red Clover

Aug 17 Hairy Vetch and Hemp

Harvest - August 21

Peas and Hemp Grain Sample

Farmer Tested North of Saskatoon 2017

Seed Rates:

- Peas 90 lbs/ac
- Hemp 25 lbs/ac

Peas seeded 1 week before hemp, then harrowed then hemp seed.

Yields:

- 10 bu/ac Pea
- 1000 lbs/ac Hemp

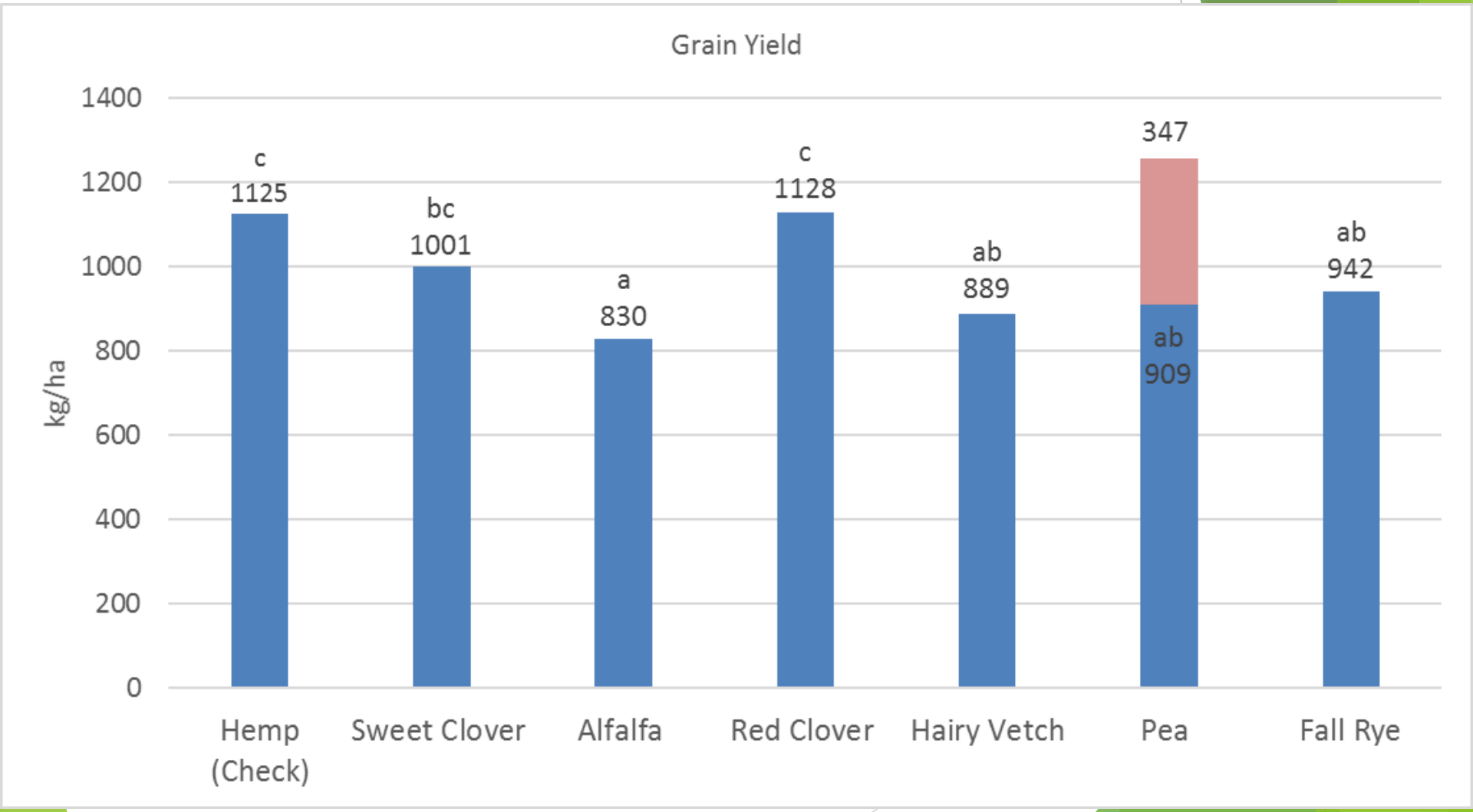
2017

P value = 0.005

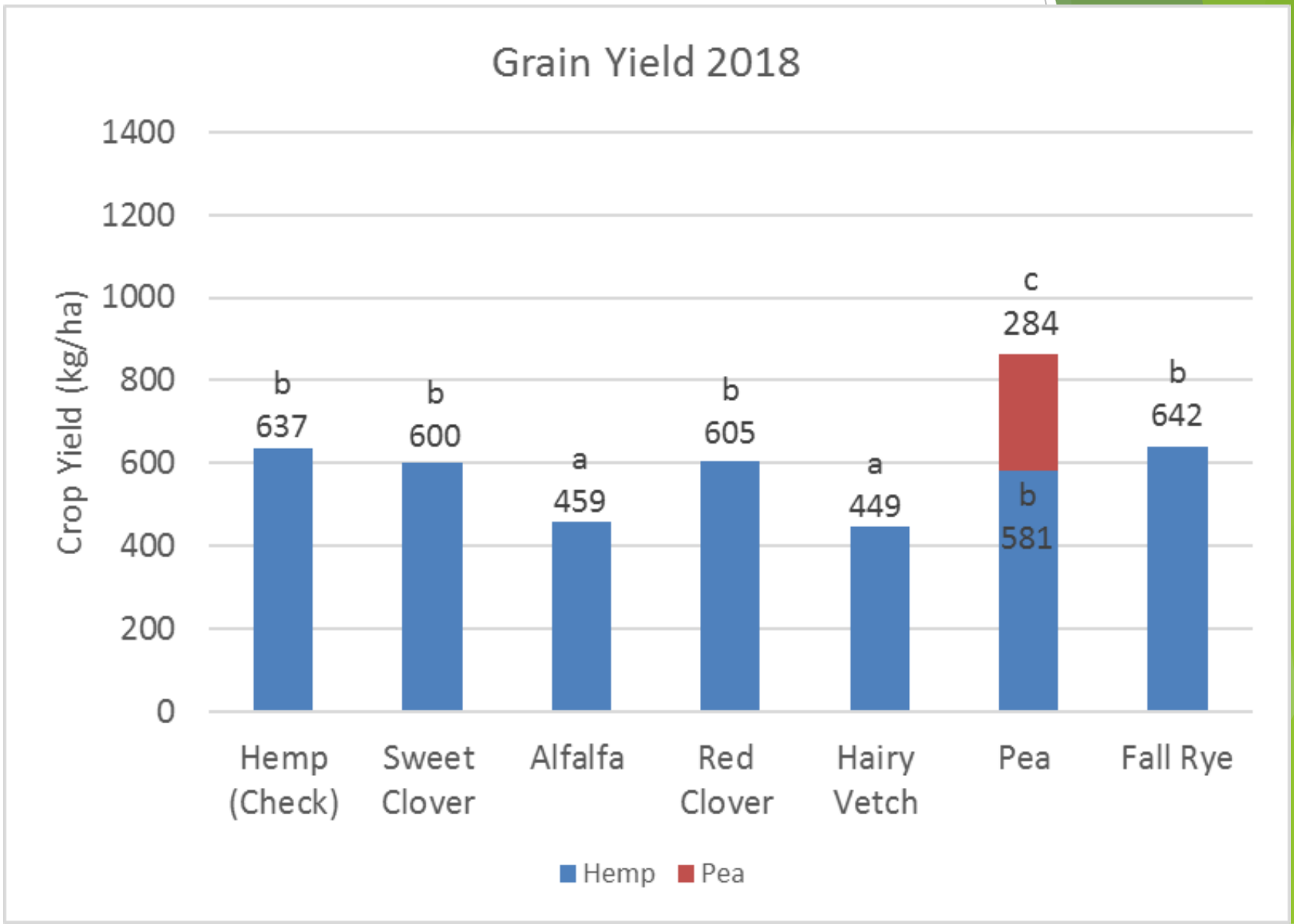
Significant Differences

CV=8.6%

LSD (hemp only) = 149 kg/ha



2018

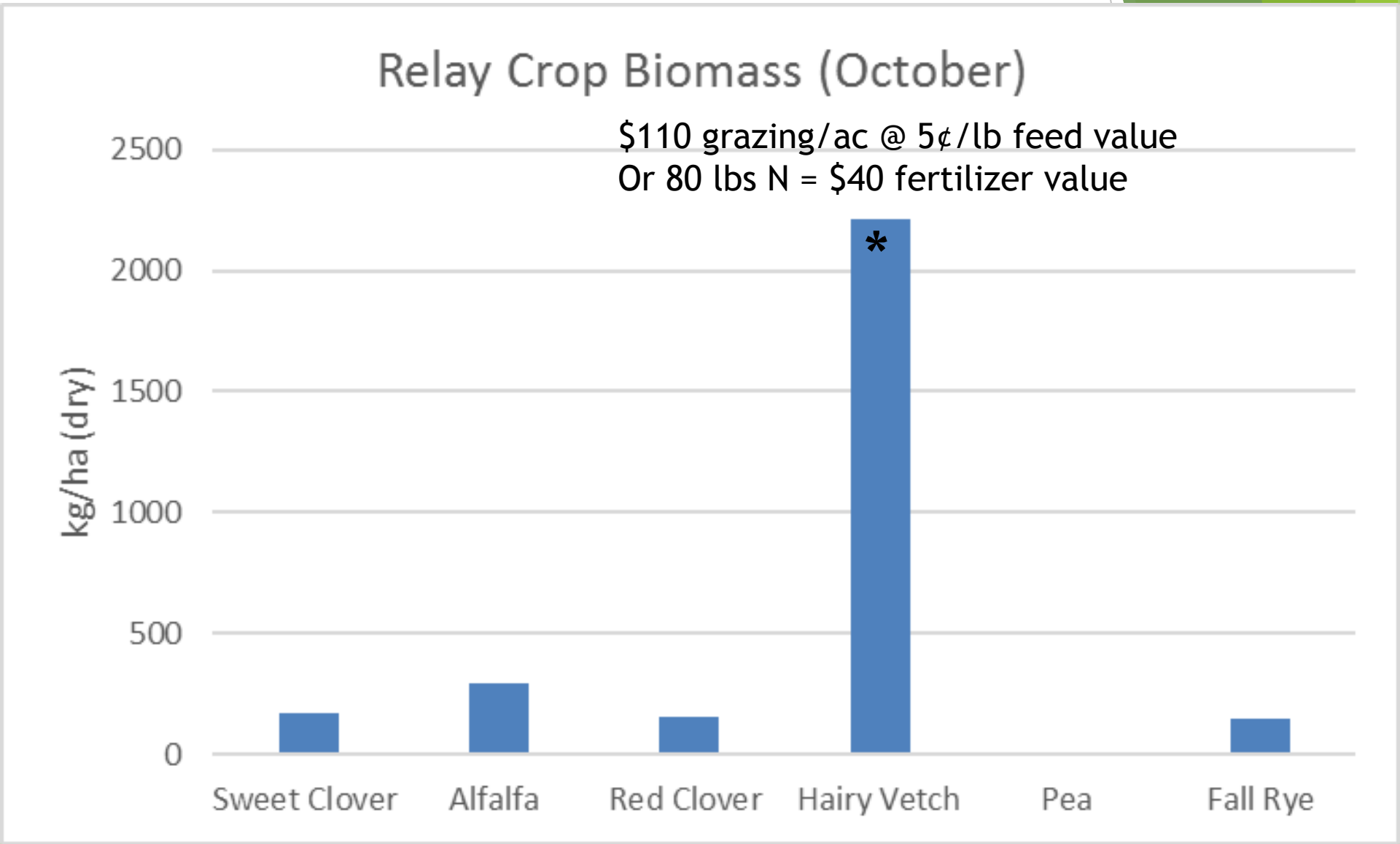

Grain Yield 2018
Crop Yield (kg/ha)
1400
1200
1000
800
600
400
200
0
b
637
b
600
a
459
b
605
a
449
c
284
b
581
b
642
Hemp (Check)
Sweet Clover
Alfalfa
Red Clover
Hairy Vetch
Pea
Fall Rye
Hemp
Pea

Sept 20, 2017

Sept 25, 2018

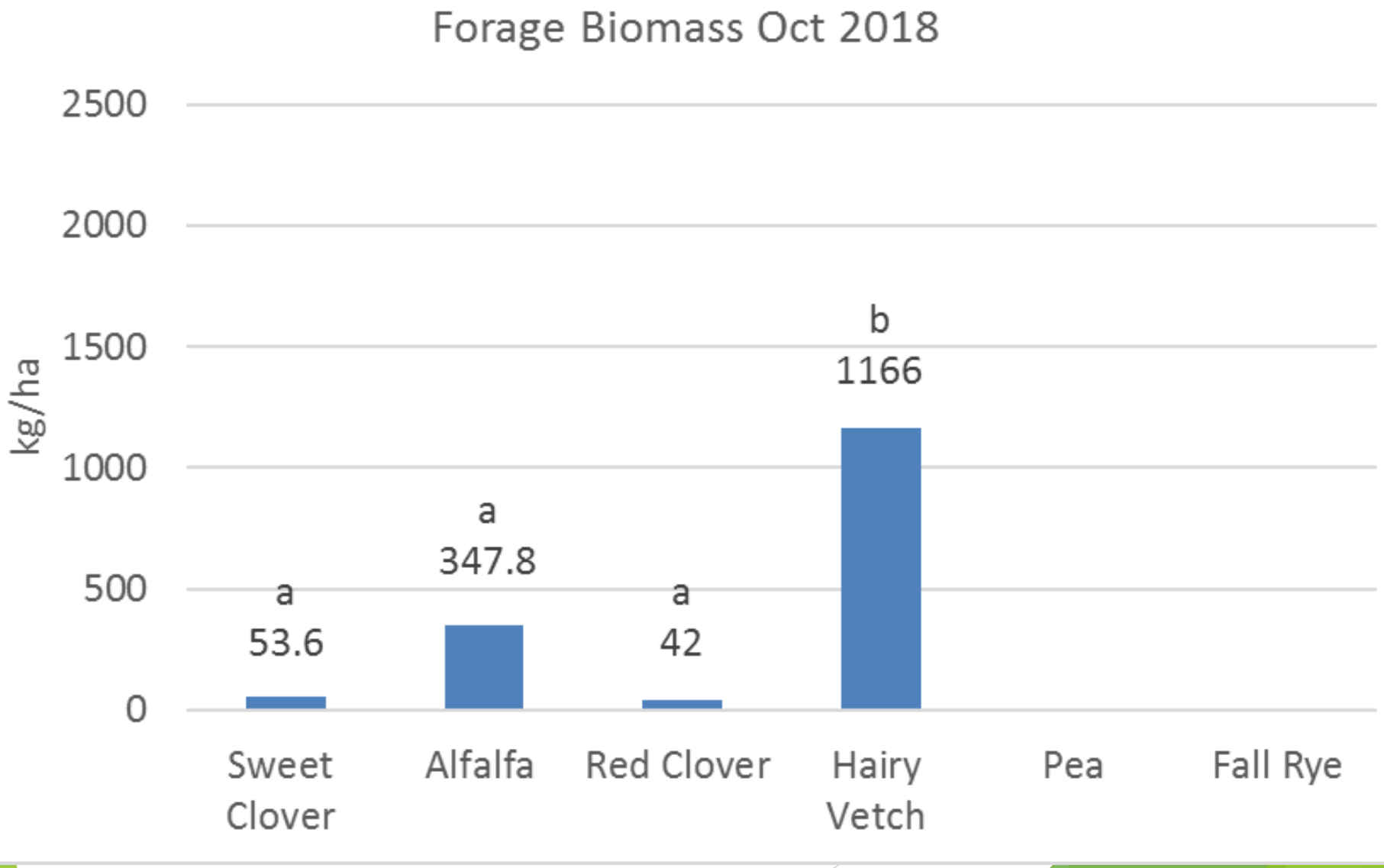
2017

P value = <0.001

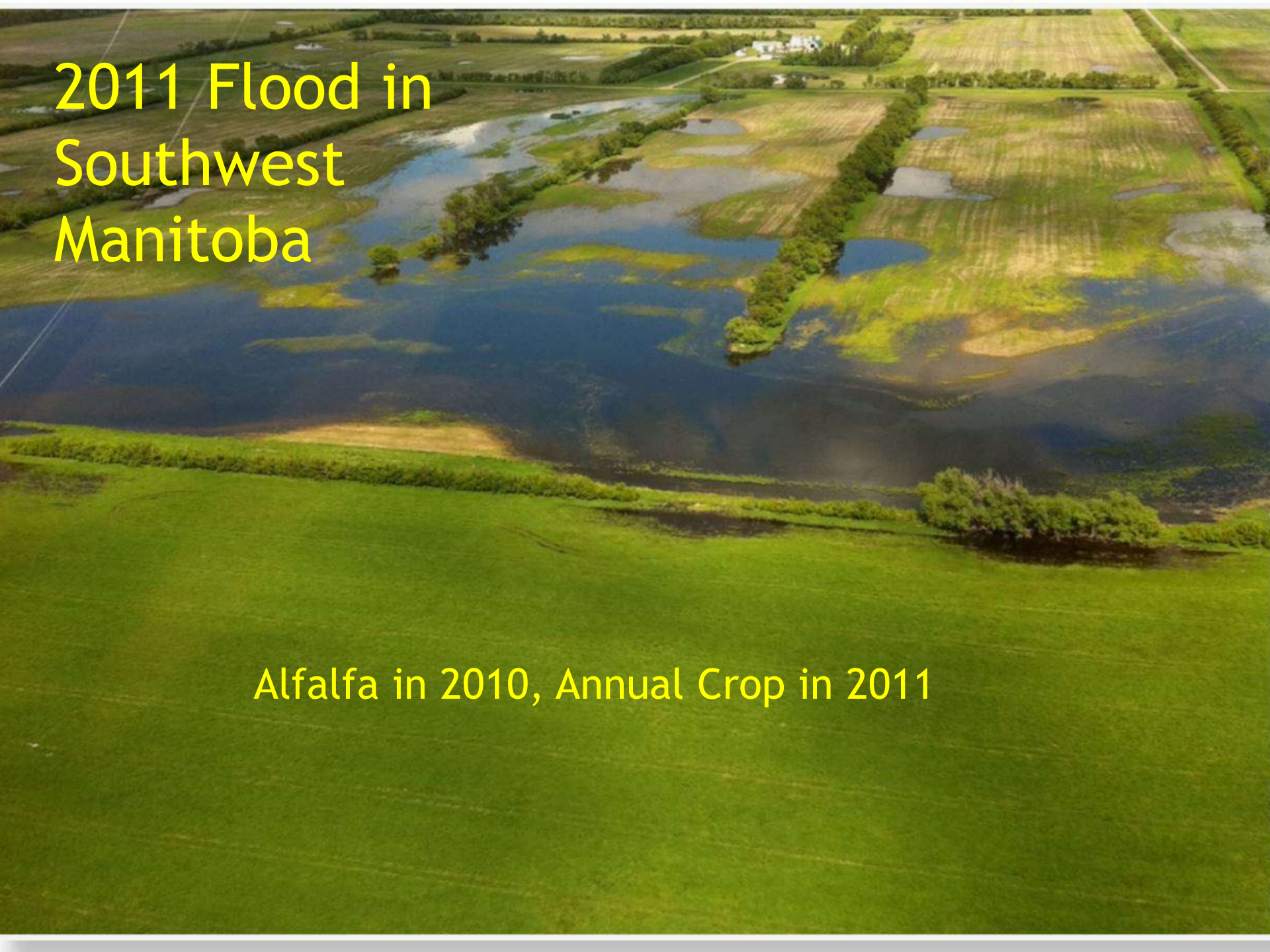


2018

P value = <0.001



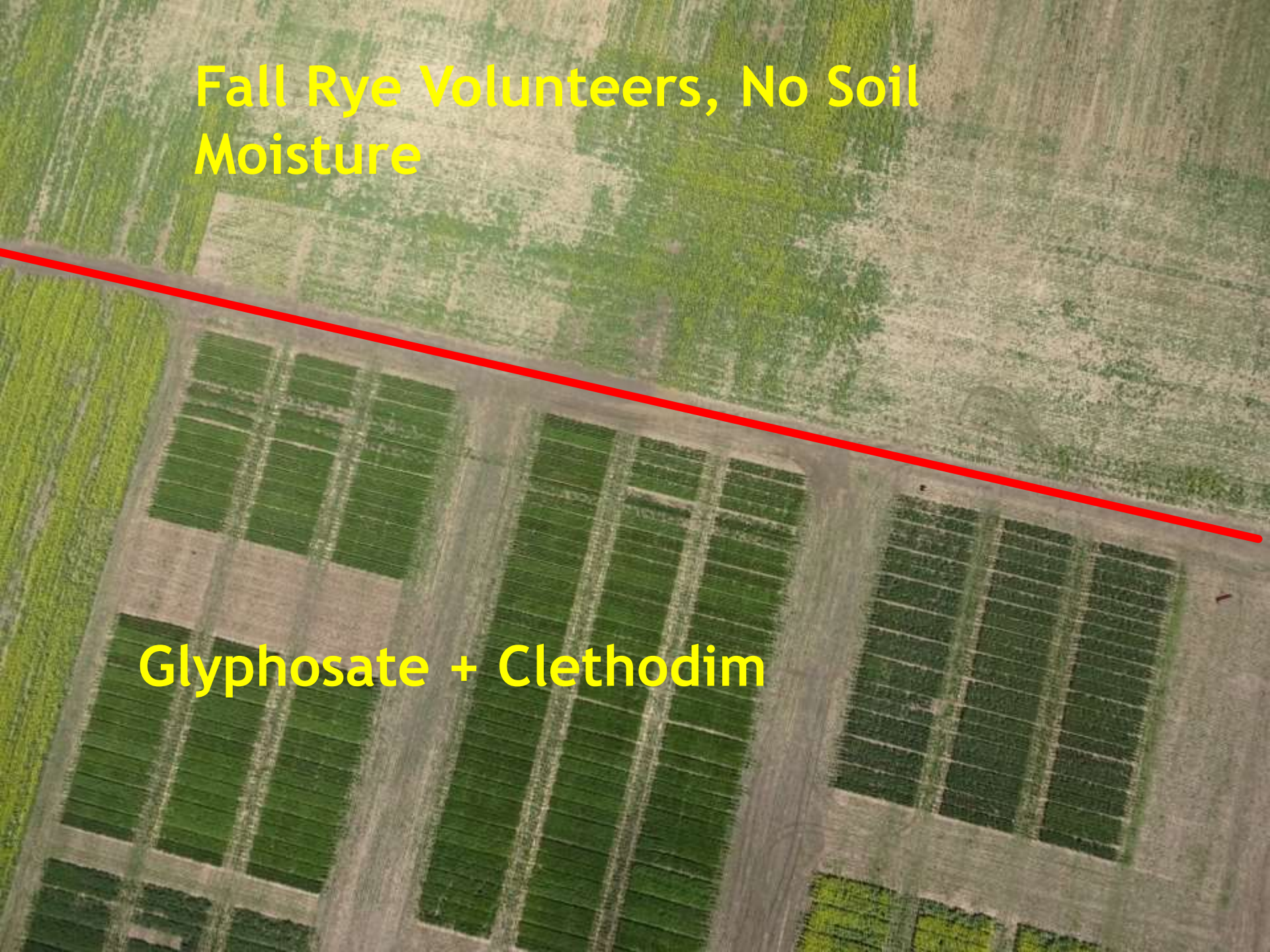
Oct 26, 2016 (156 mm rainfall!)


2011 Flood in Southwest Manitoba
Alfalfa in 2010, Annual Crop in 2011

Near Melita, MB 2011

2011 Stuck in the Muck photo contest winner

Every drop of Water Count
It's management is everything


Fall Rye Volunteers, No Soil Moisture
Glyphosate + Clethodim

France 2018 – Near Château de Chambord

France 2018

Tillage Without Covers

No till Covers and Livestock

Consider

- End goals
- Insurance issues
- Marketability Issues
- Maturities and Harvest-ability
- Remember the Green Bridge
- Volunteers and Control
- Future Rotation
- Residue Management
- Climate Conditions (too wet, too dry)

Slido Questions

- How many acres do you Intercrop/Relay Crop on your farm annually?

A. <40 acres

B. 160 Acres

C. <640 acres

D. >640 acres

Slido Questions

- IN the last 5 years how many years have you tried intercrops/relay crops?

A. One year
B. Two years
C. Three years
D. Four years
E. Five years in a row

Slido Questions

- Why have you not tried intercrops or returned back to doing it?

A. I am too chicken

B. My Neighbors are not doing it

C. Too much financial risk

D. I have equipment complications

E. I do not know enough about it yet

Thanks for Listening!

- Scott.chalmers@gov.mb.ca
- Ph 204-522-3256
- Westman Agricultural Diversification Organization
- Twitter: @WADOresearch @scottchalmers15

WADO