Improving canola production and production systems with genetic and agronomic advances to increase canola acreage in the Pacific Northwest.

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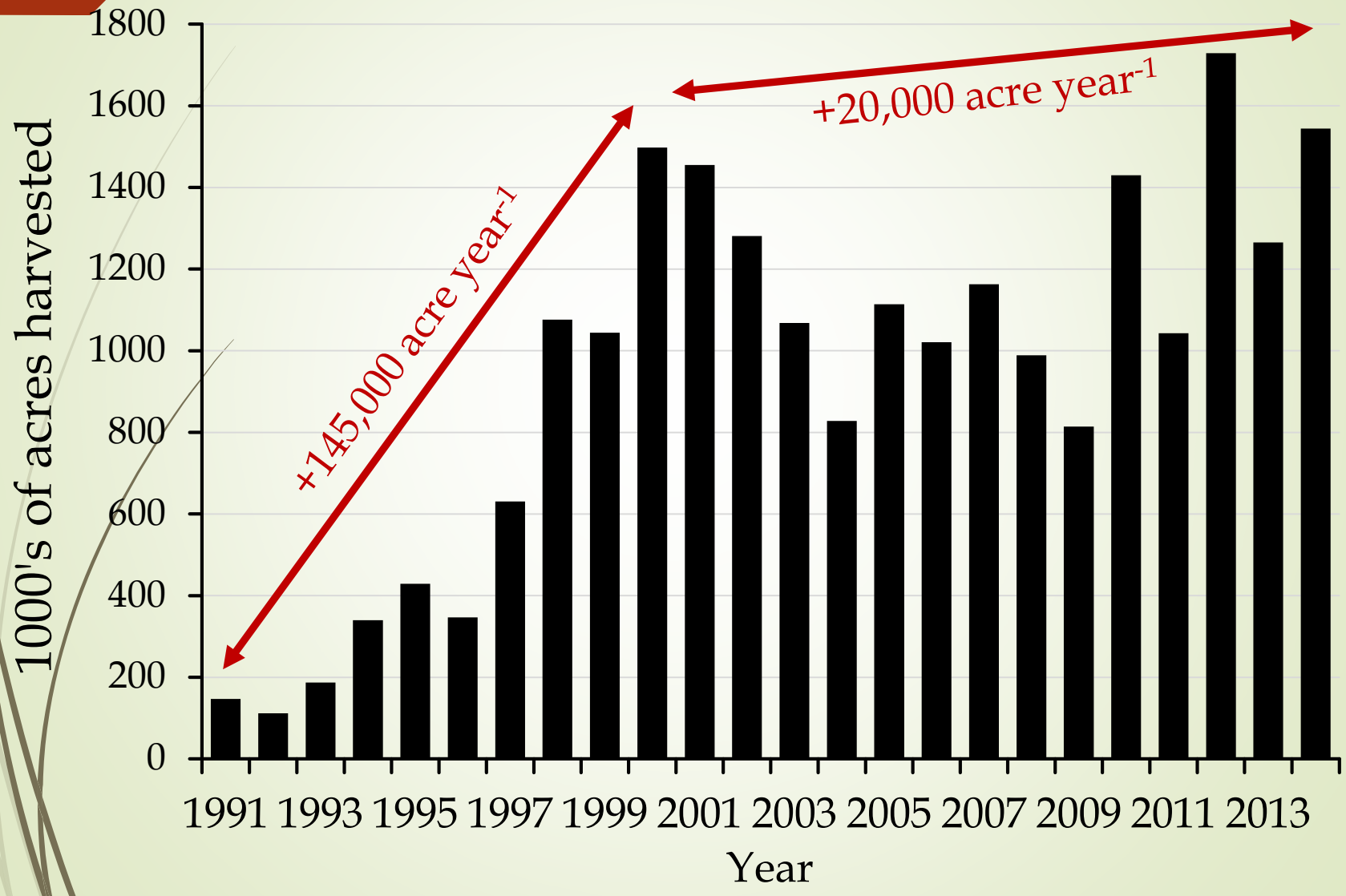
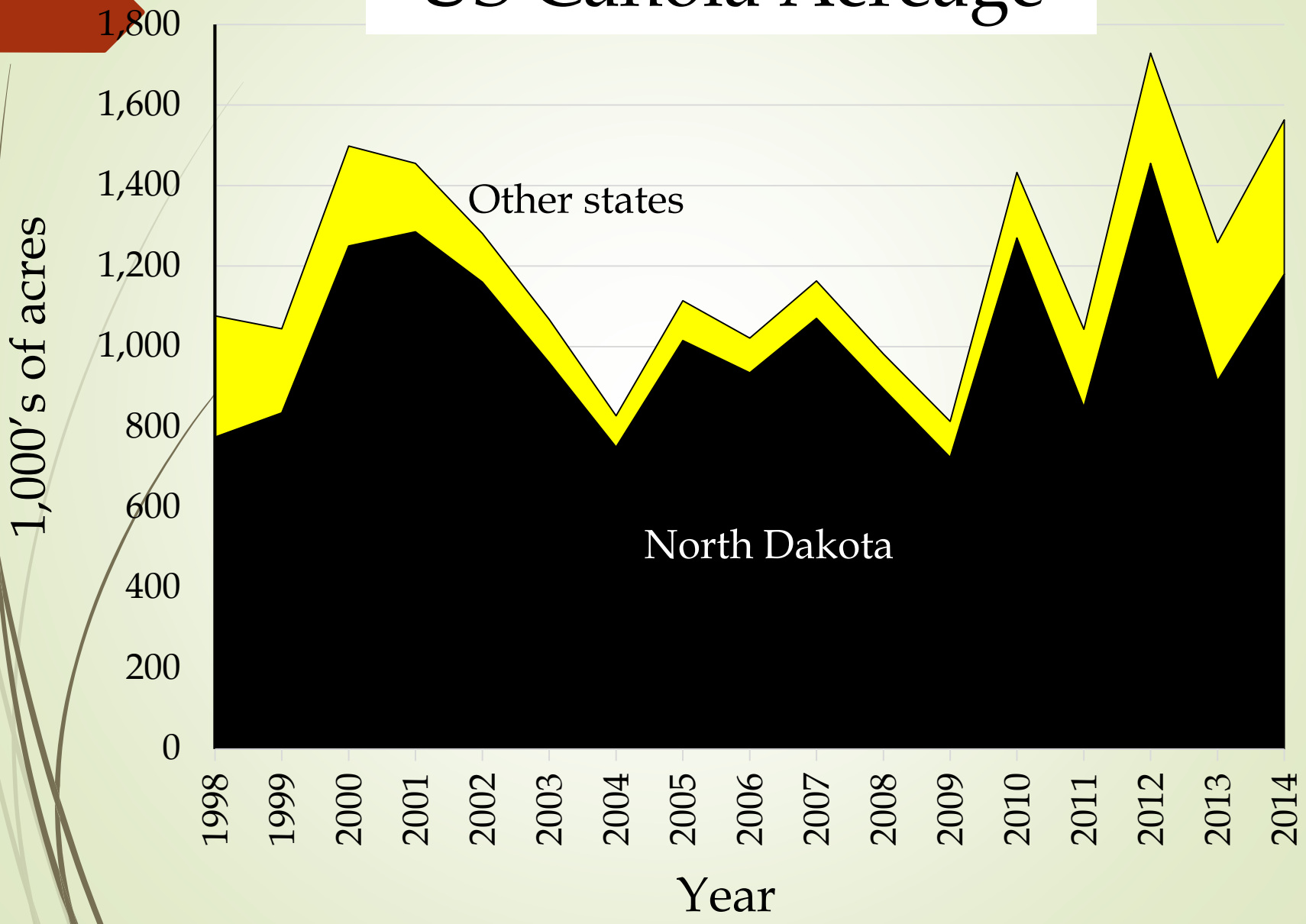
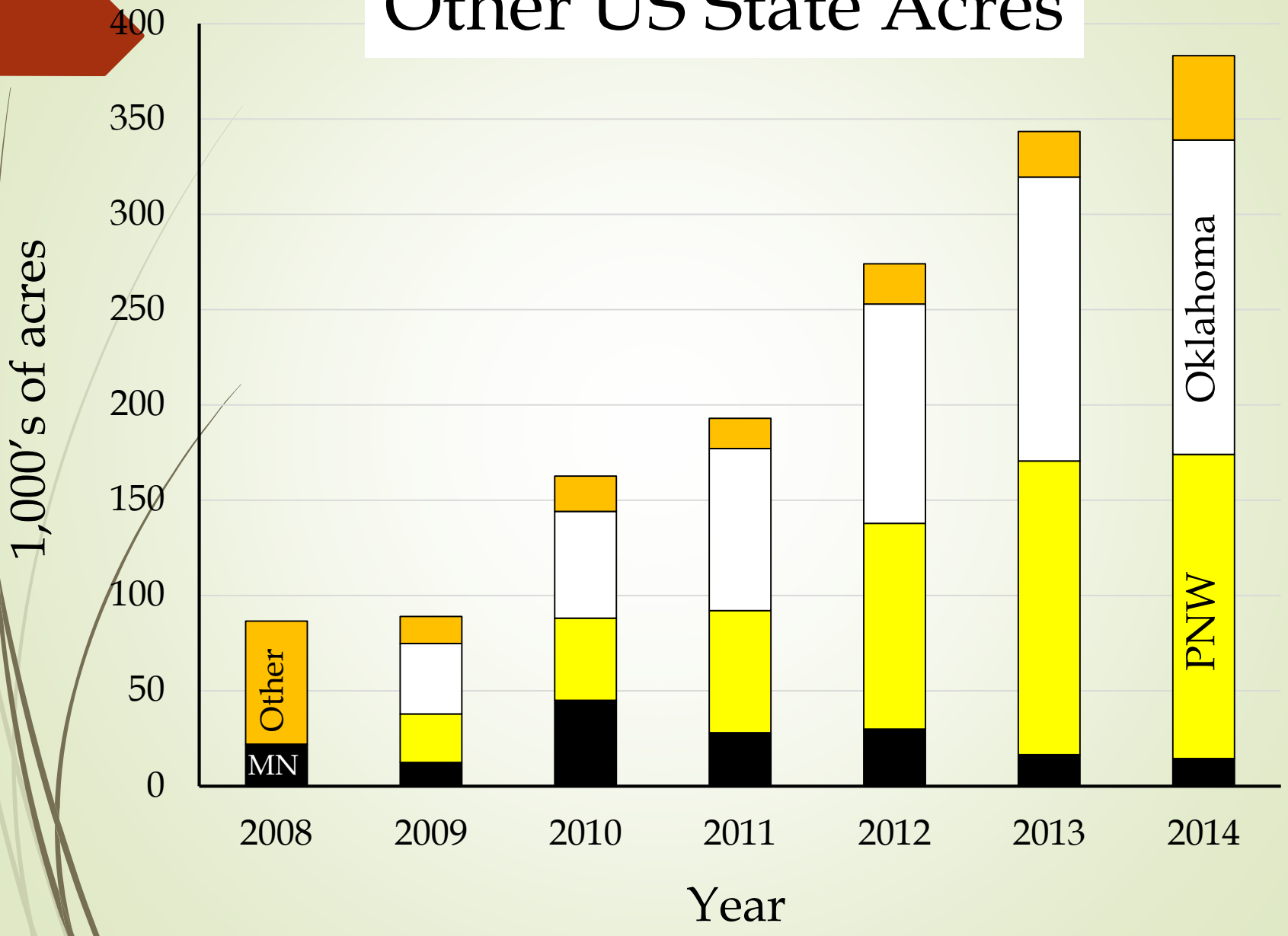
US Canola Acreage



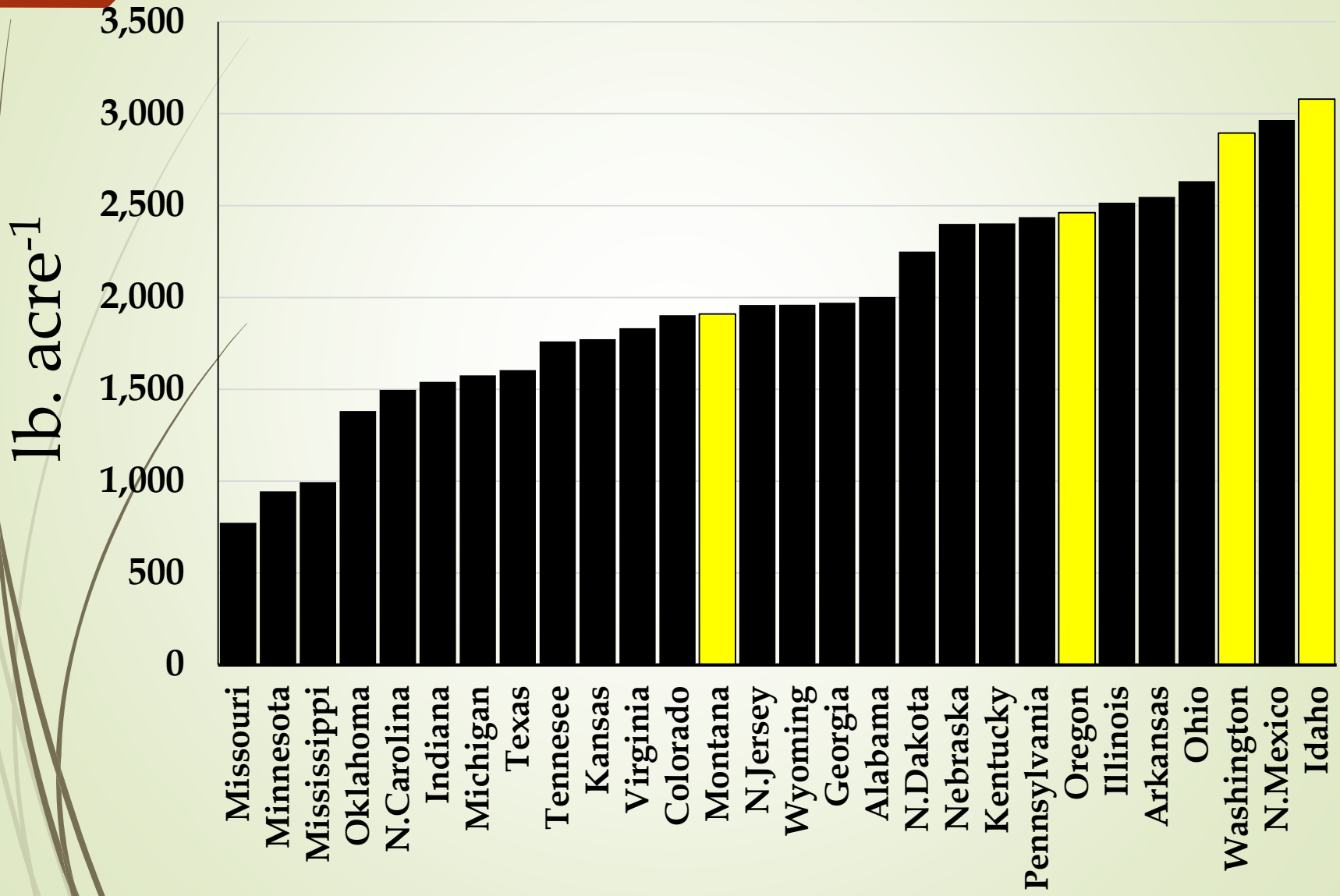
US Canola Acreage



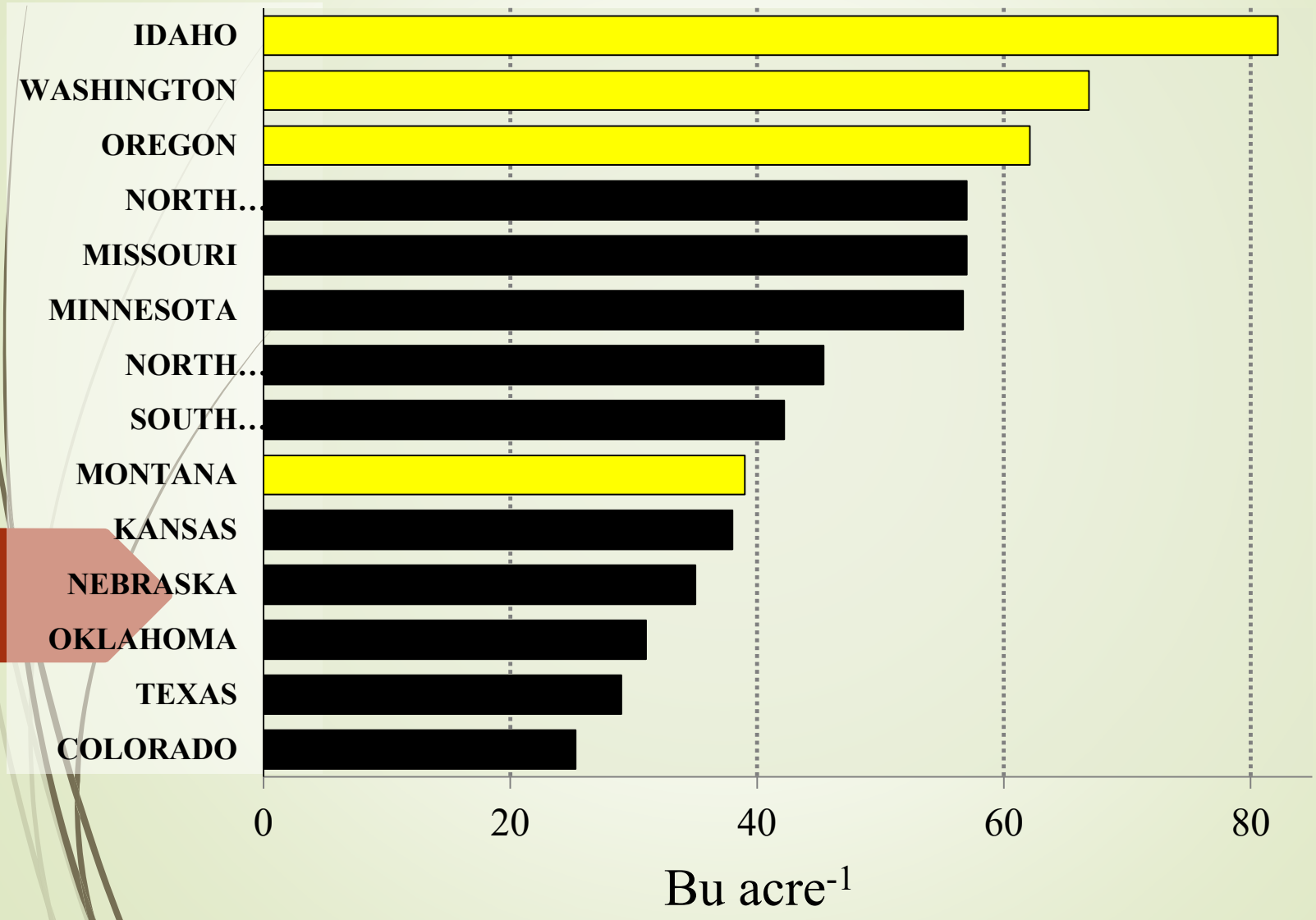
Other US State Acres

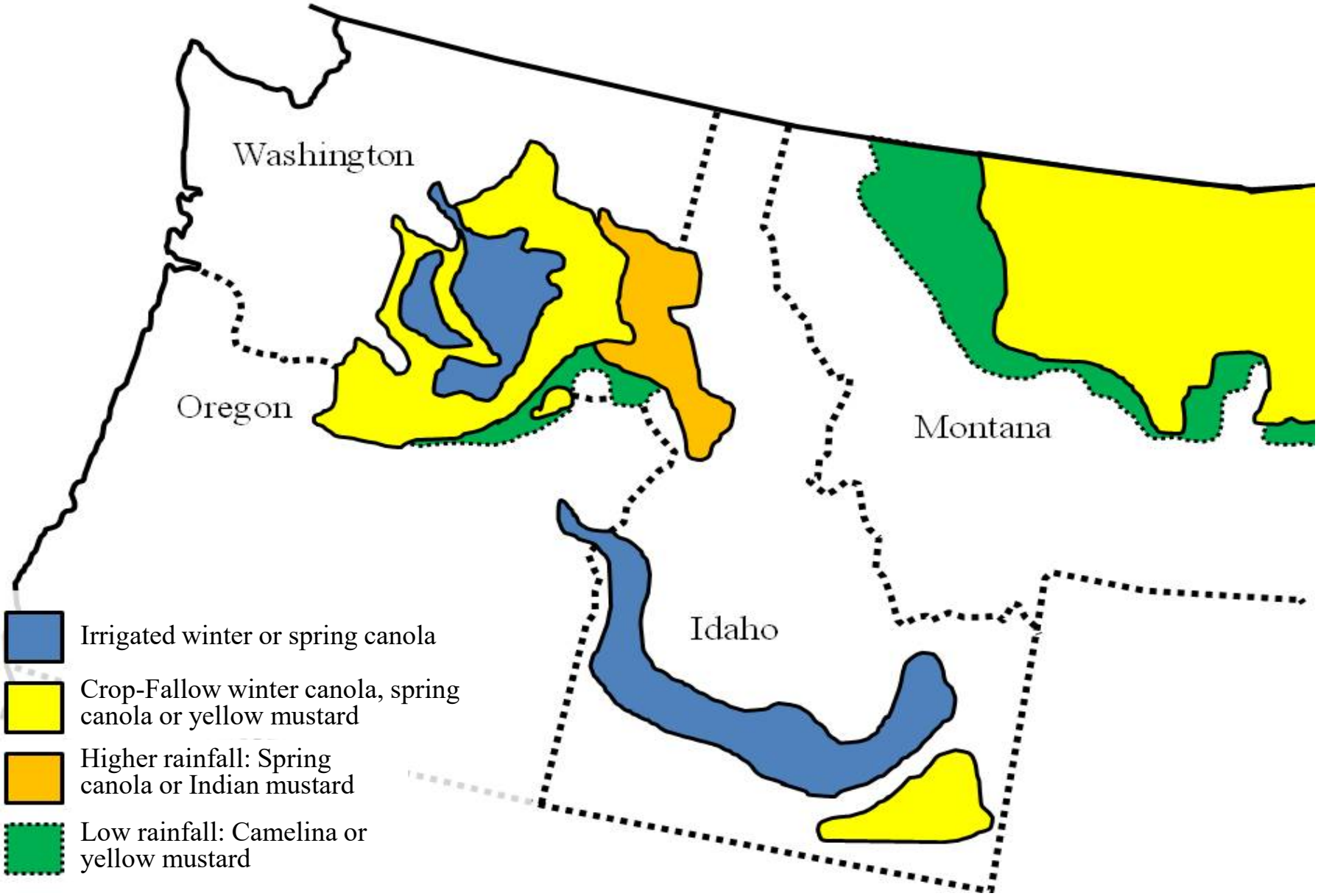


35 years of Cultivar Trials



US wheat yield by state harvested in 2013.




Washington
Oregon
Montana
Idaho
Irrigated winter or spring canola
Crop-Fallow winter canola, spring canola or yellow mustard
Higher rainfall: Spring canola or Indian mustard
Low rainfall: Camelina or yellow mustard

Potential Canola Acreage

Environment type	Total acres†	Crop	Canola acre	Seed yield	Canola oil	Canola seed meal
				- lb acre^{-1} -	-- tons --	-- tons --
Low rainfall	10.5	Spring canola	0	0	0	0
		Winter canola	400,000	2,500	200,000	400,000
Intermediate rainfall	1.6	Spring canola	50,000	1,300	13,000	26,000
		Winter canola	150,000	2,900	87,000	174,000
High rainfall	1.7	Spring canola	70,000	2,000	28,000	56,000
		Winter canola	20,000	3,200	12,800	25,600
Irrigated	1.5	Spring canola	60,000	2,800	33,600	67,200
		Winter canola	75,000	3,750	56,250	112,500
Total	15.0		825,000	18,450	430,650	861,300

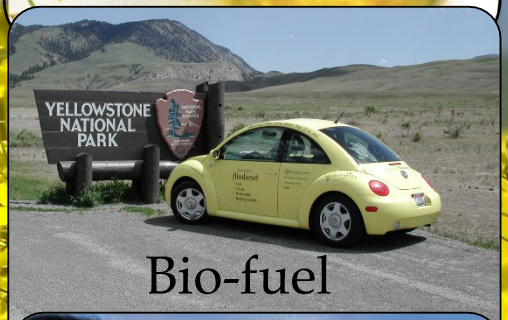
Objectives

- ✓Objective 1: Develop and identify canola cultivars that afford the highest productivity and greatest profitability for different agronomic zones in the PNW.
- ✓Objective 2. Quantify the effects of growing canola in rotations with wheat in the PNW.

Breeding Objectives

Yield

Quality

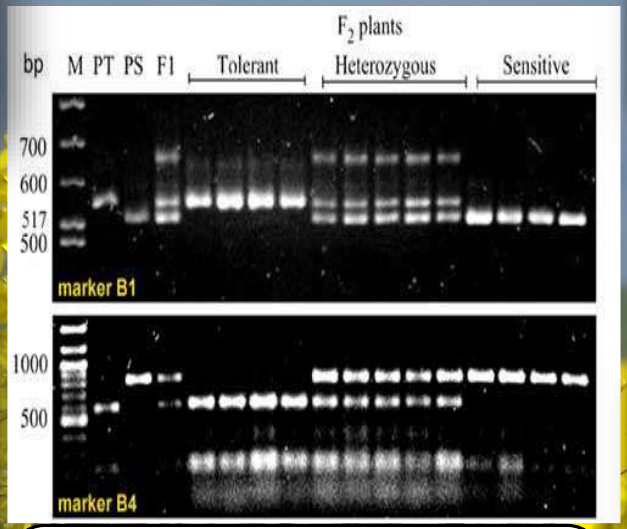


Reduce inputs

Selection

Field Trials

Disease Test

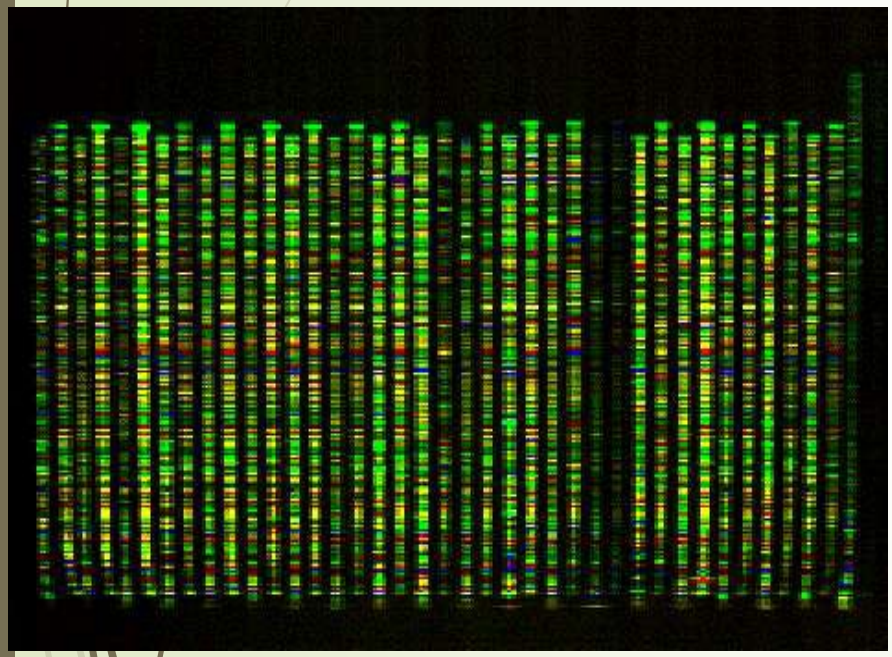


Molecular Markers

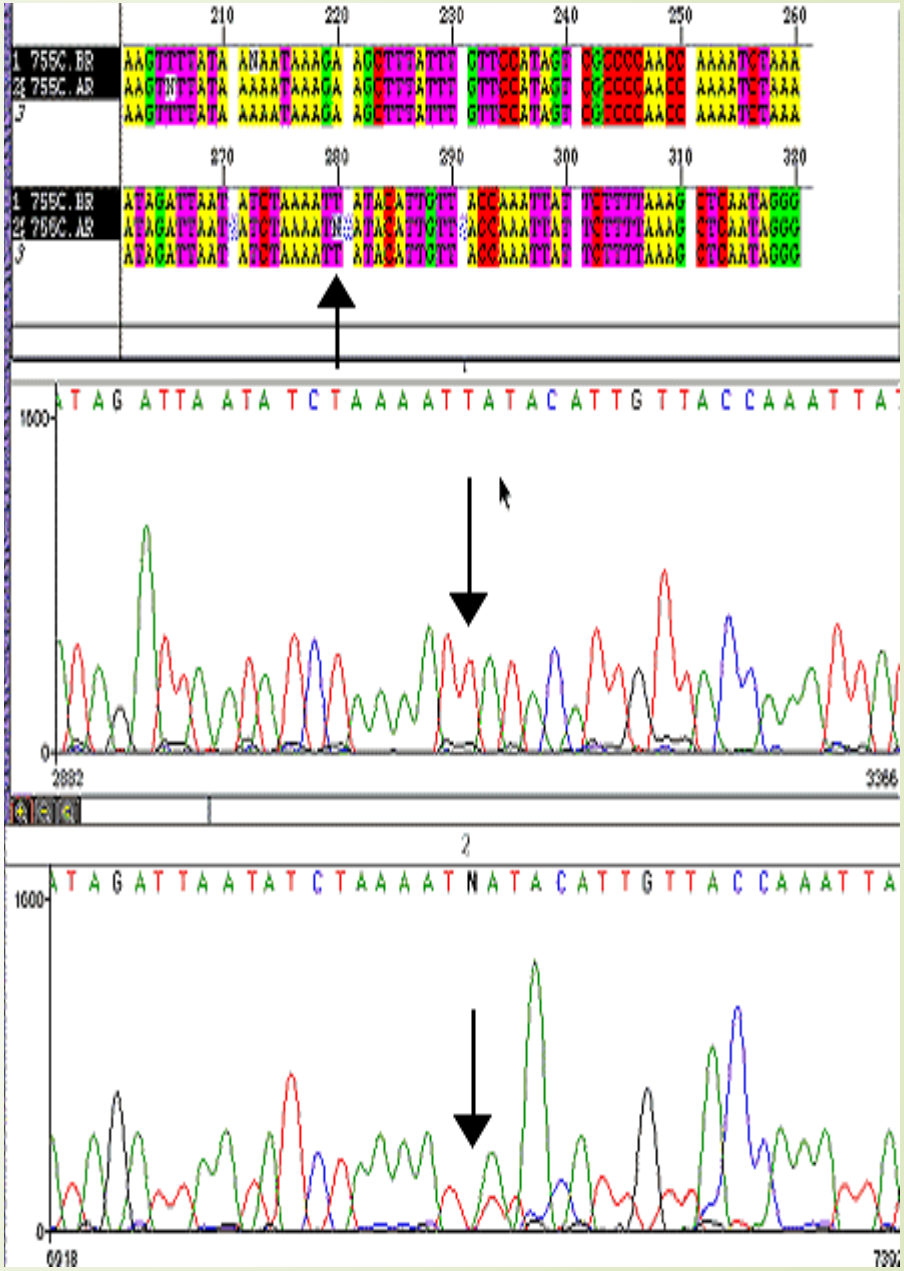
Tissue Culture

Quality Test

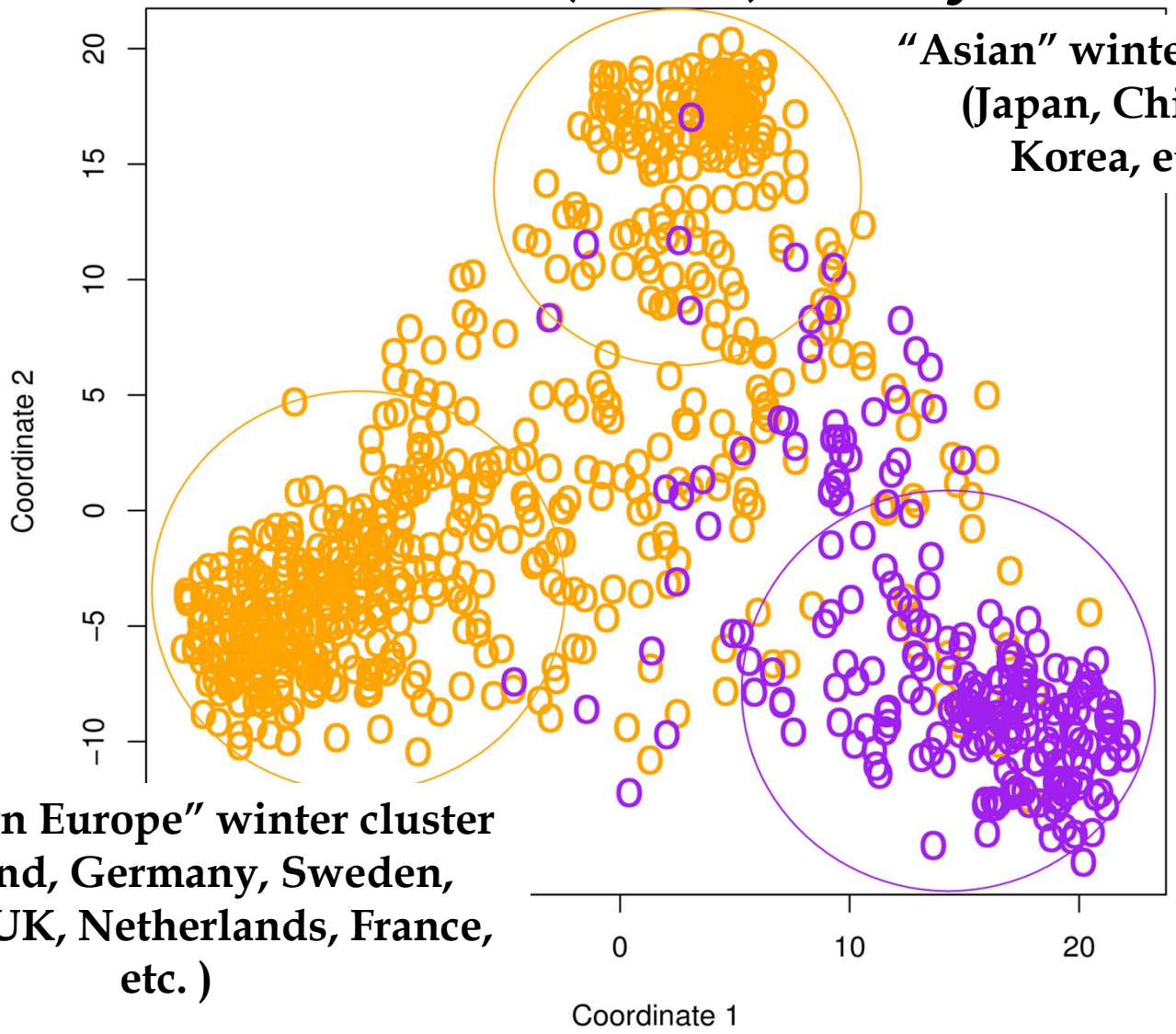
Genomic Wide Association Studies



900 genotypes
40K SNP's



Population Structure: Principal coordinate (PCO) analysis



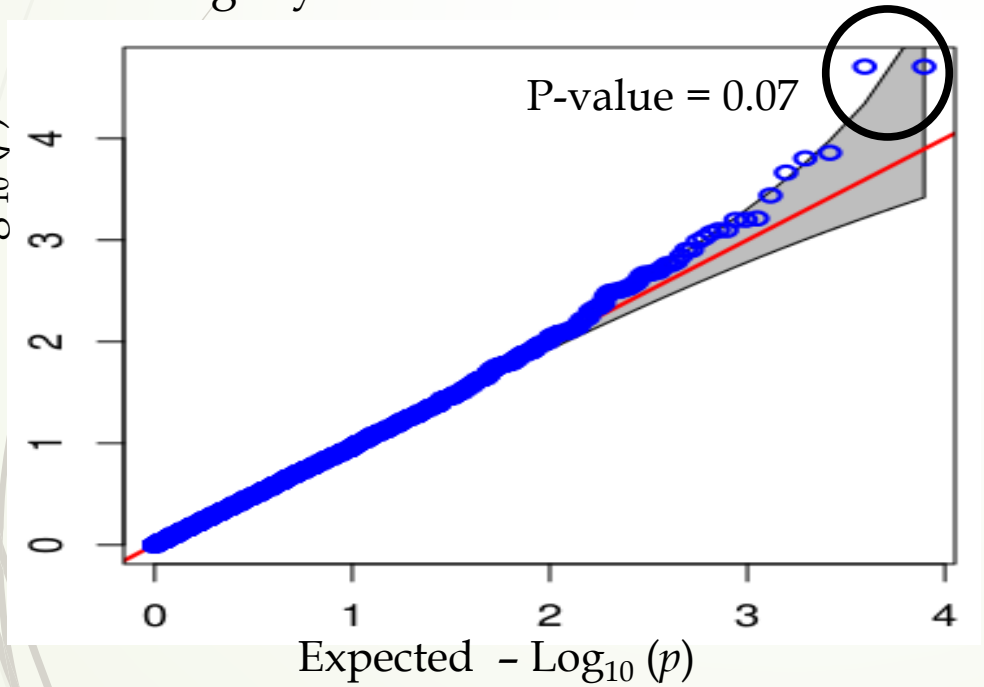
"Asian" winter cluster (Japan, China, S. Korea, etc.)

Spring

"Western Europe" winter cluster (Poland, Germany, Sweden, Latvia, UK, Netherlands, France, etc.)

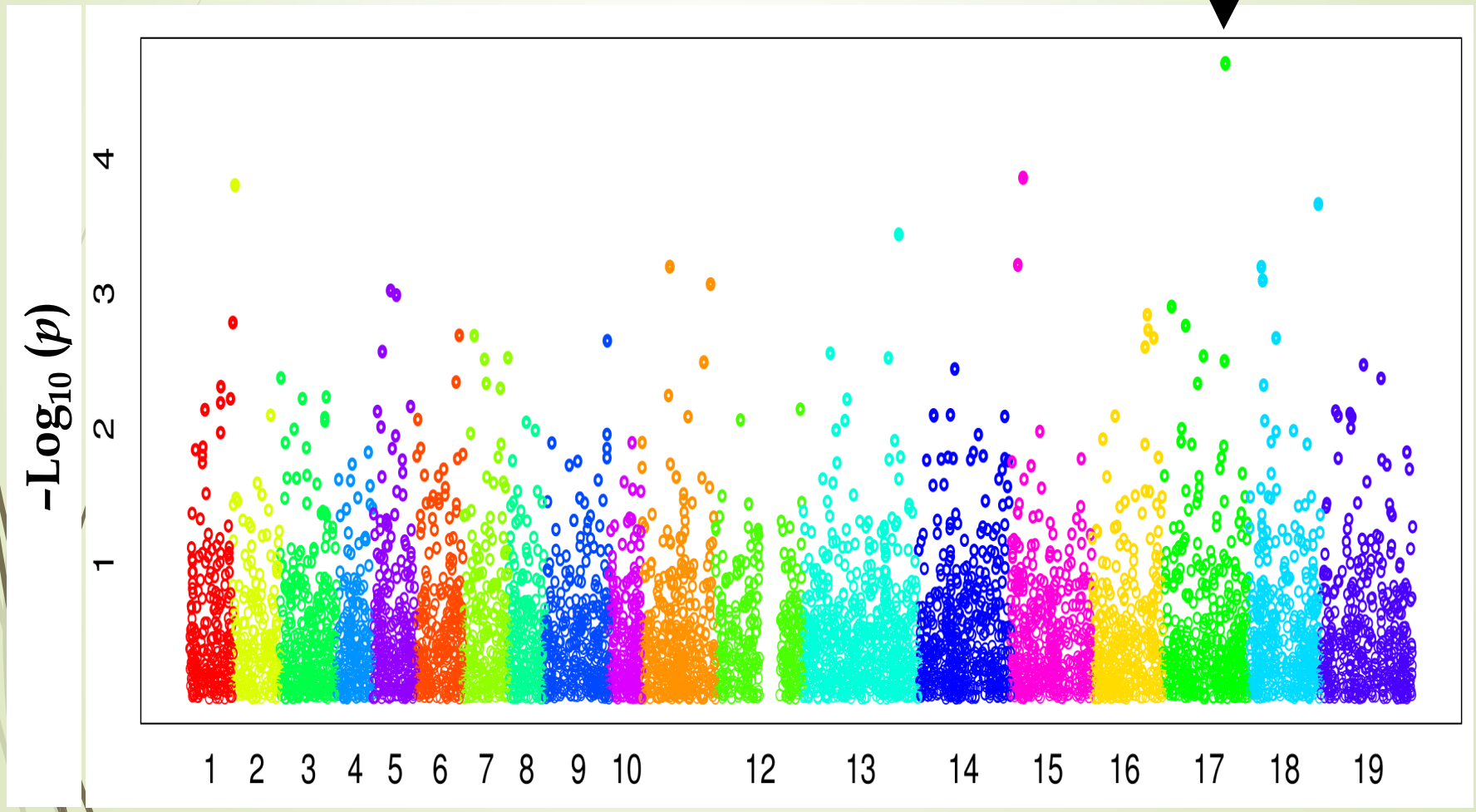
PCOs based on 260 SNPs from SNP array data set

- Best Linear Unbiased Estimates (BLUE's)→ observed yield values corrected for environment.
- Incorporated within-spring population structure and kindship as covariate in the GWA's.
- Top 20 low and high yielding accessions from 2014.
  - ✓ stronger year and site effect.



BLUES_2014	Accession ID / cv name	Origin
Low yield	Ames 2777	Eur
Low yield	Matador	Eur
Low yield	Lisora	Eur
Low yield	Stellar	Am
Low yield	Gisora	Eur
Low yield	PI 470079	Asia
Low yield	Norin 5	Asia
Low yield	S. V. Gulle	Eur
Low yield	Mokpo 23	Asia
Low yield	Yonkokuban	Asia
Low yield	PI 633124	Eur
Low yield	Mokpo 32	Asia
Low yield	PI 458979	Am
Low yield	Bronowsky	Eur
Low yield	Svalof gullen	Eur
Low yield	Norin 8	Asia
Low yield	IMC_202	Am
Low yield	PI 458936	Eur
Low yield	PI 470018	Asia
Low yield	Gulliver	Eur
High yield	03IL5.6.1	Am
High yield	04SC28.4.3	Am
High yield	05SC.14A9.21.6	Am
High yield	05SC.1A4.10.1	Am
High yield	05SC11.A1.35.2	Am
High yield	07SC38.16_duplo	Am
High yield	07SI.42.3	Am
High yield	5SC11A1.24.6	Am
High yield	5SC11A1.8.1	Am
High yield	5SI.BA5_JB8.16	Am
High yield	Estrade	Am
High yield	IMC 105	Am
High yield	KAB36_LL	Am
High yield	Pioneer_46A76	Am
High yield	PM.2	Am
High yield	Profit	Am
High yield	UISC001.3.5	Am
High yield	UISC003.1.17	Am
High yield	UISH00.3.19.23	Am
High yield	PI 432392	Asia

Manhattan plot




Winter Kill

Cold & Drought Tolerance

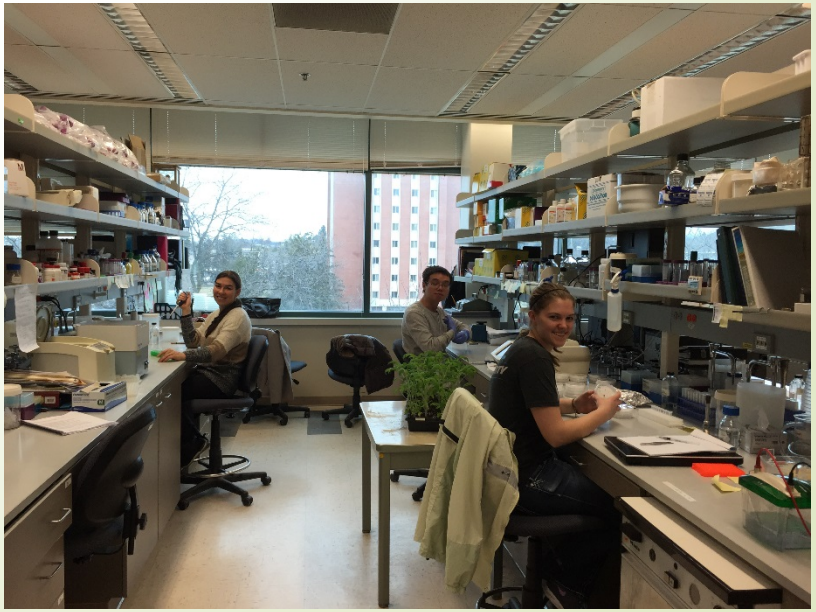
- ✓ Develop cold- and drought-tolerant canola varieties that will efficiently utilize water and express extreme winter hardiness.
- ✓ The *RC12A* gene that plays a significant role in abiotic stress tolerance will be genetically manipulated into 'Amanda' and '06UIWC.1' winter canola.
- ✓ The *RC12A* gene encodes for a plasma membrane-related protein that is specifically related to cold stress tolerance.

Cold & Drought Tolerance

- ✓ Two approaches to manipulate the *RC12A* gene.
  - One is over-expression of the endogenous canola *RC12A* gene (*BnRC12A*);
  - the other one is heterogeneous expression of the *Arabidopsis RC12A* gene (*AtRC12A*) in canola.
- ✓ In both cases, the *RC12A* gene (*BnRC12A* or *AtRC12A*) will be cloned into a strong CaMV 35S promoter-driven plant expression vector and over-expressed in the locally-adapted winter canola cultivars and advanced breeding lines.

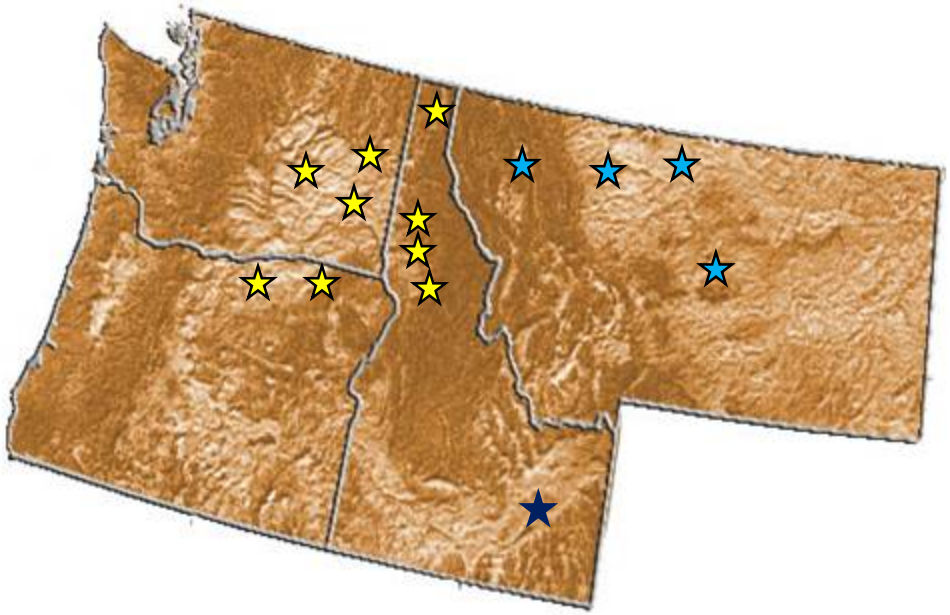
Cold & Drought Tolerance

- ✓ We have generated the necessary cDNAs from both *Arabidopsis* and canola plants.
- ✓ Cloning the *RC12A* gene from these cDNA's is in process.



Pacific Northwest Cultivar Variety Trials

- 616 different spring canola cultivars from 30 different companies have been tested.
- 453 different winter canola varieties have been tested from 20 different private and commercial breeding.



Winter Canola

Cultivar	Mean	2014	2013	2012
Amanda	2,583	3,546	3,515	3,833
Athena	2,461	3,350	3,439	3,682
06.UIWC.1	2,660	3,543	3,739	4,058
05.UIWC.15.7.5[1]	2,430	3,345	3,367	3,599
HyClass-125RR[2]	2,347	2,881	2,776	3,825

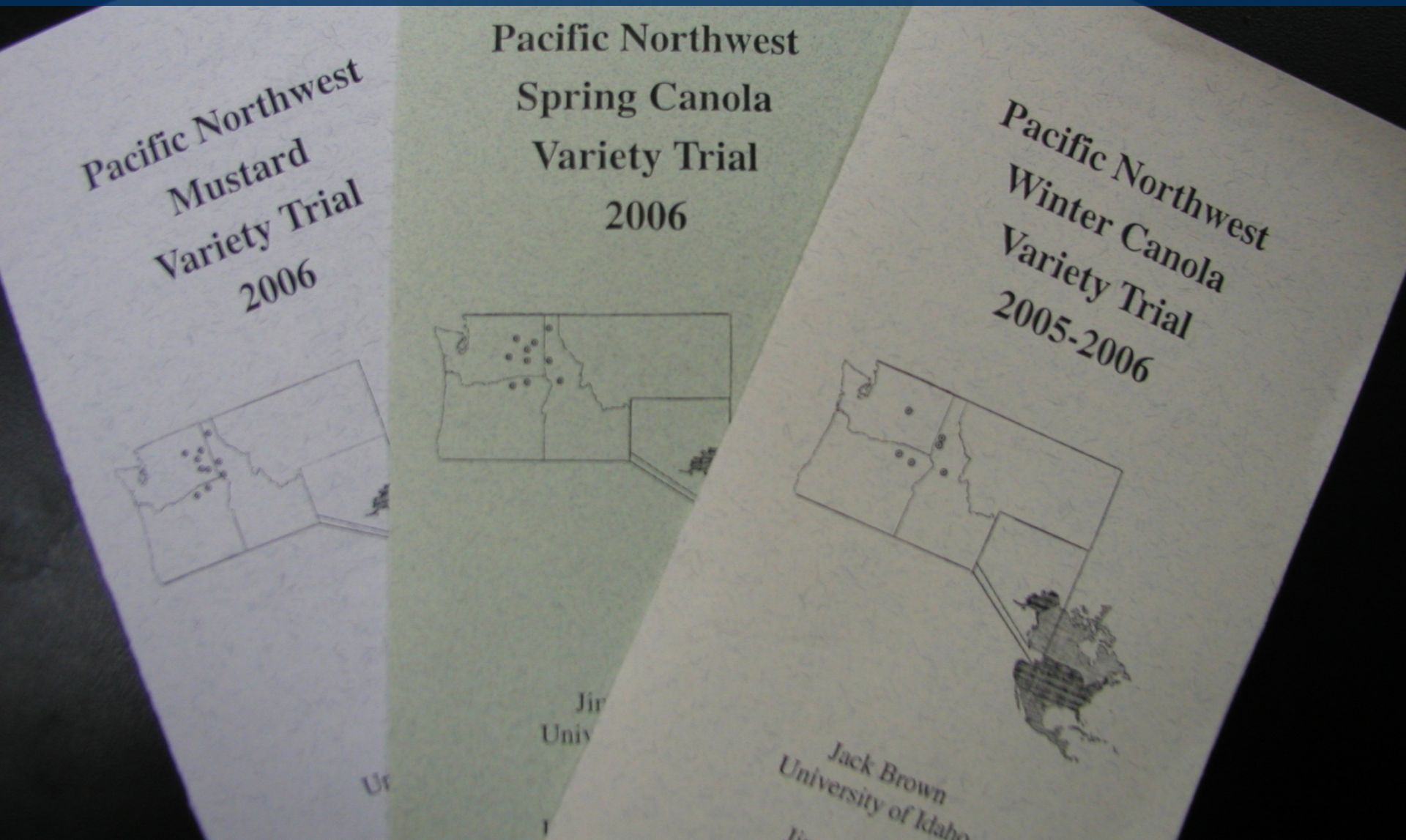
[1] IMI Resistant; [2] Roundup Ready,

Spring Canola Cultivars

Cultivar	Mean	2015	2014	2013
Westar	1,754	1,723	1,788	1,902
HyClass.955 RR[1]	2,299	2,387	2,420	2,499
DKL30-42 RR[1]	2,259	2,334	2,283	2,546
InVigor-L139LL[2]	2,378	2,213	2,241	2,582
Cara CL[3]	1,828	1,706	1,695	1,831
Empire	1,960	1,917	1,855	2,095
07SC27.12.B3	1,837	1,703	1,775	1,975

[1] Roundup Ready, [2] LibertyLink, [3]IMI resistant

http://www.cals.uidaho.edu/brassica/
http://webpages.uidaho.edu/jbrown/brassica/



Pacific Northwest Agriculture

We must reduce soil erosion and improve water and air quality.

Pesticide applications cause environmental concerns.

Ron Henning's

2007 2008 2009

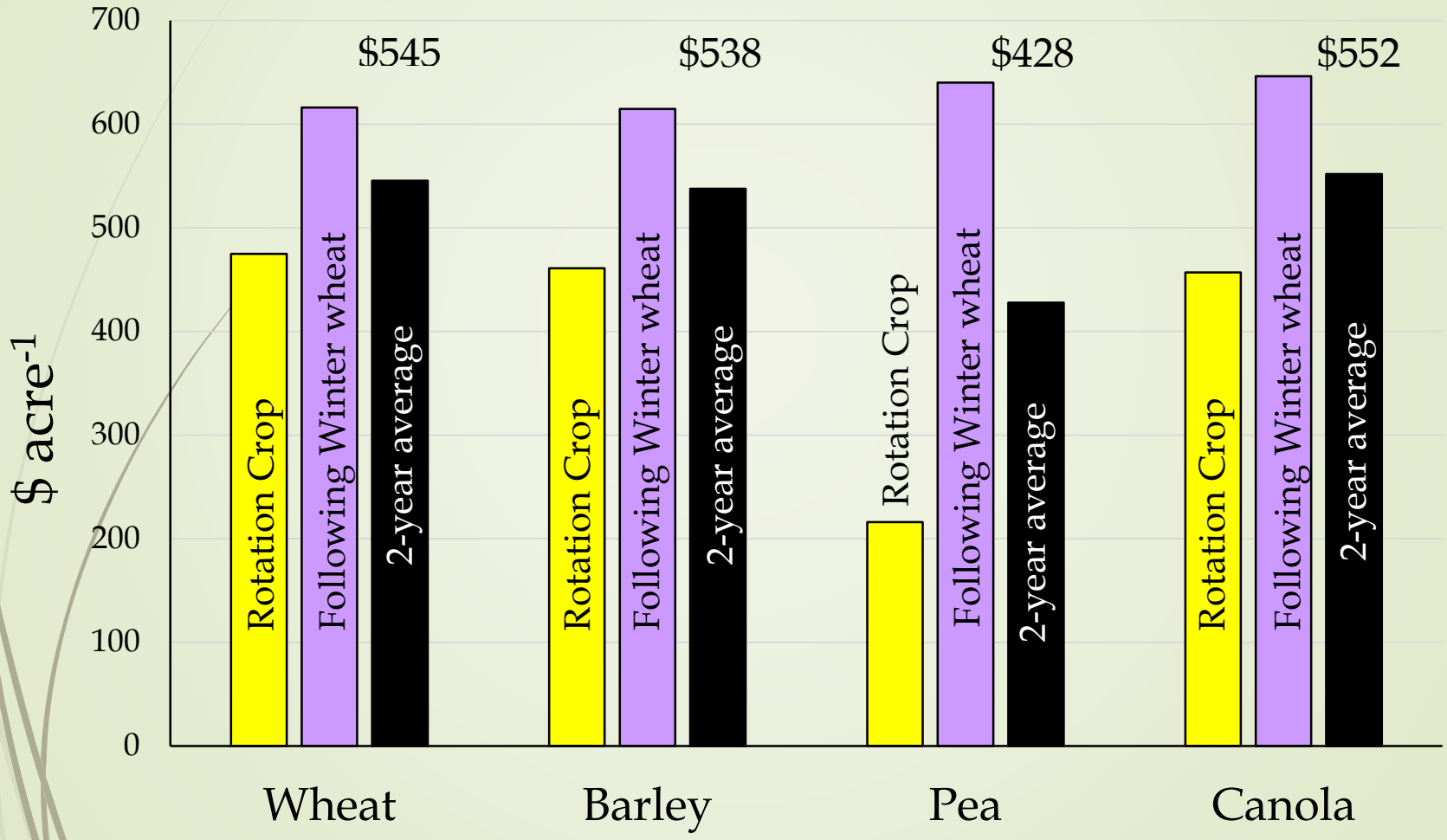
- winter canola → fallow → winter wheat
- winter wheat → fallow → winter wheat

Date:	2007		2009		
Treatment	Yield (#/ac)	Gross $ ($/ac)	Yield (bu/ac)	Gross Return ($/ac)	Gross Return ($/ac)
Wheat	2,602	$355	34.1	$142	$496
Canola	1,724	$293	47.5	$197	$490
Sig.	0.01	0.05	0.05	0.05	n.s.

Aaron Esser: County Director, Adams County, WSU

Pre-Proposal Research

Gross Crop Returns



Crop Rotation Effects

Study Site	Year 0	Year 1	Year 2	Year 3
ID Spring Rotation	Spring wheat	Spring canola Spring pea Spring barley Spring wheat	Winter wheat (SWWW)	
ID Winter Rotation	Winter wheat & Fallow	Winter canola Austrian winter pea Winter wheat	Winter wheat (SWWW)	
WA Spring Rotation	Spring barley	Spring canola Spring wheat Spring Pea	Winter wheat (HRWW)	
WA Winter Rotation	Fallow	Winter canola Austrian winter pea Winter wheat	Spring wheat (HRSW)	
OR Winter Rotation	Fallow	Winter canola Austrian winter pea Winter triticale Winter wheat	Fallow	Winter wheat (SWWW)

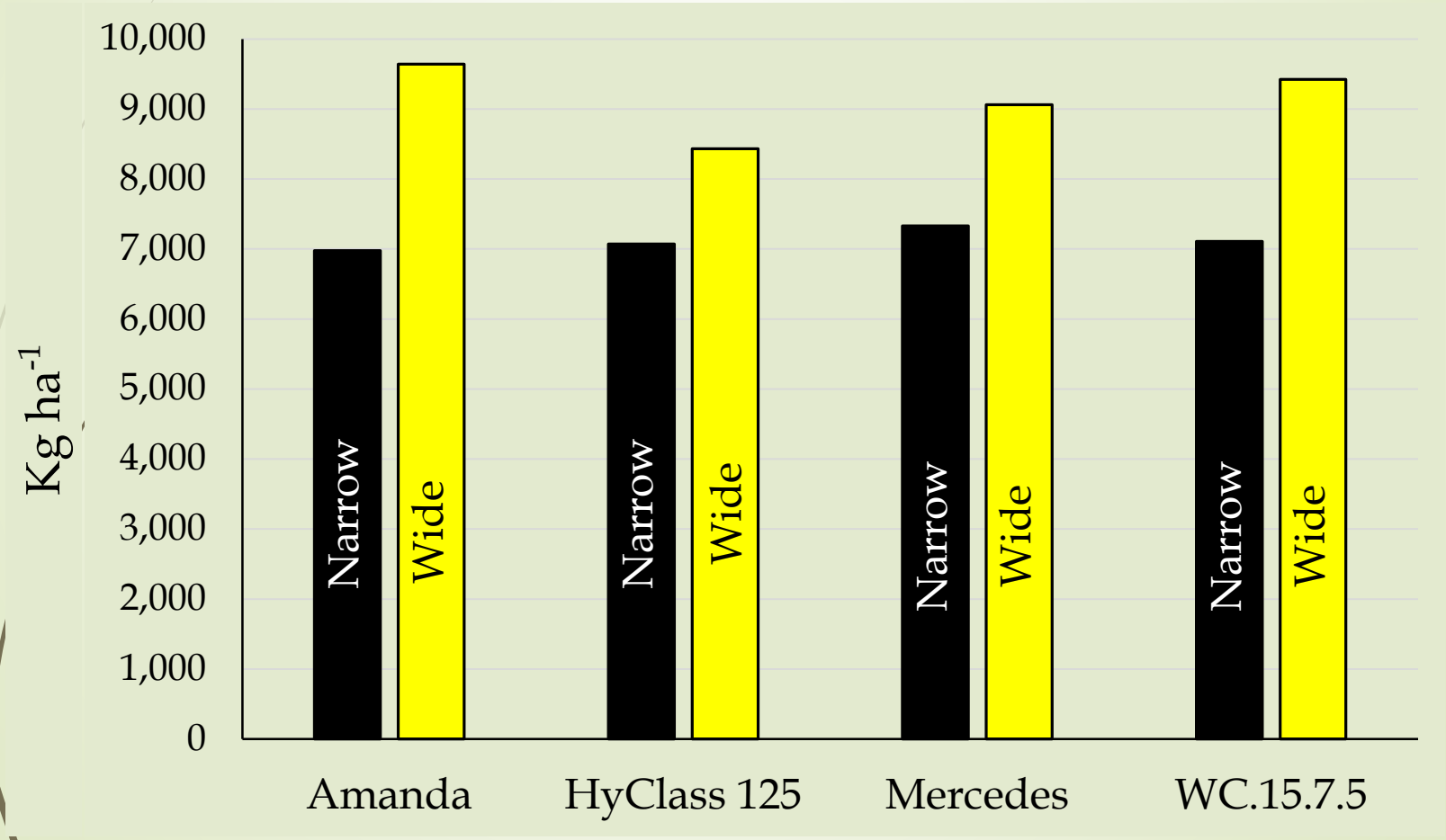
Objectives

- ✓ **Objective 3.** Determine the effects of row spacing, seeding rate, planting date, and mowing on winter survivability and productivity of early-planted winter canola in the PNW.
- ✓ **Objective 4.** Survey the PNW's potential for development of blackleg.

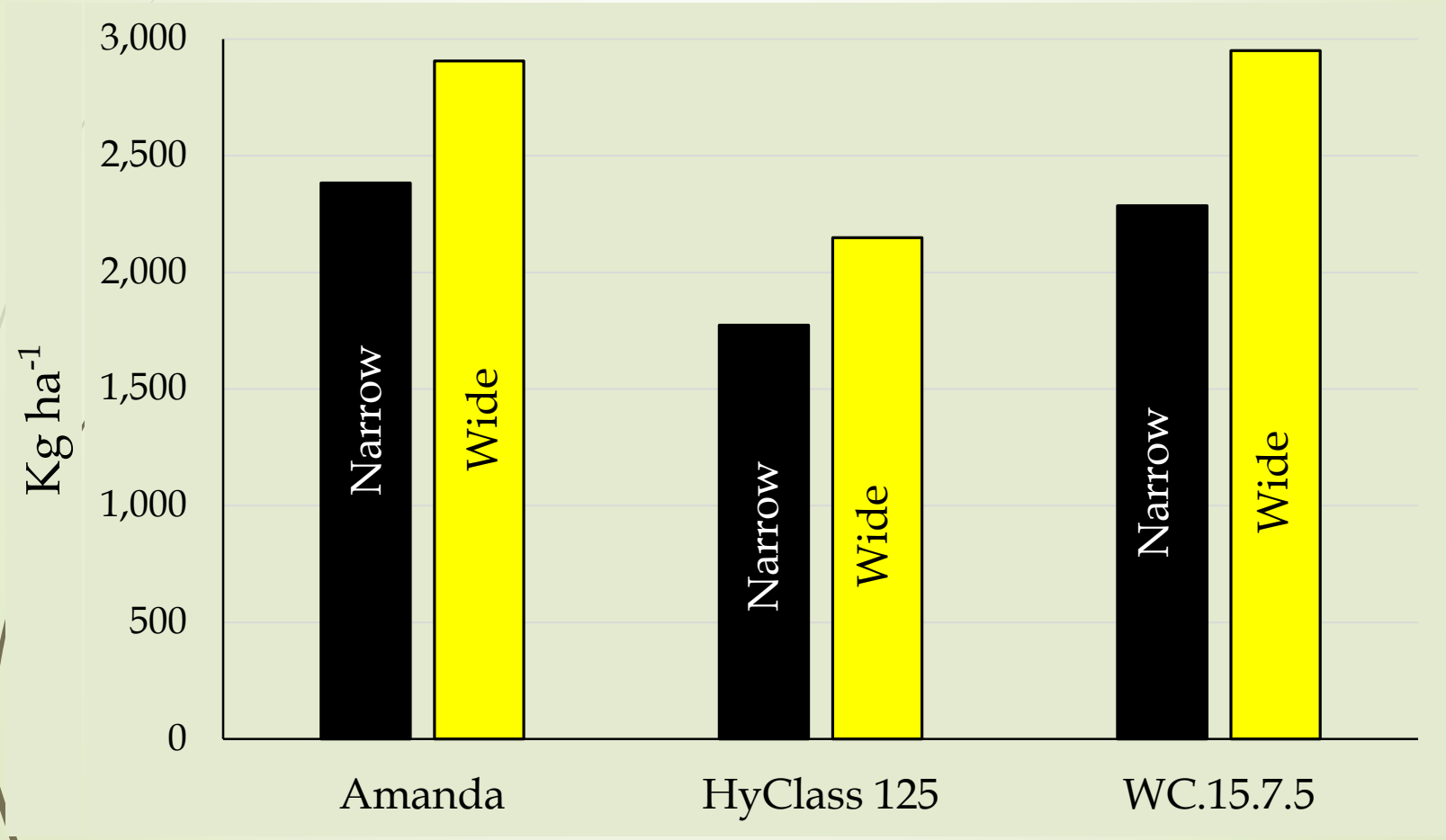
Row Spacing/Seeding Rate

- ✓ Four cultivars (Amanda, HyClass 125, Mercedes, and WC.15.7.5);
- ✓ Two planting dates (late June & early August);
- ✓ August planting only (mowed and not mowed);
- ✓ Two locations (Moscow & Genesee);
- ✓ Two row spacing (25 cm and 50 cm);
- ✓ Four replicates treatment^{-1}.

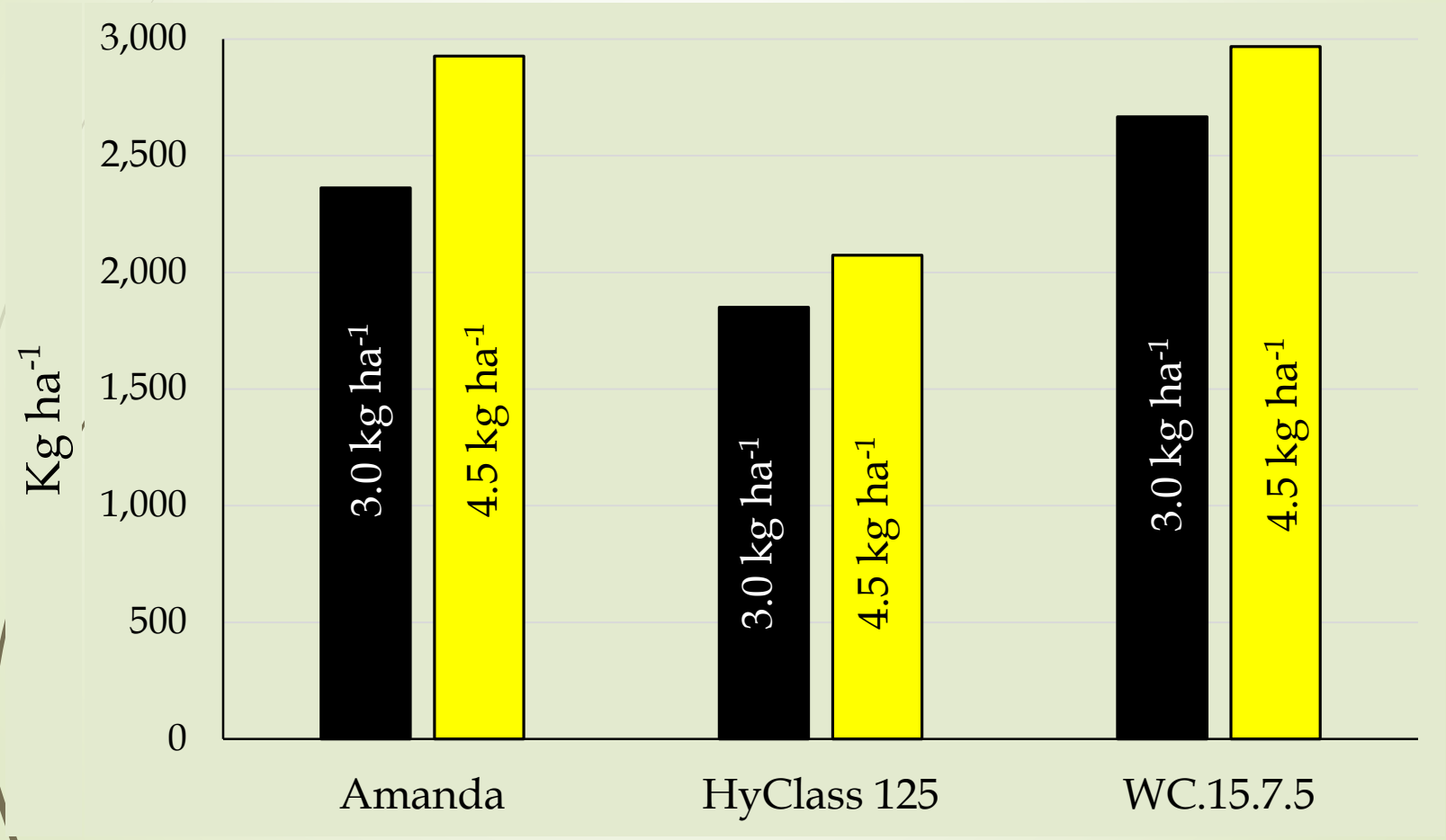
Row Spacing/Seeding Rate
(Fall plant biomass)



Row Spacing/Seeding Rate
(Seed Yield 2015)



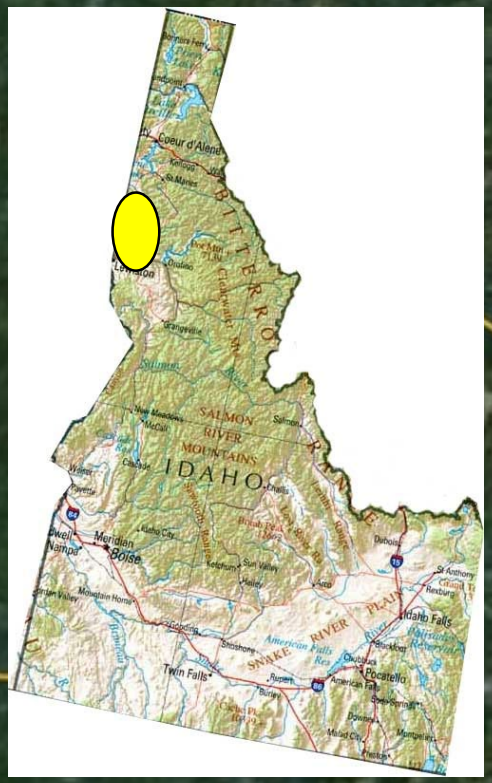
Row Spacing/Seeding Rate
(Seed Yield 2015)



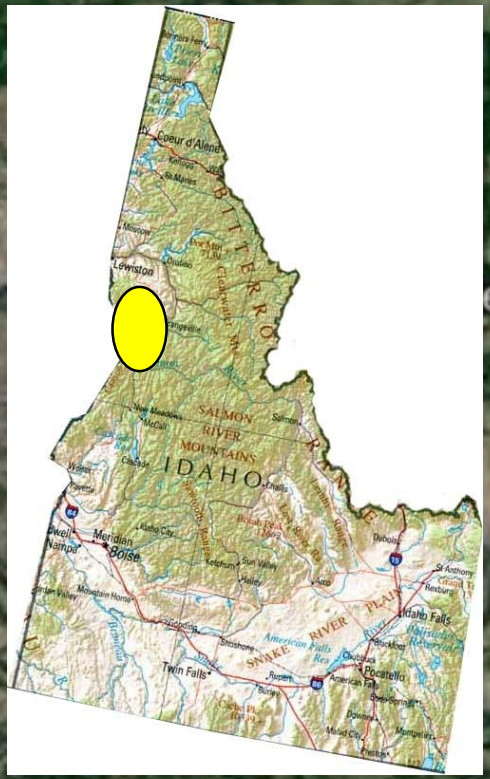
Blackleg on Canola

Northern Idaho Panhandle

Plummer
St Maries
St Regis
Tekoa
90
ohn
Palouse
Fiscus Rd
Colfax
Deary
Elk River
Pullman
3204-3206
Plant Science Rd
1 h 59 min
90.0 miles
Pierce
480 Rd
Trautman Rd
Kamiah
Kooskia
Cottonwood

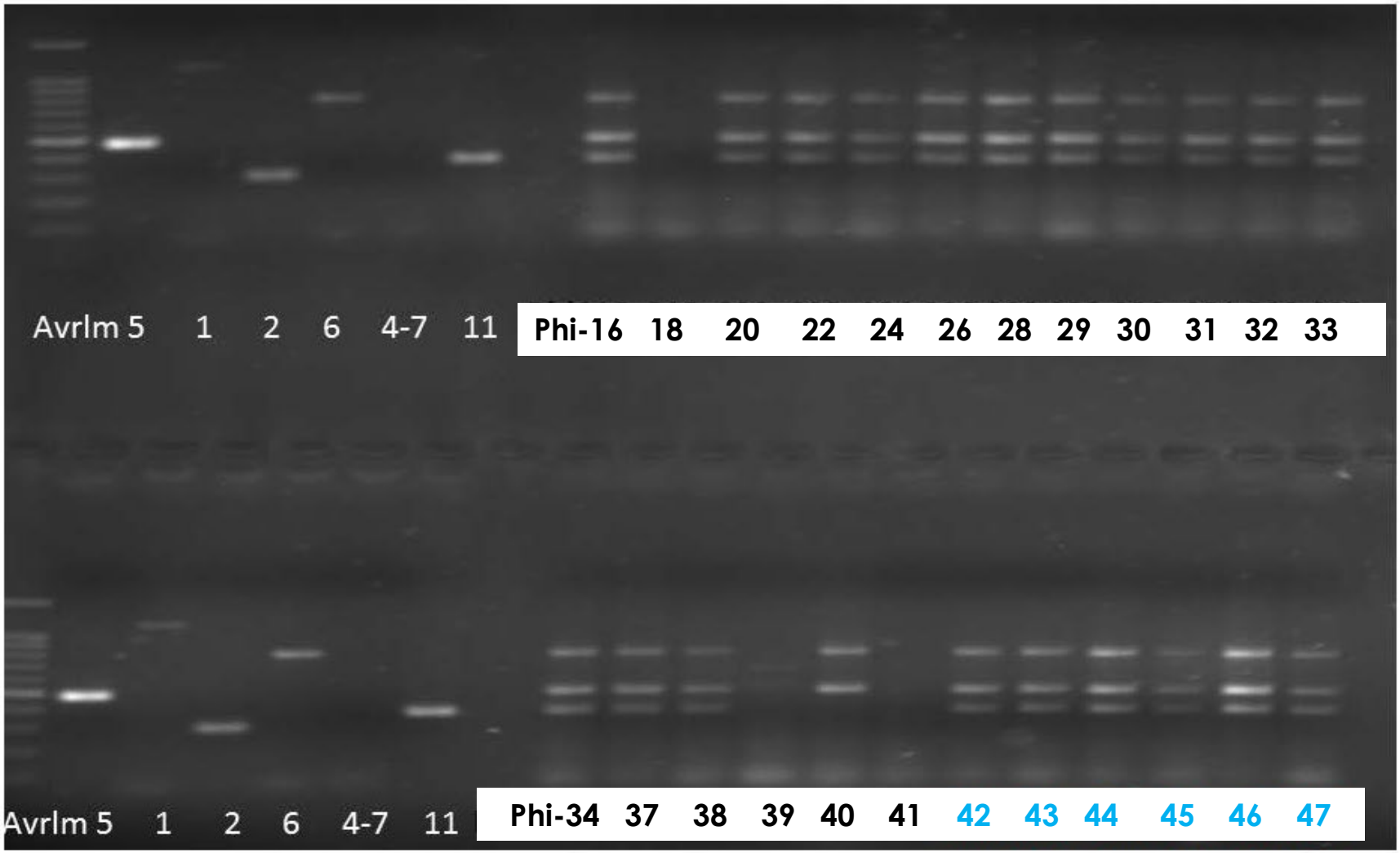


Idaho Camas Prairie



Winchester
95
Nezperce
Kamiah
12
Greencreek
Cottonwood
euterville
95
Yellowbrook Rd

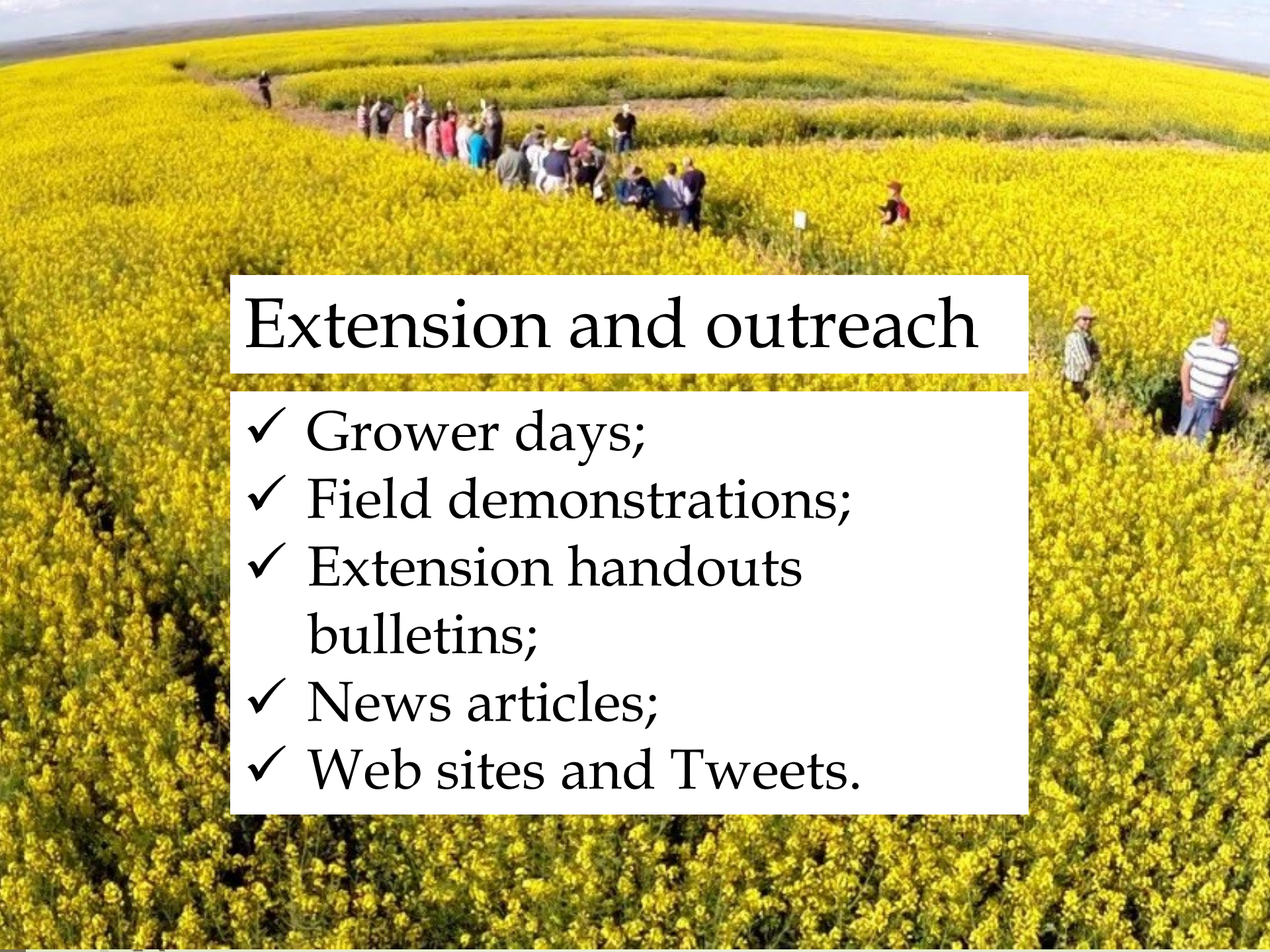
PCR differentiations of 6 *Avr* genes of 24 isolates



Distribution of *L. maculans* race structure from different locations

Location	*L. Muculans* races	# Isolates
Willamette Valley, OR	Avr-3-5-6-7-11-LepR1	2
	Avr-5-6-7-11-LepR1	4
Lewiston, ID	Avr-1-3-4-5-6-7-9-11-LepR1-LepR2-(LepR3)	4
	Avr-1-3-4-5-6-7-9-11-LepR1-(LepR3)	1
	Avr-1-5-6-7-9-11-LepR1-(LepR3)	1
Camas Prairie, ID	Avr-5-6-7-11-S-LepR1	10
	Avr-5-6-7-11	1
	Avr-1-2-5-6-7-11-LepR1	1
	Avr-5-6-11	1
	Avr-2-5-6-7-11-S-LepR1	1
	Avr-1-2-3-4-S-LepR1-LepR2	1
	Avr-5-6-7-9-LepR1	1
	Avr-3-5-6-7-11-LepR1	2

Blackleg on Canola



Extension and outreach

- ✓ Grower days;
- ✓ Field demonstrations;
- ✓ Extension handouts bulletins;
- ✓ News articles;
- ✓ Web sites and Tweets.


Questions