

Breeding for FHB in North Dakota: More Questions than Answers



Introduction



NDSU Agronomy Seed Farm, Casselton, ND. July 2018

- I started at NDSU in June 2016
- Previously at Kansas State University (Fritz) & Virginia Tech (Griffey)
- Primary objective at NDSU is variety development
- Other interests include drought tolerance, durable rust resistance, prediction of baking quality parameters, experimental design

Spring Wheat in North Dakota

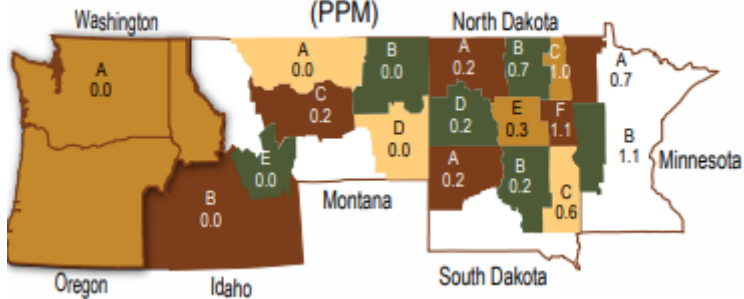
- FHB resistance is a “gatekeeper” trait
- Planted 6.6 million acres in 2018; state average yield was 49 bu/ac
- Average annual precipitation ranges from 14” (west) to 22” (east).



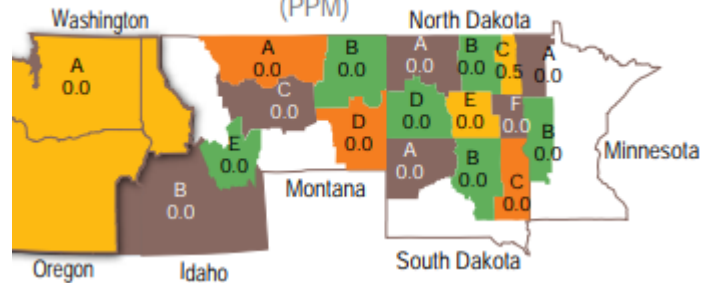
Hettinger County, ND. July 2018

“FHB is an Eastern ND Problem”

2018
AVERAGE DON BY AREA
(PPM)

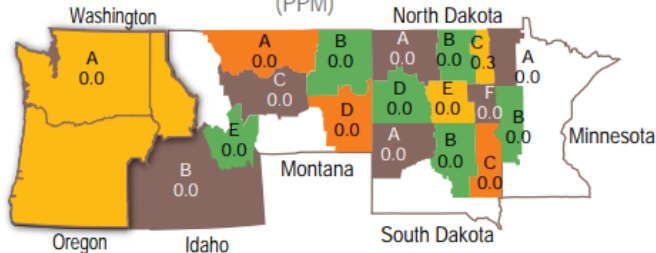


2017
AVERAGE DON BY AREA
(PPM)



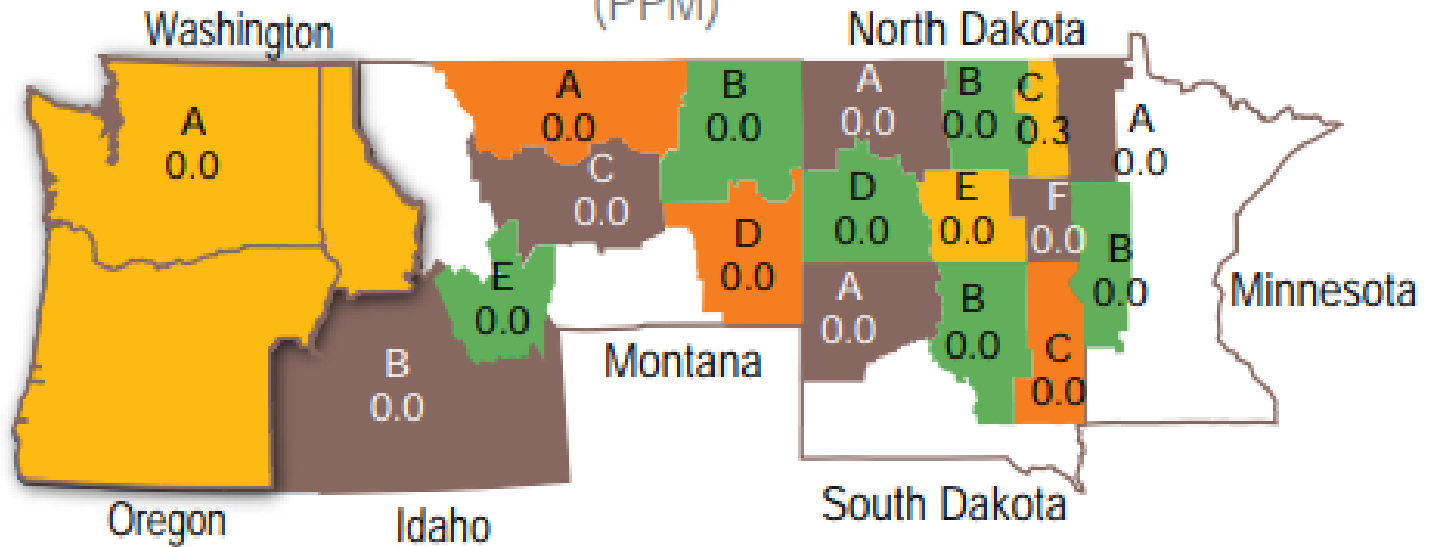
2016

AVERAGE DON BY AREA
(PPM)

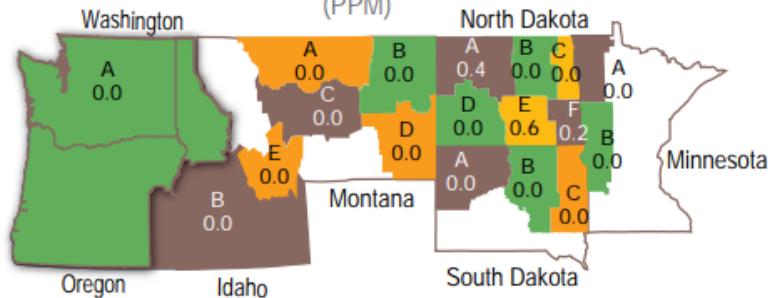


2016-2018

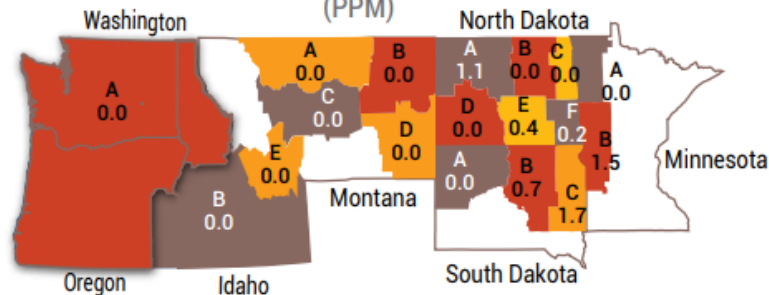
AVERAGE DON BY AREA (PPM)



2015 AVERAGE DON BY AREA (PPM)

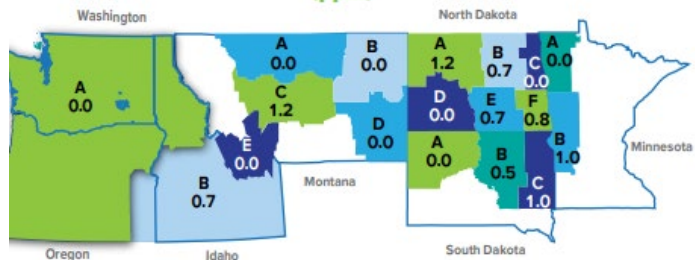


2014 AVERAGE DON BY AREA (PPM)



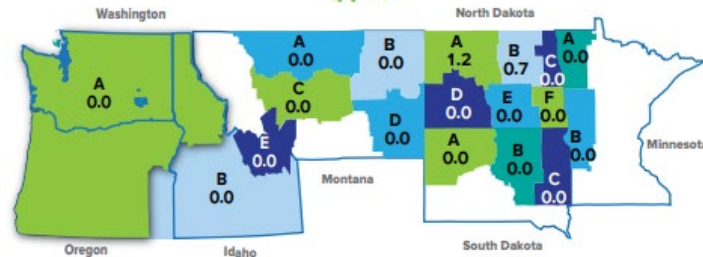
2013

AVERAGE DON BY AREA (ppm)



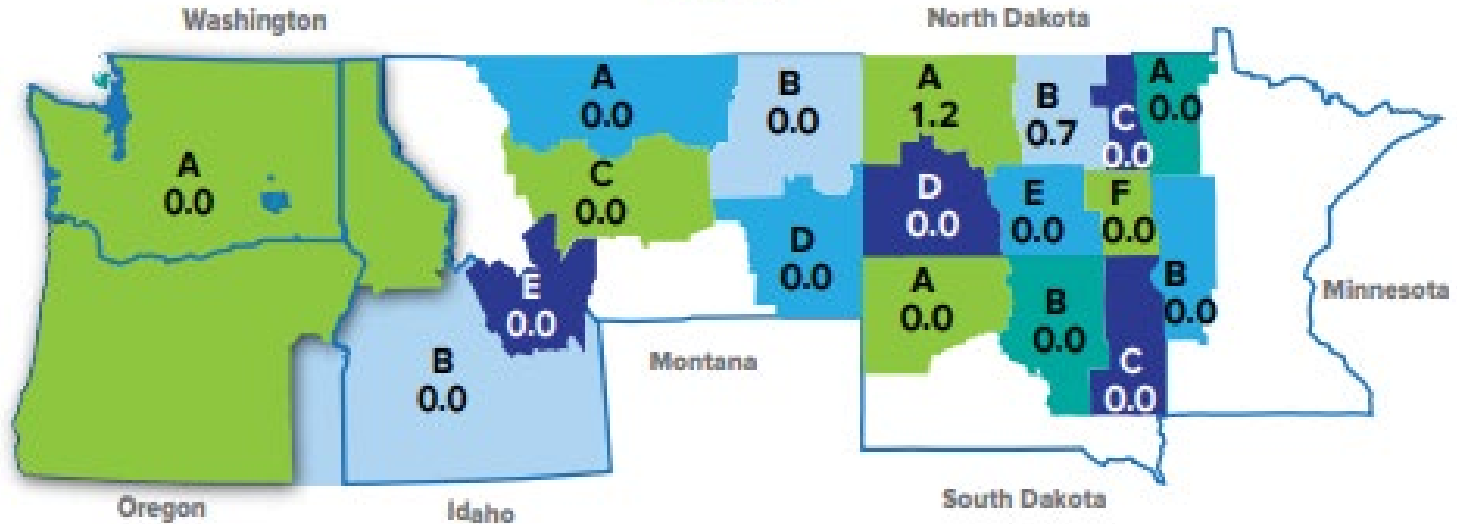
2012

AVERAGE DON BY AREA (ppm)



2012-2015

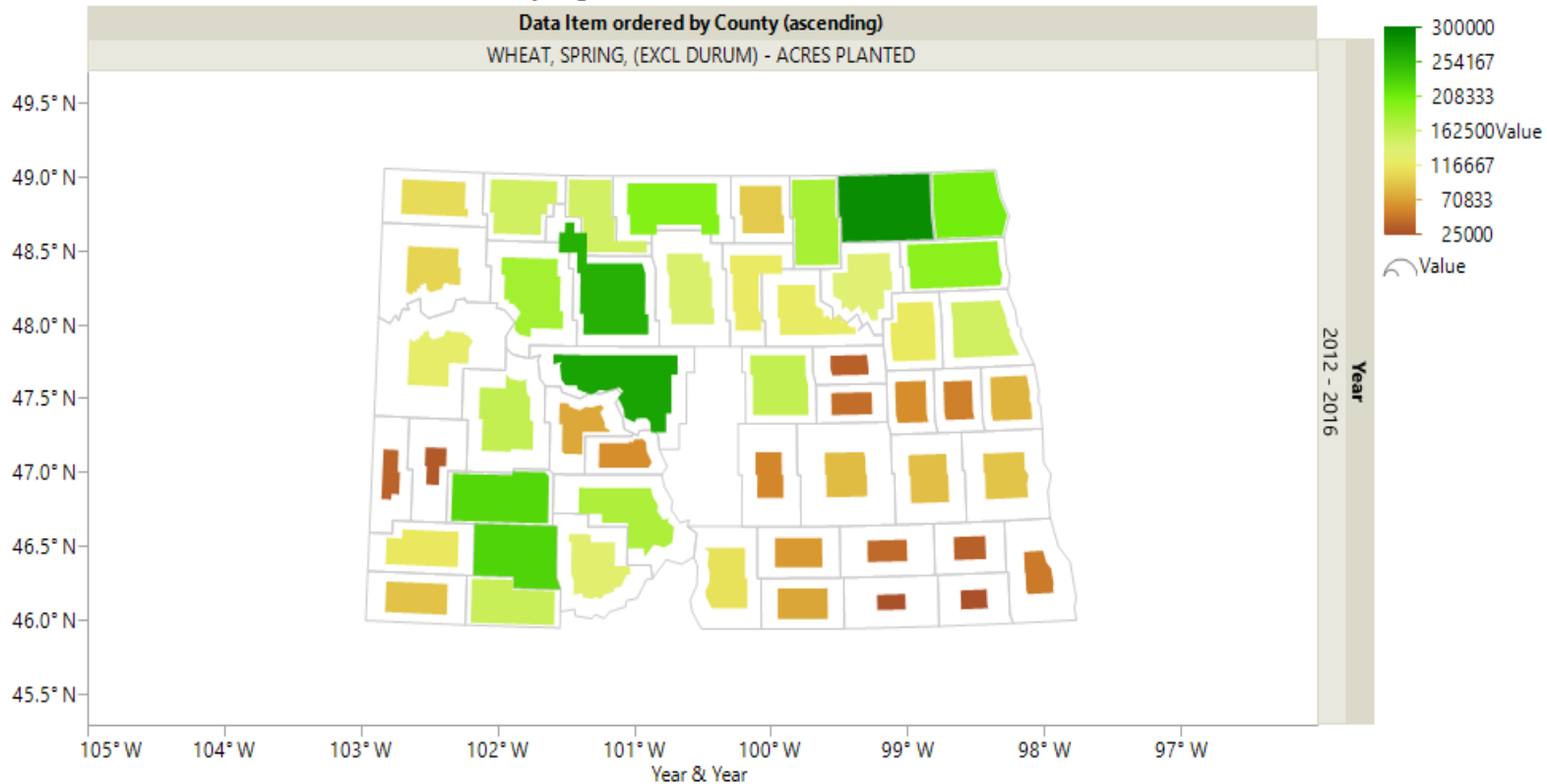
AVERAGE DON BY AREA (ppm)



Spring Wheat Planted Acres

Data Item ordered by County (ascending)

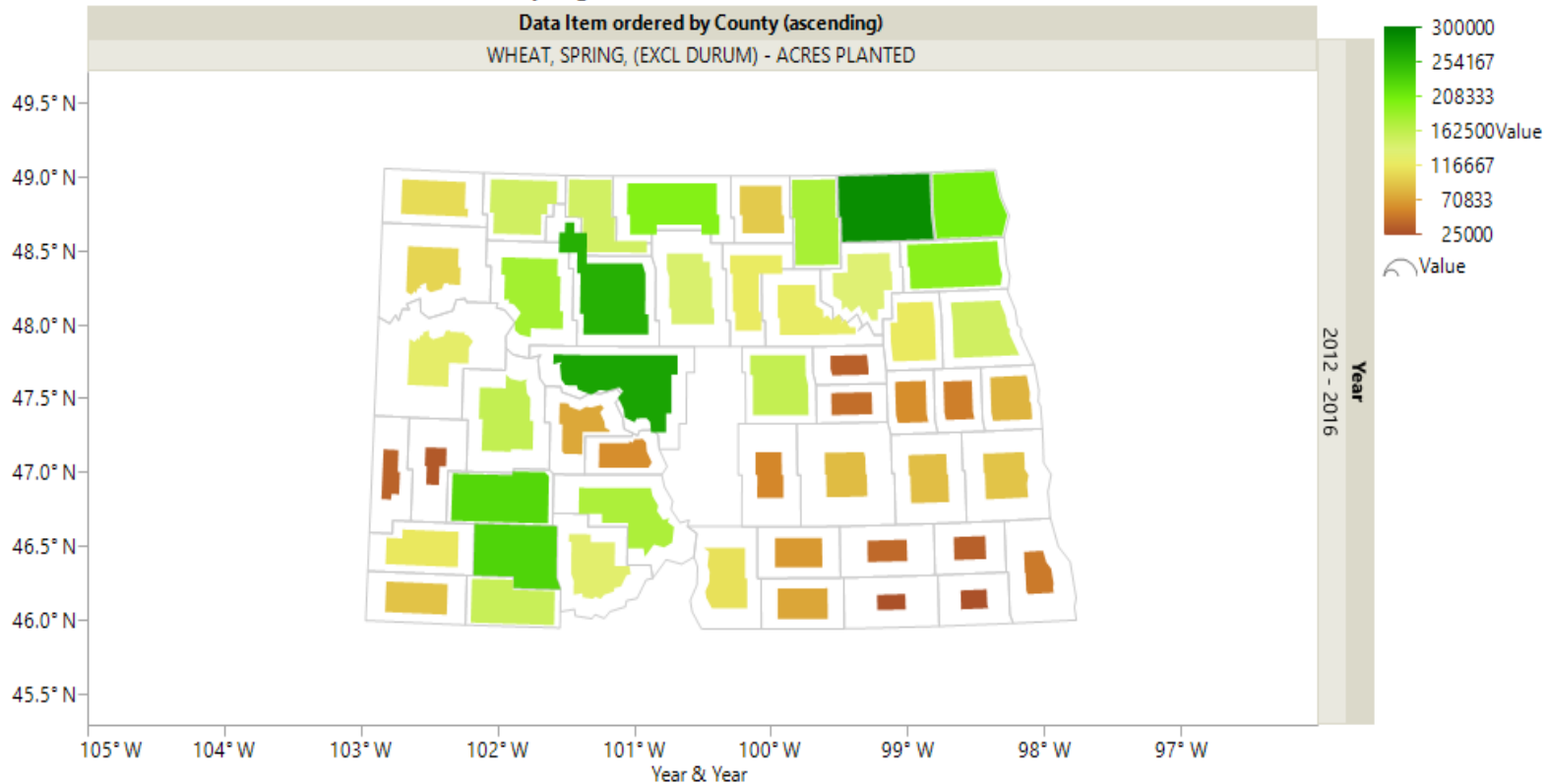
WHEAT, SPRING, (EXCL DURUM) - ACRES PLANTED



Spring Wheat Planted Acres

Data Item ordered by County (ascending)

WHEAT, SPRING, (EXCL DURUM) - ACRES PLANTED



Western North Dakota

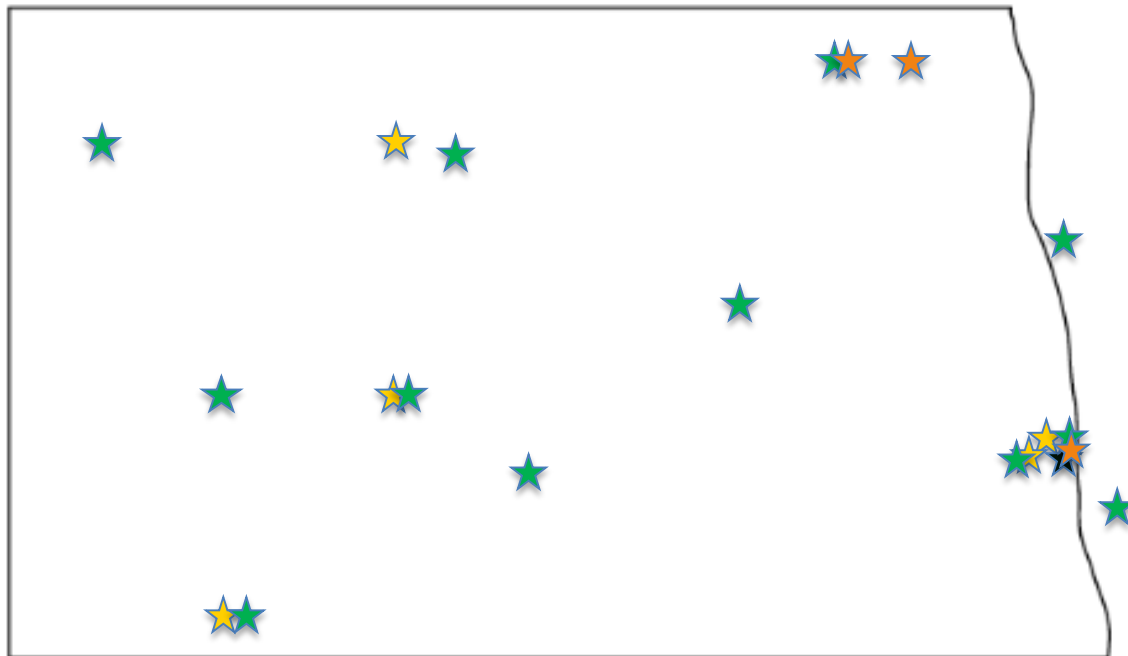
- Diverse rotations (flax, pea, canola, barley, spring wheat, Durum wheat, corn, soybean)
- Overall lower yield potential (vs. East)
- Minimum tillage/ no-till prevalent



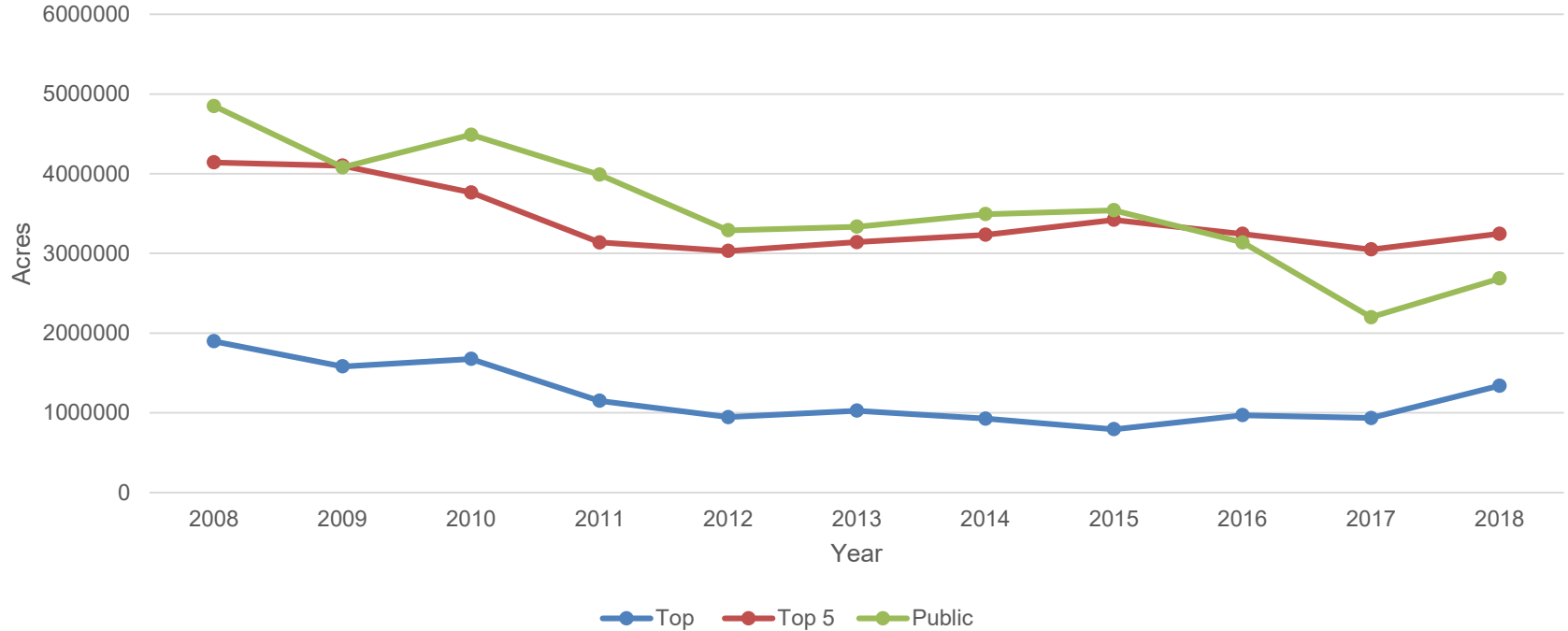
Ward County North Dakota, July 2017

Line Development

- ★ Early Generation
- ★ Yield Trials
- ★ FHB Nursery



ND Spring Wheat Variety Trends



ND Spring Wheat Variety Trends

- In 2018, 25% of varieties in the ND Spring Wheat variety trial were tested for the first time
- Annual percentage of the top 5 and the top 20 named varieties has decreased by 0.68% and 0.64%, respectively, each year since 2008
- Planted acres of publicly developed varieties have decreased by 2.6% annually since 2008

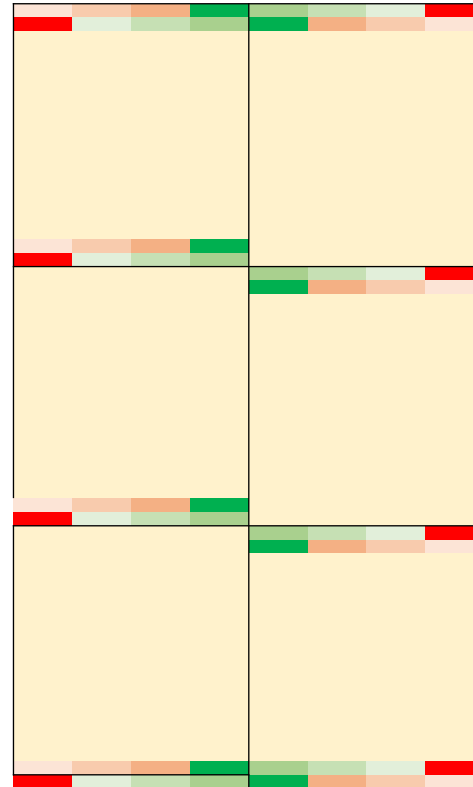
ND Spring Wheat Variety Trends

- Increased variety diversity, and range of FHB resistance
- How do we get quality data to producers in a timely fashion?



Spatial Checks, Stratified by Maturity

Susceptible Early	Susceptible Medium	Susceptible Late	Historical Resistant
Historical Susceptible	Resistant Early	Resistant Medium	Resistant Late

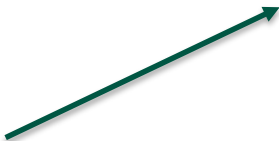
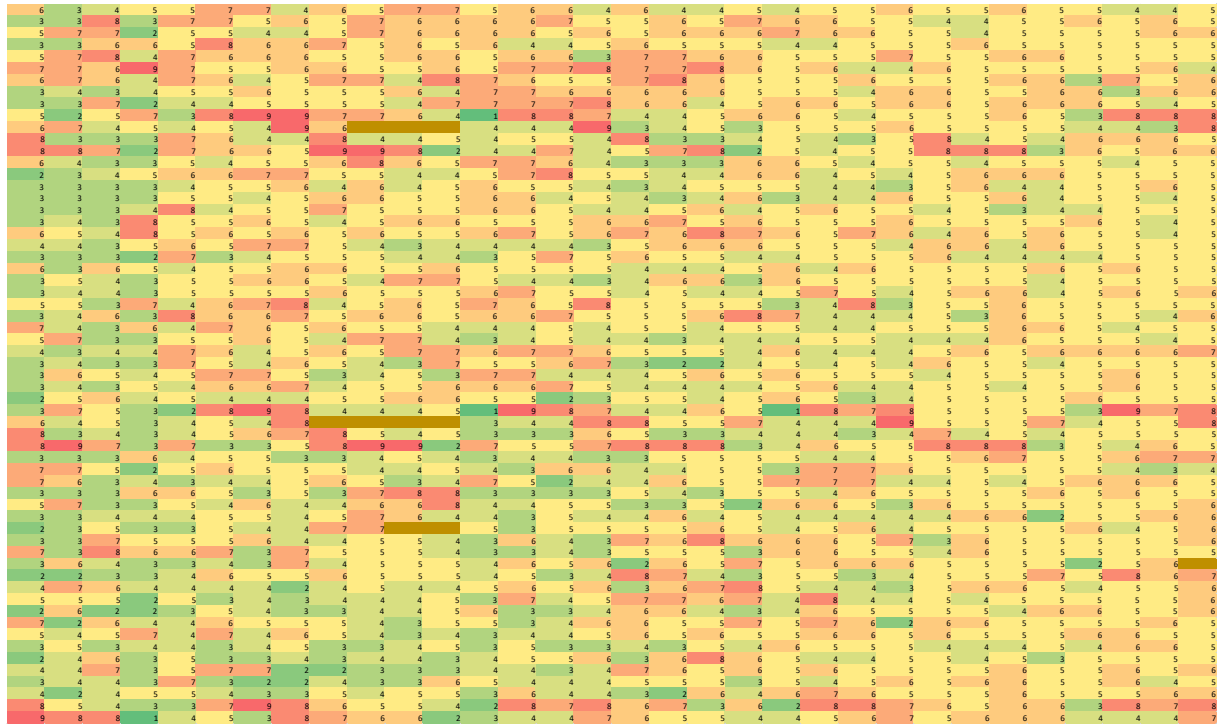


Plot= Single Hill

Advanced Generations and Uniform Nurseries replicated

2-3 locations

2018 Prosper, ND Heat Map

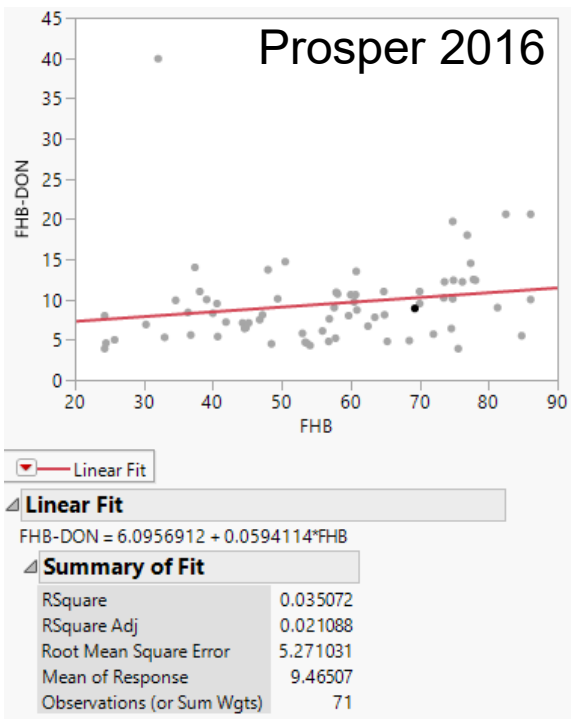


ND Variety Trial Results and Selection Guide

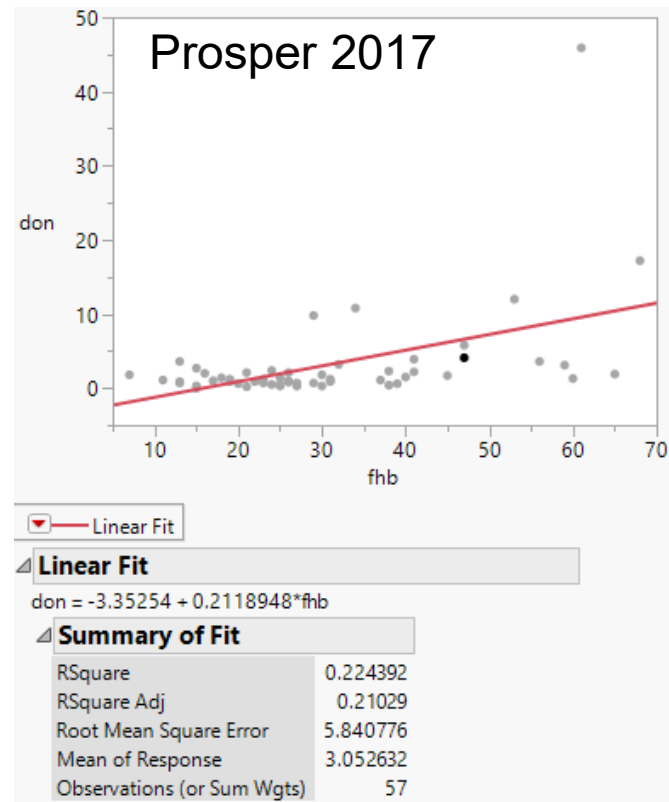
Table 1. North Dakota hard red spring wheat variety descriptions, agronomic traits, 2018.

Variety	Agent or Origin ¹	Year Released	Height (inches)	Reaction to Disease ⁴							
				Straw Strength ²	Days to Head ³	Stem Rust ⁵	Leaf Rust	Stripe Rust	Tan Spot	Bact. Leaf Streak	Head Scab
AAC Brandon	AAC	2014	31	5	47	NA	2	NA	NA	4	5
AAC Goodwin	AAC	2018	32	5	48	NA	2	NA	NA	7	5
AAC Penhold	AAC	2015	30	3	49	NA	3	NA	NA	6	6
Ambush	DynaGro	2016	30	5	46	1	4	3	NA	8	5
Barlow	ND	2009	32	6	47	1	6	4	6	7	5
Bolles	MN	2015	32	4	52	2	3	5	4	8	5
Boost	SD	2016	33	5	51	1	4	3	8	5	4
Caliber	DynaGro	2016	28	2	48	1	3	5	NA	7	8
Elgin-ND	ND	2012	34	5	48	1	6	5	6	7	5
Faller	ND	2007	32	5	50	1	7	8	7	7	5
Glenn	ND	2005	33	4	47	1	6	4	6	7	3
HRS 3100	Croplan	2016	30	4	48	1	4	6	8	7	6
HRS 3419	Croplan	2014	31	2	53	1	3	4	7	8	5
HRS 3504	Croplan	2015	30	3	50	1	1	6	8	7	7
HRS 3530	Croplan	2015	33	4	51	1	2	8	6	8	5
HRS 3616	Croplan	2016	31	4	49	1	5	5	4	8	7
HRS 3888	Croplan	2017	31	4	49	NA	1	NA	NA	8	4
Lang-MN	MN	2017	33	5	51	1	2	1	7	6	5
Lanning	MT	2017	29	3	51	NA	NA	NA	NA	8	5

Variety Trial FHB Index by DON



Yield loss and DON are what affect farmers- but that data is difficult to interpret and present



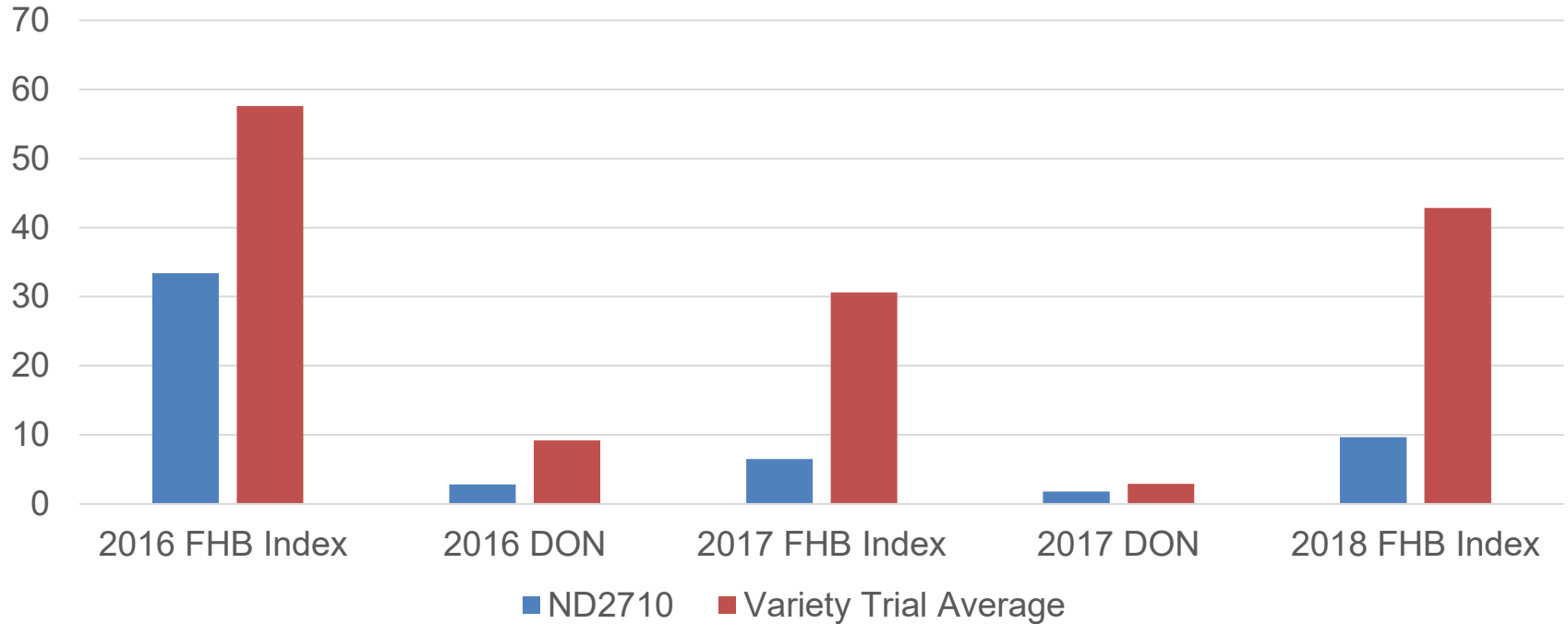
Fhb1 and Yield Drag?

ND2710

SUMAI 3/WHEATON//GRANDIN



ND2710 vs. Average of ND Variety Trial



Source of Resistance in 'Glenn'

- 'Glenn' (PI 639273)

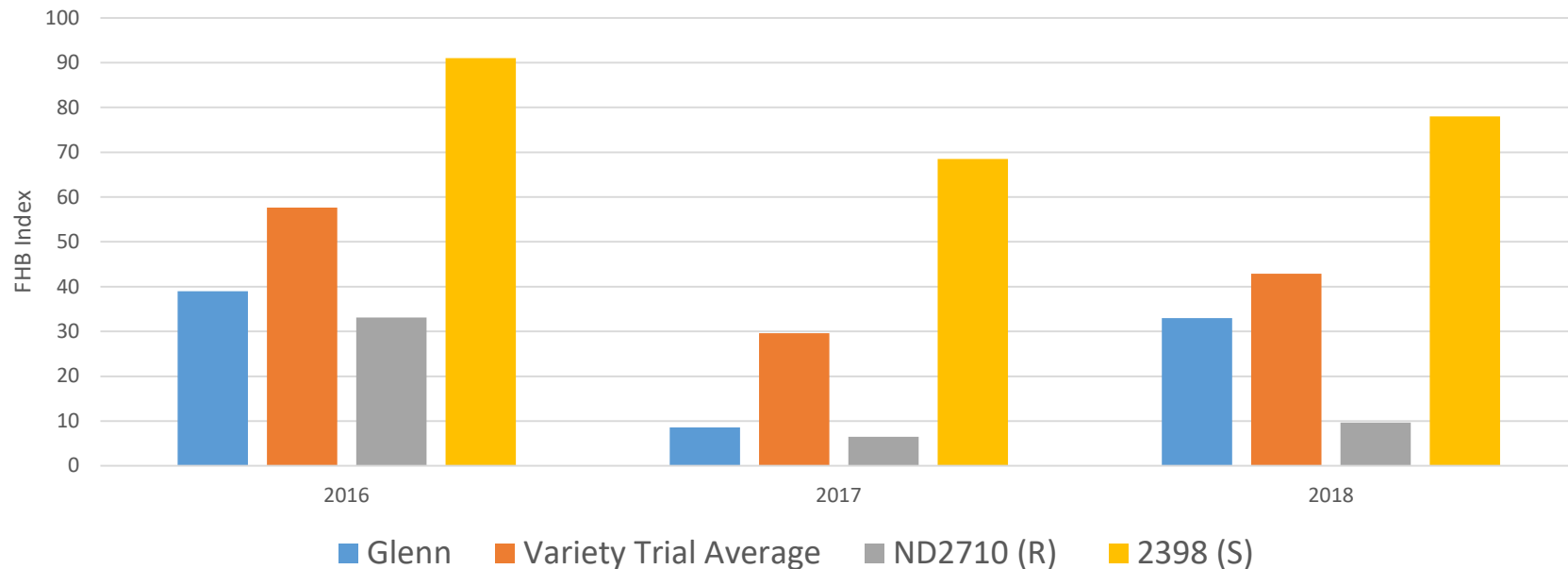
(ND 2831//PARSHALL/ND706)

- No FHB markers ever detected
- Consistently rated as very moderately resistant



Resistance of 'Glenn'

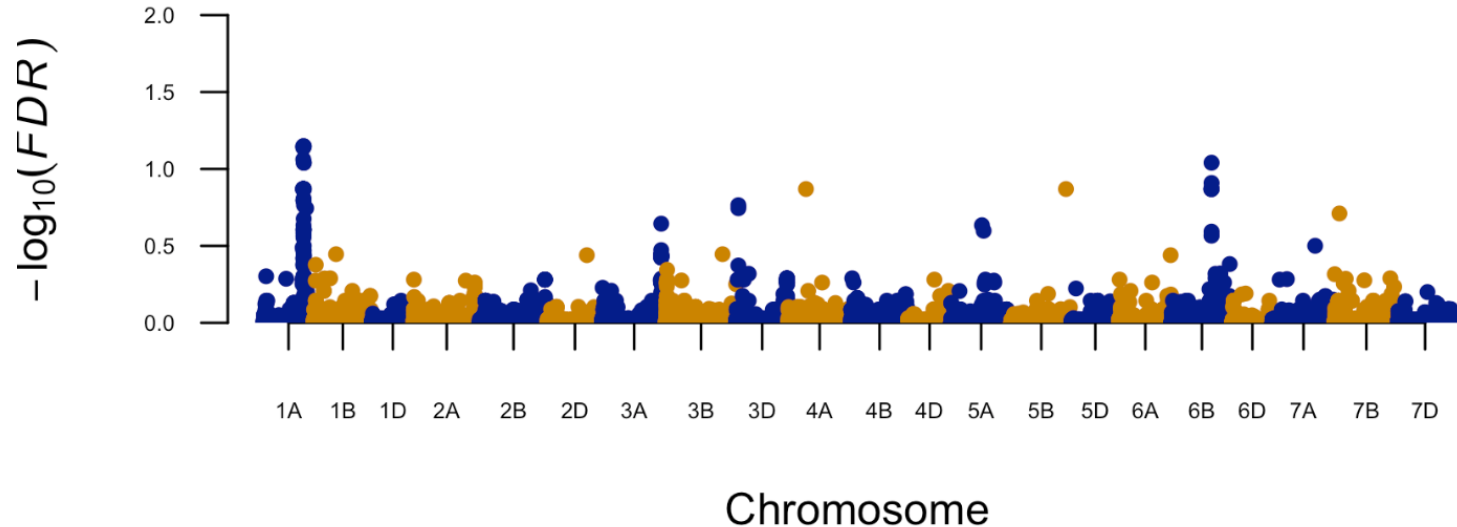
FHB Index of Glenn vs. Variety Trial Average



Resistance Genes

- 6 year study of 439 Advanced lines, *Fhb1* was found in **33%** of those lines, explaining 2.3% of phenotypic variation
- Demonstrates importance of Glenn
- QTL on 1A and 6B explaining 5.3% and 4.8% respectively

Genome Wide Association Analysis



Genetic mapping and prediction analysis of FHB resistance in a hard red spring wheat breeding population; Liu et al., 2018 (in press)

Conclusions

- FHB persistent in drier west as well as east
- Variety diversity is positive but comes with challenges in testing and management recommendations
- Original Sumai-3 derivatives have unmatched level of resistance in breeding program
- Most common form of resistance can't be tracked with markers, and has an unknown origin...but does that matter?



Langdon, ND July 2018