

What to Expect When Marketing to Breweries

Kevin Smith – University of Minnesota



Rotationally Raised

MAKING SMALL GRAINS WORK

Malting and Brewing

- Malting

Barley grain \longrightarrow Malt

- Brewing

Malt \longrightarrow Food for Yeast (maltose)

Yeast ferment maltose \longrightarrow Alcohol



“Reinheitsgebot”

- Water
- Malt
- Hops
- Yeast





Malting

- Cleaning
- Steeping
- Germinating
- Kilning



Steeping

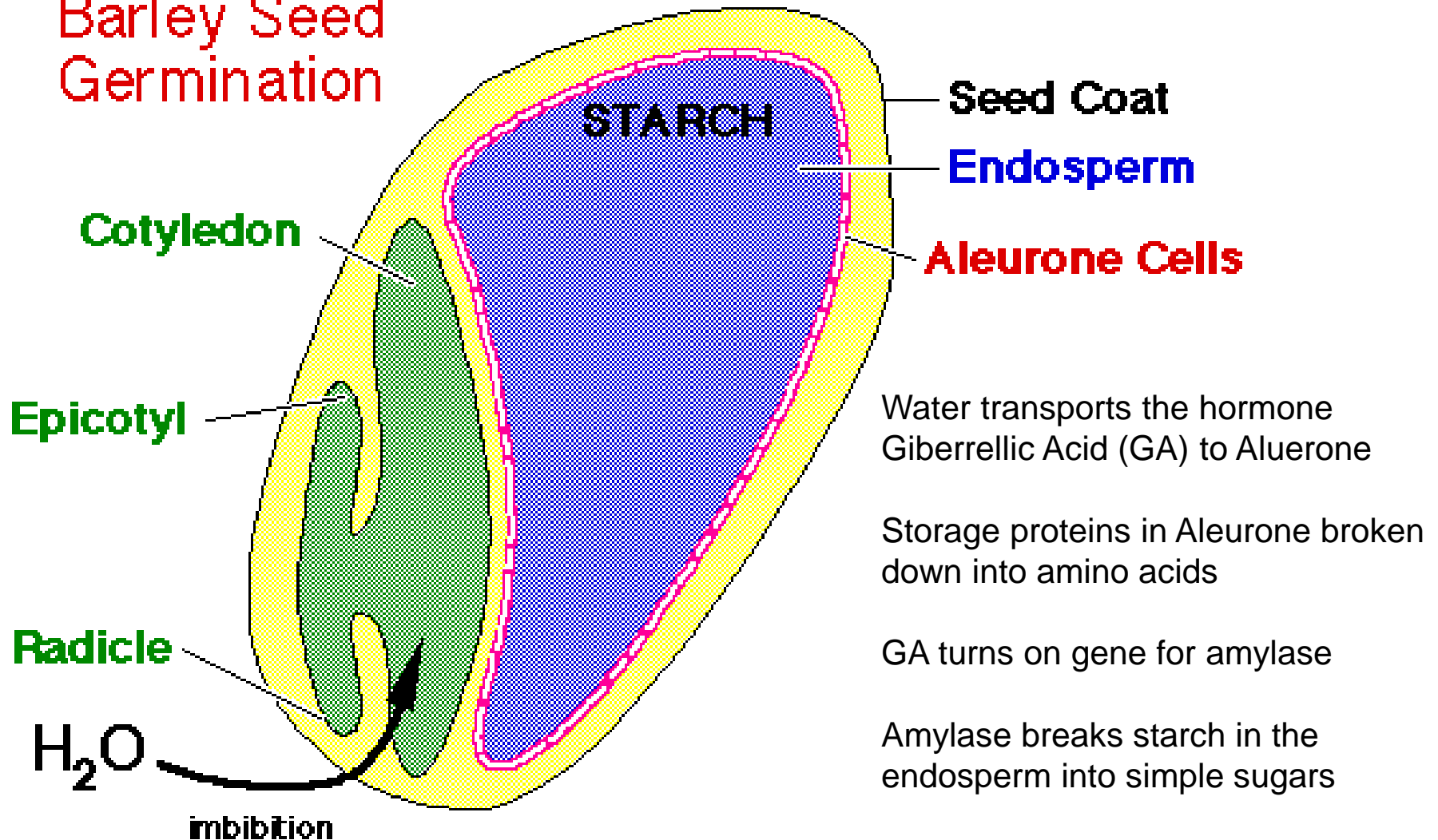
- Soak the grain in water
- 2 - 3 days
- grain moisture 12% to 40%
- Water is drained and barley allowed to sit for 6 to 10 hours



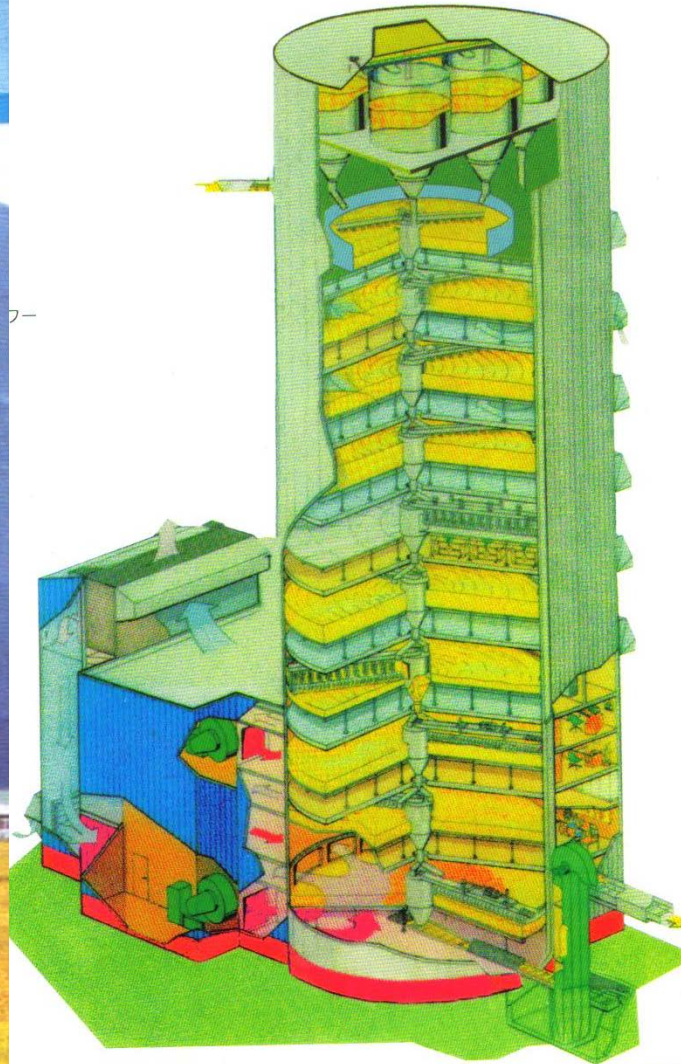
Steep Tank



Barley Seed Germination



Malt House



Germinating

- Barley spread on to malt house floor
- grain begins to germinate
- generates heat (from 55 to 70 degrees)
- turned and thinned repeatedly
- 4 - 5 days germinating

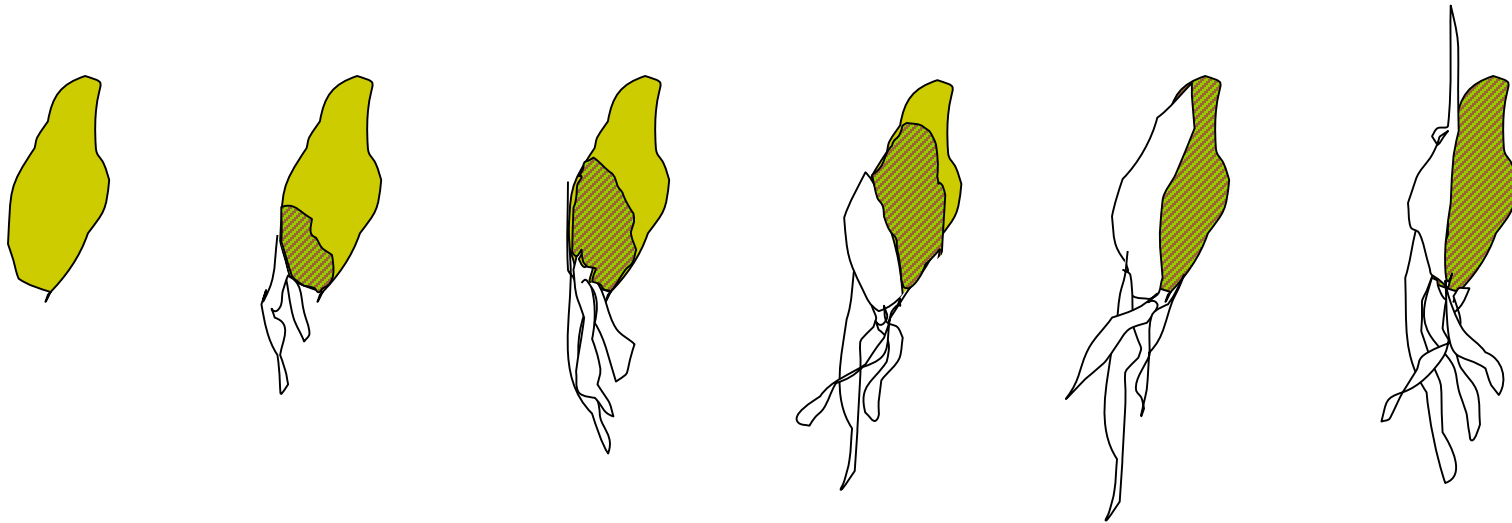


Germination bed



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Modification in Malting



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Kilning

- “Green Malt” is moved into the kiln
- Exposed to a series of kiln temperatures
- Kiln time
- Kiln temp



Brewing

- Mashing
- Lautering
- Boiling
- Fermentation



Mashing

- Malt is crushed
- Add water “mash in”
- Series of rests at different temperatures
- Enzyme activity - proteins and starches
- Raise to high temp; halts enzymes
- product is called the “wort”



Lautering

- Mash transferred to *lauter tun*
- Filtered
- Draw off wort
- grains rinsed or “sparged”



Boiling

- Hops added to the wort
- Boiled in “Coppers”
- kills bacteria and extracts the hop oils
- Bitter wort



Coppers or Brew Kettle



Fermentation

- Bitter wort transferred to fermentation vessels
- Yeast is added
- 3 to 7 days
- Cooled to 10 C; yeast settle out
- Filtered



Breeding Barley for Malting and Brewing

- Barley Market Classes:
 - 2-row, 6-row, spring, winter
- Production Traits
- Quality Traits
- Breeding Pipeline



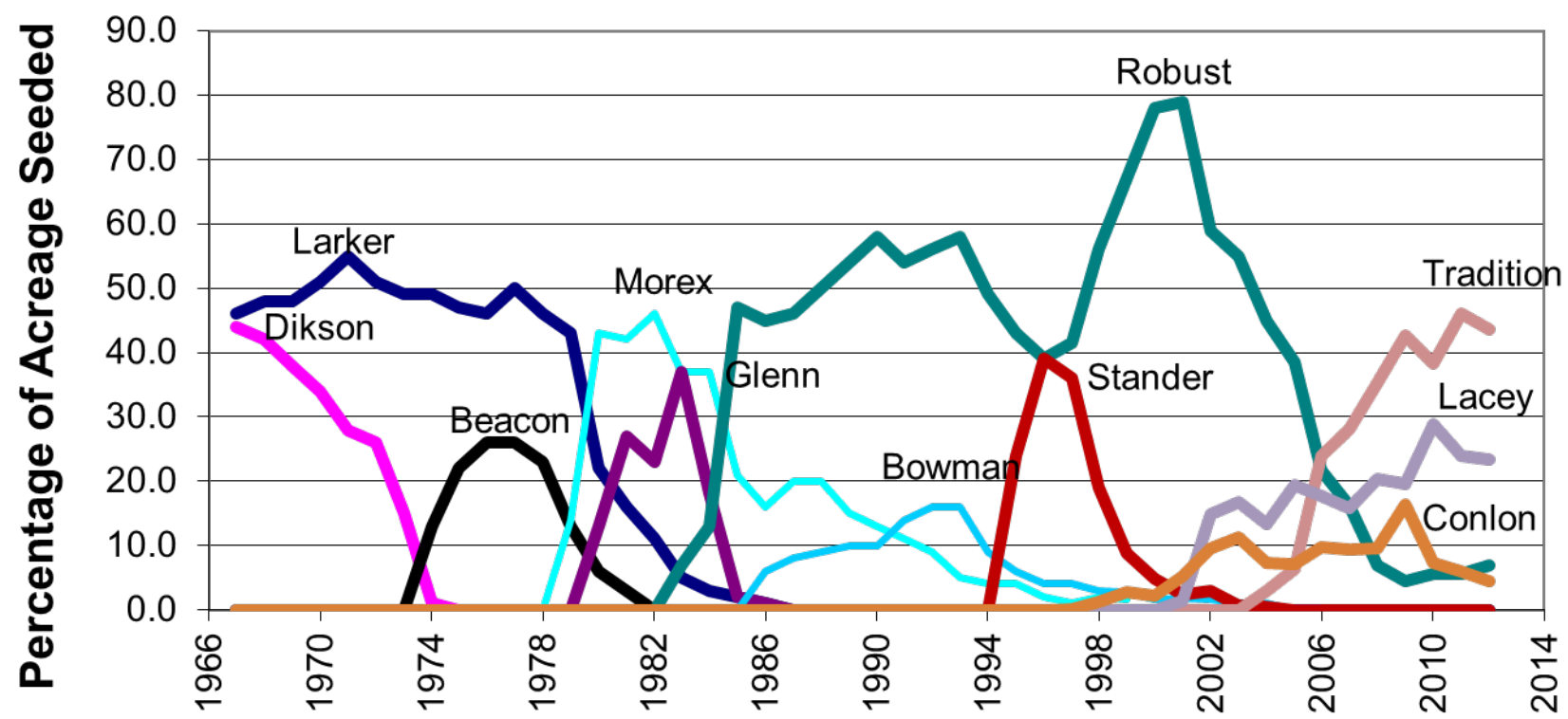
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Barley Varieties Planted in Midwest

Tri State Area (MN, ND, SD)



Barley varieties persist for many years



University of Minnesota Barley Breeding

SPRING BARLEY

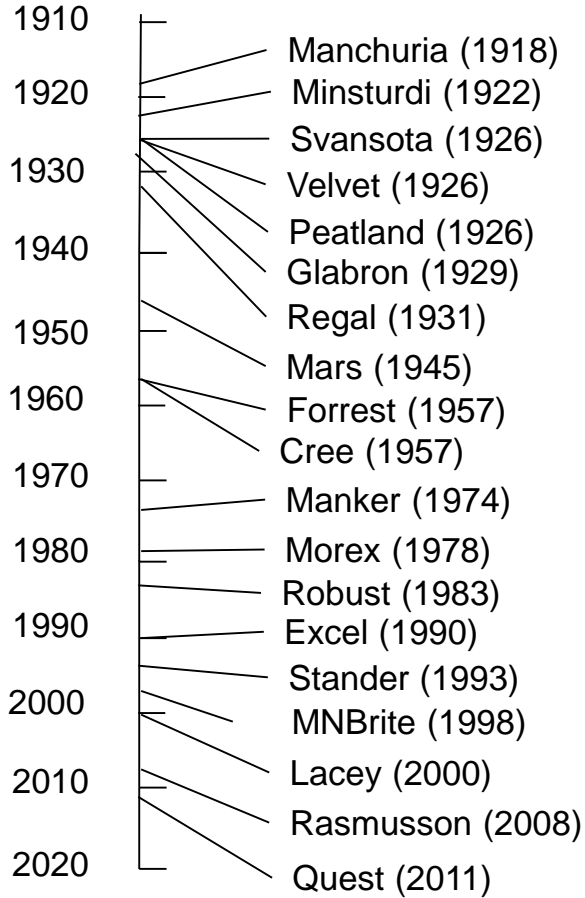
WINTER BARLEY

6-Row

2-Row

6-Row

2-Row



Started 2009

Started 2012

Started 2013



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2-ROW



Plump
Higher Extract
Lower DON
Lower Protein

Higher Amylase
Higher yield in Midwest
Better leaf disease resistance

6-ROW



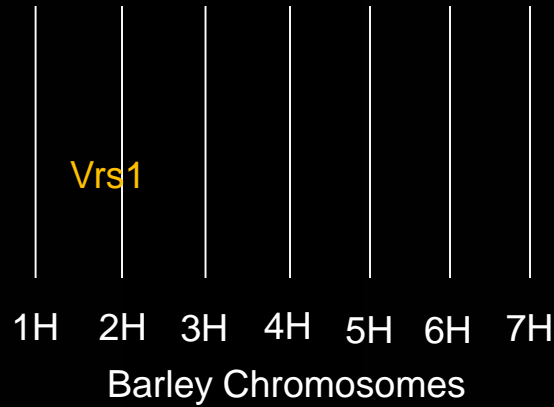
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2-ROW



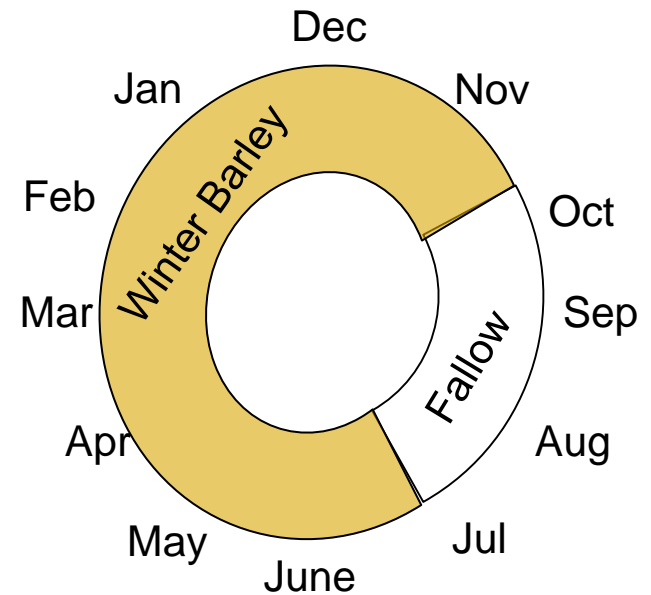
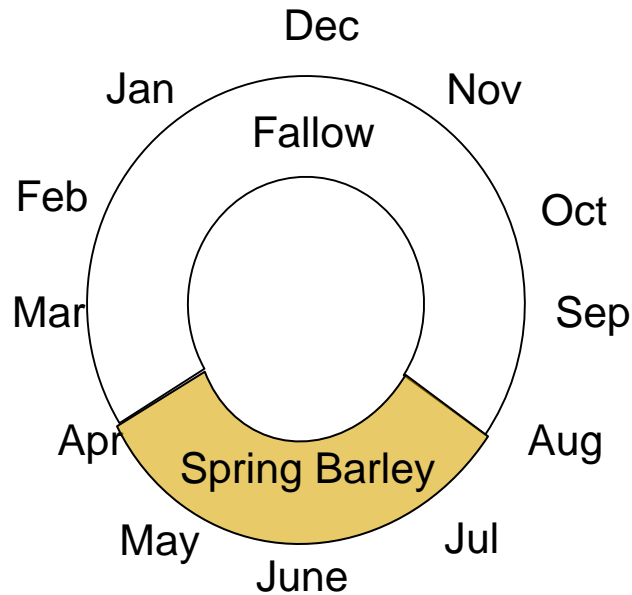
6-ROW



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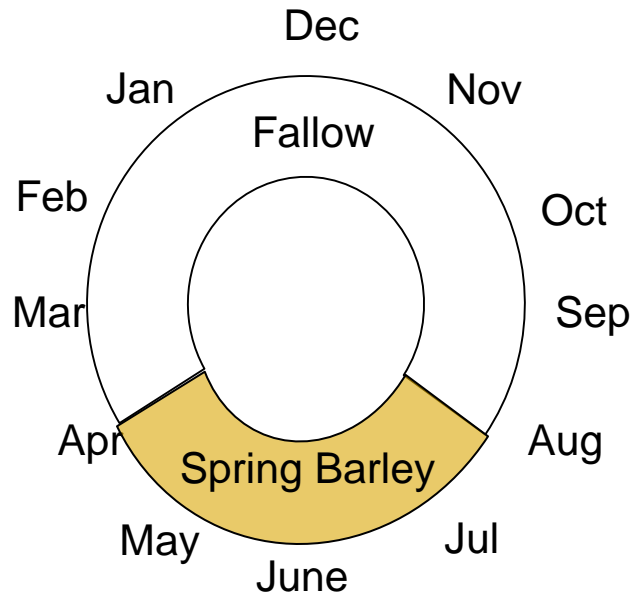
Spring Barley and Winter Barley



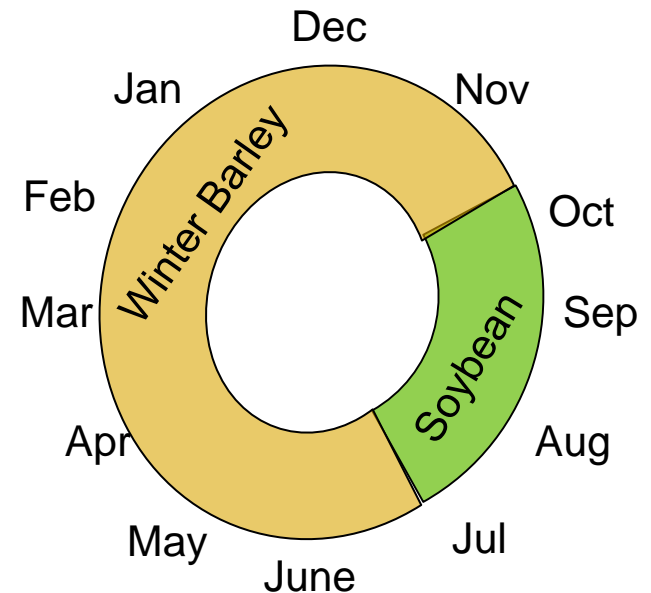
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Spring Barley and Winter Barley



Double Cropping



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Agronomic Benefits: increased yield, disease avoidance, weed suppression, water use efficiency, nitrogen use efficiency

Ecosystem Services: carbon sequestration, nutrient cycling, reduced erosion, wildlife habitat

Producer/Industry Benefits: crop diversity, spread out field activities, double cropping, earlier harvest



Fall Planted



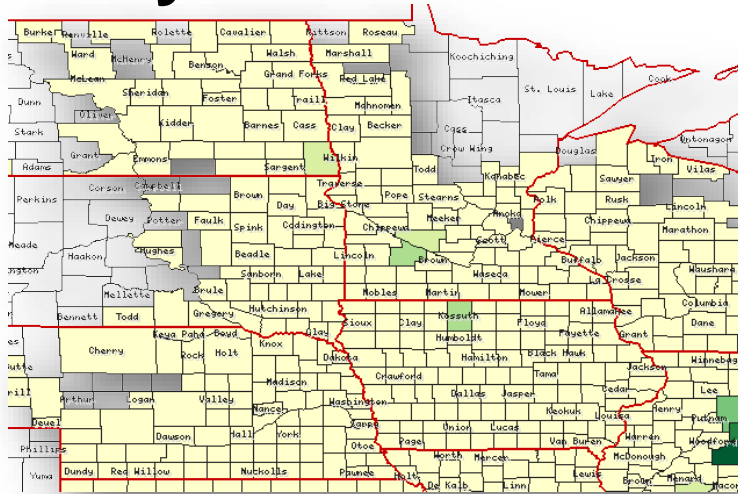
Spring Planted

Photos taken in late April

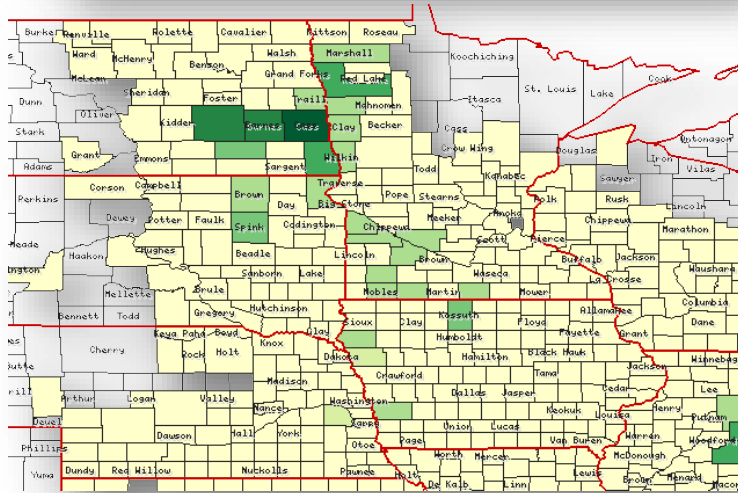


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Soybean

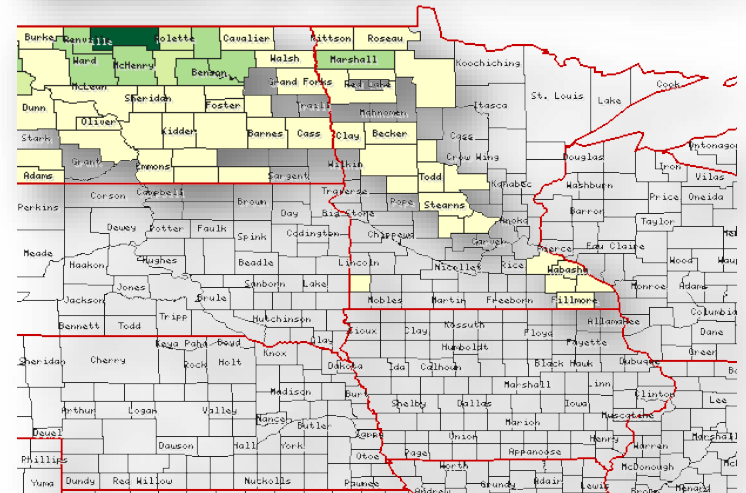
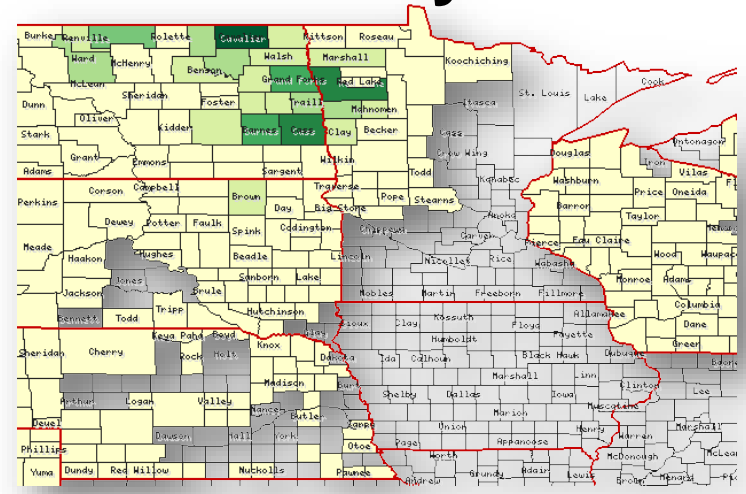


1990



2010

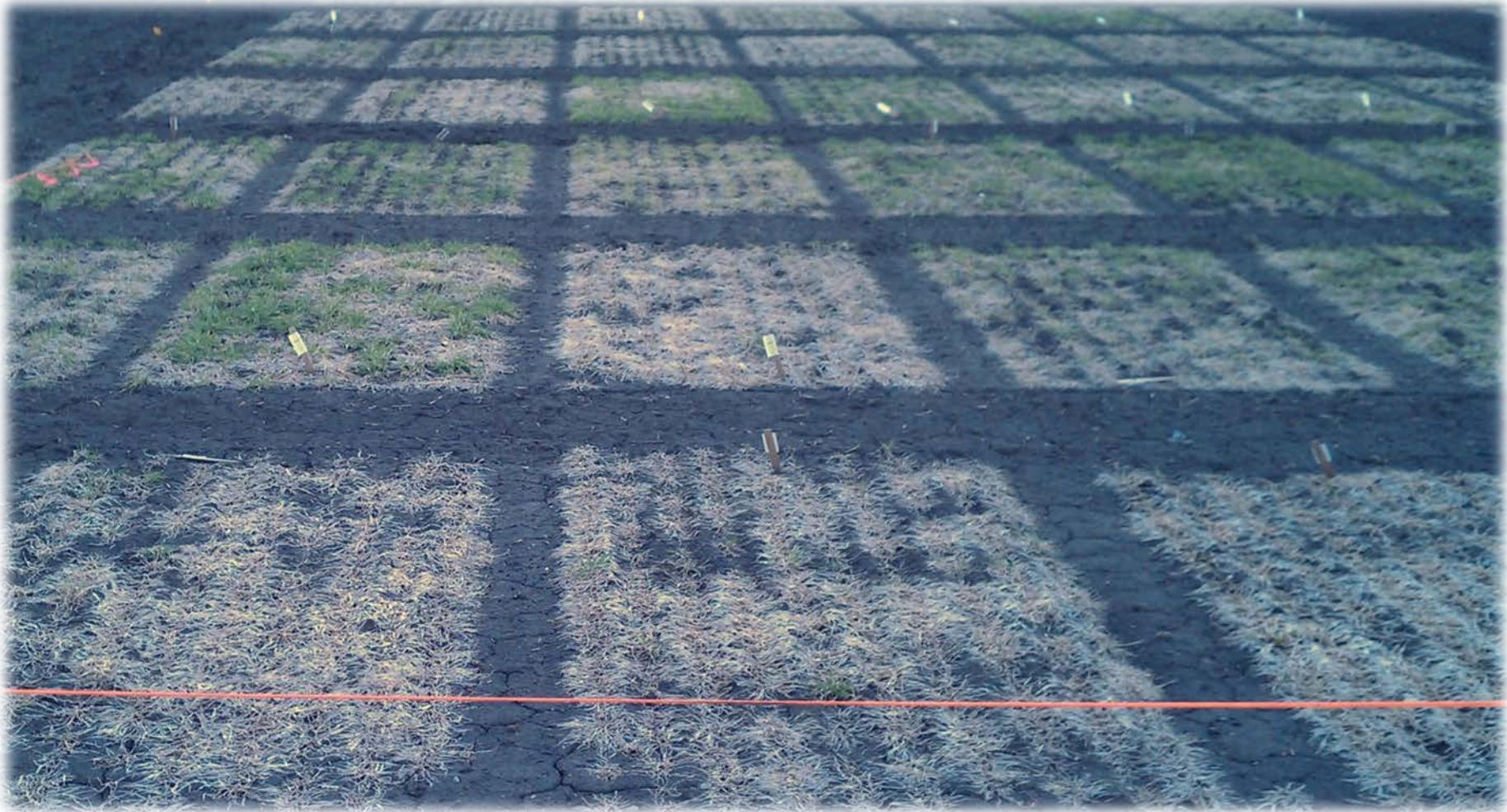
Barley



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Challenge: winter hardiness



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Production Traits

Heading

Heading Date
Days to Maturity
Lodging
Disease Resistance
Yield
Grain Pumpness
Grain Protein



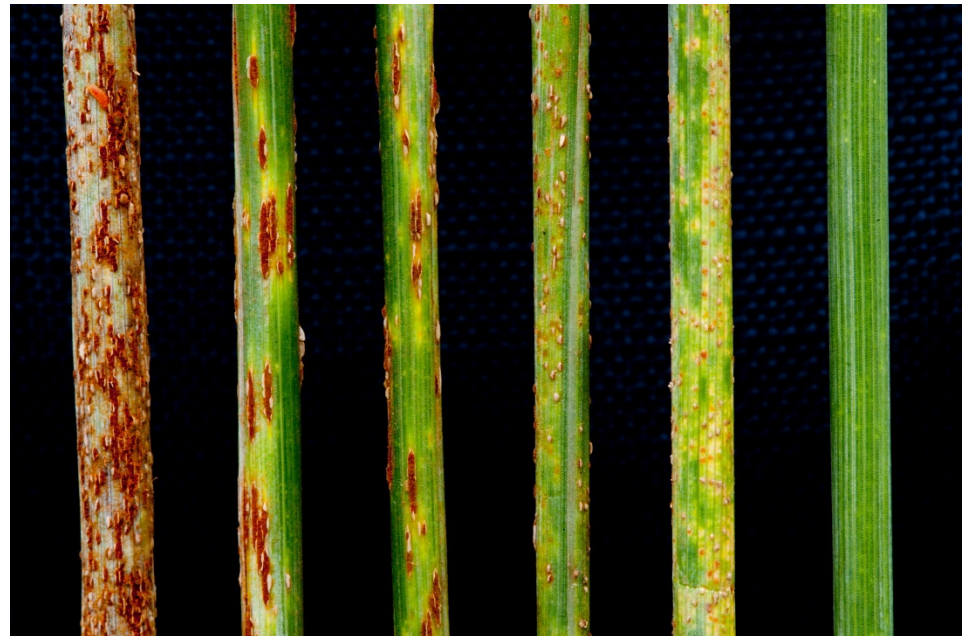
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Production Traits

Heading Date
Days to Maturity
Lodging
Disease Resistance
Yield
Grain Plumpness
Grain Protein

Stem Rust

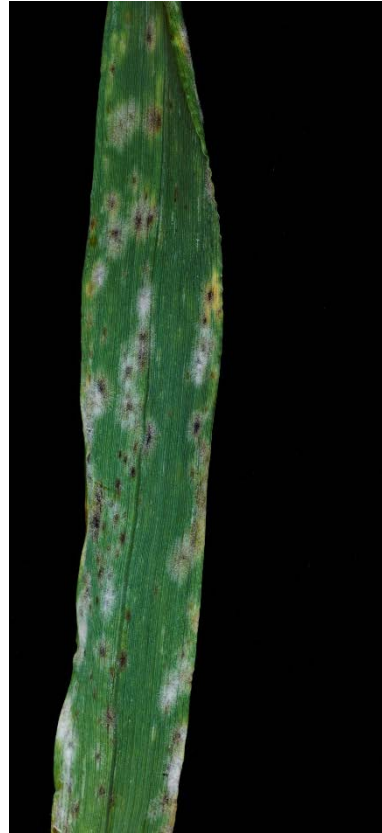


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Production Traits

Heading Date
Days to Maturity
Lodging
Disease Resistance
Yield
Grain Plumpness
Grain Protein



Powdery Mildew



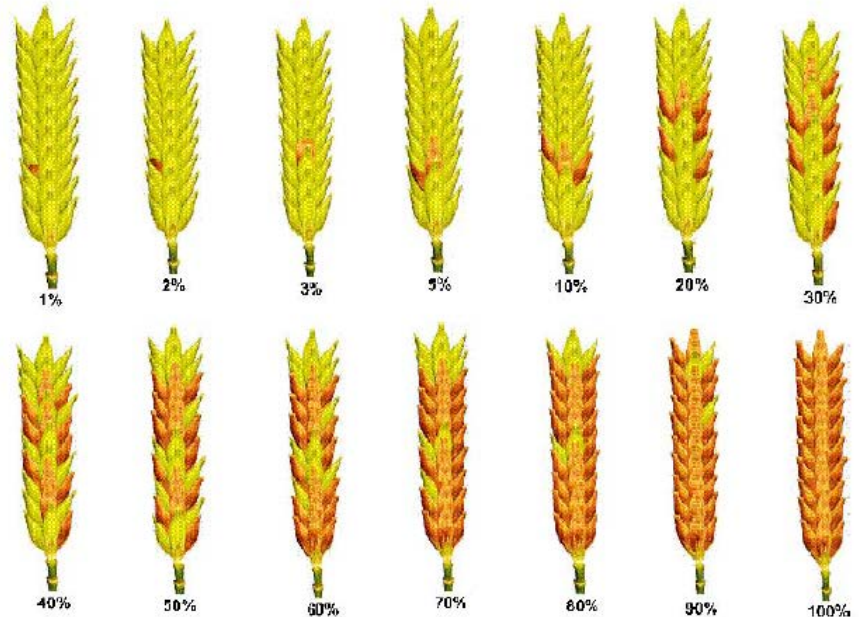
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Production Traits

Heading Date
Days to Maturity
Lodging
Disease Resistance
Yield
Grain Plumpness
Grain Protein

Fusarium head blight



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Quality Traits

Malt extract
Wort protein
S/T protein
Diastatic power
Alpha amylase
FAN
Beta-glucan
Viscosity

MALTING BARLEY BREEDING GUIDELINES IDEAL COMMERCIAL MALT CRITERIA

	Six-Row	Adjunct Two-Row	All Malt Two-Row	Distillers'
AMBA Member Interest*	10%	61%	25%	4%
Barley Factors				
Plump Kernels (on 6/64)	> 80%	> 90%	> 90%	> 70%
Thin Kernels (thru 5/64)	< 3%	< 3%	< 3%	< 5%
Germination (4ml 72 hr. GE)	> 98%	> 98%	> 98%	> 98%
Protein	≤ 13.0%	≤ 13.0%	≤ 12.0%	11.5 -14.0%
Skinned & Broken Kernels	< 5%	< 5%	< 5%	< 5%
Malt Factors				
Total Protein	≤ 12.8%	≤ 12.8%	≤ 11.8%	11.0 - 13.5%
on 7/64 screen	> 60%	> 70%	> 75%	>50%
Glycosidic Nitrile (gm/MT)				< 1.5
Measures of Malt Modification				
Beta-Glucan (ppm)	< 120	< 100	< 100	
F/C Difference	< 1.2	< 1.2	< 1.2	
Soluble/Total Protein	42-47%	40-47%	38-45%	>48%
Turbidity (NTU)	< 10	< 10	< 10	
Viscosity (absolute cp)	< 1.50	< 1.50	< 1.50	
Congress Wort				
Soluble Protein	5.2-5.7%	4.8-5.6%	< 5.3%	>6.0%
Extract (FG db)	> 79.0%	> 81.0%	> 81.0%	> 79.0%
Color (°ASBC)	1.8-2.5	1.6-2.5	1.6-2.8	<4.0
FAN	> 210	> 210	140-190	>250
Malt Enzymes				
Diastatic Power (°ASBC)	> 150	> 120	110-150	>200
Alpha Amylase (DU)	> 50	> 50	40-70	>75

Quality Traits

Malt extract
 Wort protein
 S/T protein
 Diastatic power
 Alpha amylase
 FAN
 Beta-glucan
 Viscosity

	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Variety or Selection	Rowed	Kernel Weight (mg)	on 6/64" (%)	Barley Color (Agron)	Malt Extract (%)	Wort Color	Wort Clarity	Barley Protein (%)	Wort Protein (%)	S/T (%)	DP (*ASBC)	Alpha-amylase (20°DU)	Beta-glucan (ppm)	FAN (ppm)	
ND_Genesis	2	42.4	98.1	37.5	82.0	3.2	1	12.1	5.1	43.8	119.5	78.9	259.4	199.3	
ND_Genesis	2	41.9	97.4	34.5	82.4	2.9	1	12.4	5.2	44.9	113.2	79.9	279.1	217.8	
ND_Genesis	2	42.7	97.7	30.5	82.4	2.7	1	12.0	5.1	45.4	111.3	81.1	241.8	195.0	
Pinnacle	2	41.7	95.8	29.5	82.1	3.4	1	12.0	5.2	45.3	98.1	65.4	293.6	192.4	
Pinnacle	2	43.4	97.8	22	82.2	2.7	1	11.8	5.0	43.8	104.3	61.5	296.4	177.7	
Pinnacle	2	43.1	98.0	23	81.9	2.8	1	12.5	5.2	43.2	94.8	85.9	343.2	189.6	
2MS14_3323-012	2	41.1	94.8	29.5	79.7	2.9	1	13.3	5.1	39.0	131.7	57.6	391.0	194.6	
2MS14_4005-006	2	40.5	93.3	37.5	80.6	4.5	1	14.7	6.1	44.0	111.1	69.2	192.1	238.9	
2MS14_4005-007	2	42.6	97.1	43.5	80.4	4.1	1	14.7	6.3	44.8	118.4	68.8	174.8	294.4	
2MS14_4005-010	2	41.2	95.2	26	80.7	4.1	1	13.9	6.1	44.4	153.1	78.3	209.5	249.3	
2MS14_4009-007	2	45.4	95.8	30	80.4	2.5	1	14.2	5.4	40.1	145.6	74.5	343.1	207.3	
2MS14_4012-009	2	42.4	97.8	34.5	79.6	1.6	1	13.8	4.6	34.3	144.5	59.7	373.4	158.1	
2MS14_4012-011	2	42.0	97.1	32.5	81.2	3.5	1.5	13.0	5.8	47.0	107.7	80.5	309.8	259.2	
TM14.004-16	2	39.4	97.1	41	81.9	3.7	1	13.4	5.3	40.8	115.7	66.1	435.9	195.3	
TM14.004-25	2	44.4	98.6	28	80.2	2.4	2	12.8	4.6	38.2	101.3	62.9	305.9	170.0	
TM14.006-01	2	43.3	97.9	28	81.2	2.2	1.5	12.9	5.2	42.5	125.8	82.7	248.8	187.6	
TM14.013-07	2	47.1	98.7	37.5	81.5	3.8	2	12.7	5.3	44.0	68.0	60.6	392.6	209.0	
TM14.013-10	2	41.7	96.5	29	82.4	3.6	1	12.0	5.3	47.2	100.3	83.1	163.1	228.0	
TM14.013-17	2	42.9	97.5	33.5	82.9	3.1	1	12.1	5.6	49.2	102.5	76.6	225.4	231.4	
TM14.013-23	2	44.5	97.9	33.5	81.6	3.1	1.5	13.1	5.4	43.3	88.5	68.6	371.9	215.8	
TM14.013-27	2	44.1	98.8	34.5	82.5	3.2	1	12.3	5.5	46.5	86.3	73.1	139.4	233.2	
TM14.013-41	2	47.2	98.6	34.5	82.3	4.6	1	12.6	5.5	45.8	96.5	62.3	399.2	199.8	
TM14.013-42	2	46.5	98.4	29	82.6	3.5	1	11.9	5.4	48.1	110.6	89.1	229.7	233.8	
TM14.013-52	2	43.7	97.7	28.5	81.5	3.6	1	12.9	5.5	44.0	78.8	67.4	251.4	220.7	
TM14.013-61	2	44.6	96.6	32.5	83.1	3.2	1.5	12.2	5.6	47.5	82.5	78.8	303.9	245.6	
TM14.013-62	2	44.5	98.9	29	83.2	3.4	1	12.1	5.4	46.3	106.1	88.7	194.8	222.8	
TM14.026-18	2	47.6	98.6	43	82.1	1.9	1	14.5	5.6	41.4	155.6	68.2	438.3	249.9	
TM14.030-07	2	45.3	99.2	35	83.3	2.2	1.5	11.9	5.1	44.5	99.2	79.0	177.6	188.2	



Quality Traits

Malt extract
Soluble (wort) protein
S/T protein
Diastatic power
Alpha amylase
FAN
Beta-glucan
Viscosity

Flavor?



ASBC Hot Steep Malt Sensory Method

Hot Steep

Application of method: sensory evaluation of extractable malt flavors and aromas

Target audience: sensory panels, brewers

Reagents

- (a) Whole kernel malt
- (b) Deionized water

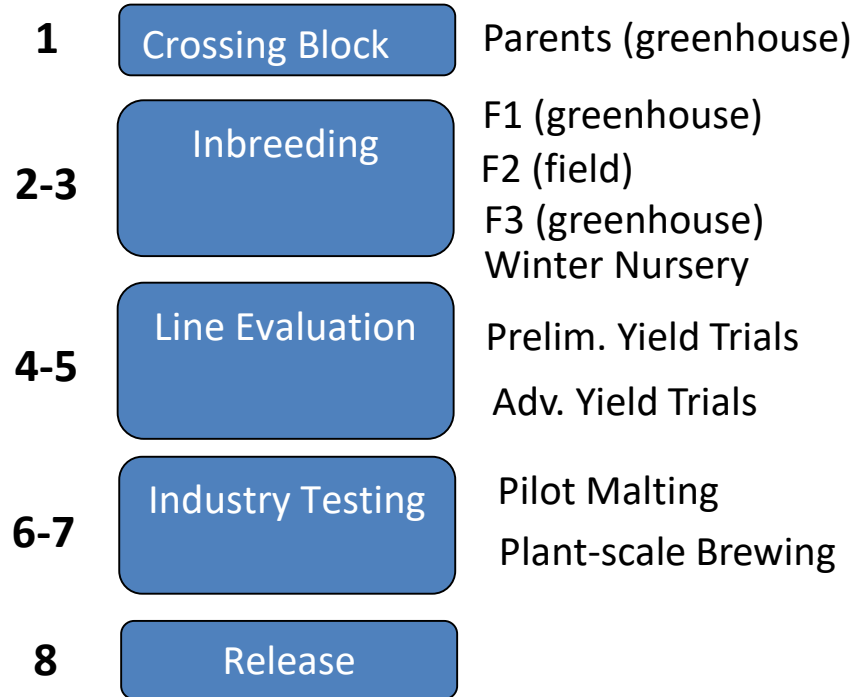
Apparatus

- (a) Thermos®, insulated, stainless steel, 24 ounce volume
- (b) Thermometer, standard, 0-200°C
- (c) Heating apparatus, capable of heating water to 65°C
- (d) Funnel, plastic, short stem, 16 cm in diameter or similar
- (e) Filter paper, fluted, 32 cm in diameter (Ahlstrom No. 515 or similar)
- (f) Electric Grinder, 3 ounce volume, 200-watt (KRUPS F203 or similar)
- (g) Glass Beaker, tall, 600 mL volume
- (h) Graduated cylinder, 500 mL volume
- (i) Analytical balance, capable of weighing 50.0 g (± 0.1 g)



Breeding Pipeline

Year



Breeding Pipeline

Select parents and
Perform Cross pollinations

Year

1

Crossing Block

Parents (greenhouse)

2-3

Inbreeding

F1 (greenhouse)
F2 (field)
F3 (greenhouse)
Winter Nursery

4-5

Line Evaluation

Prelim. Yield Trials
Adv. Yield Trials

6-7

Industry Testing

Pilot Malting
Plant-scale Brewing

8

Release

Parent A

yield
disease resistance
protein
malt extract
FAN

Parent B

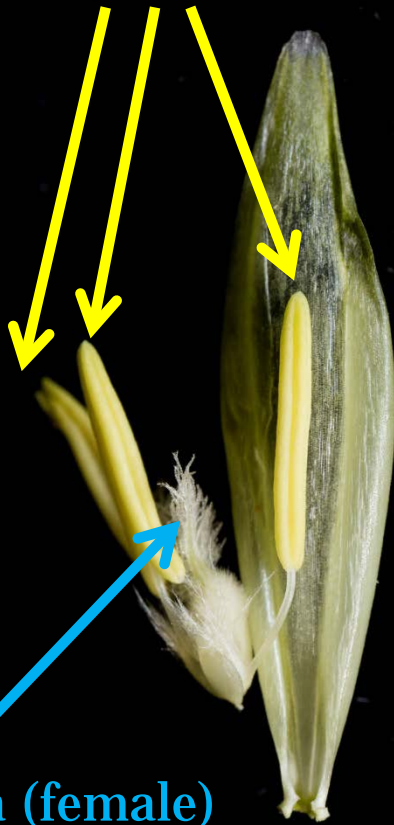
yield
disease resistance
protein
malt extract
FAN



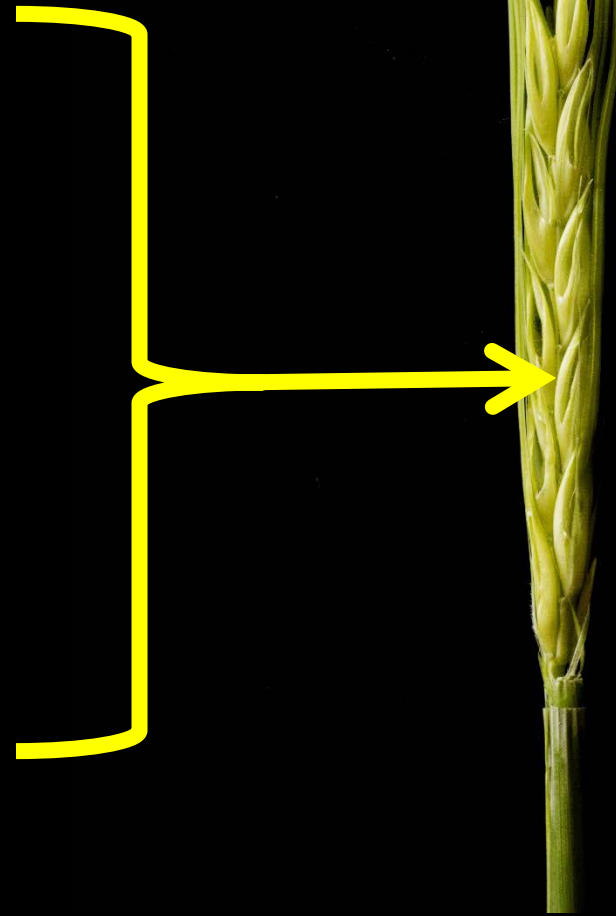
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3 anthers (male)



1 stygma (female)



Pollination



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Breeding Pipeline

Year

1

Crossing Block

Parents (greenhouse)

2-3

Inbreeding

F1 (greenhouse)

F2 (field)

F3 (greenhouse)

Winter Nursery

4-5

Line Evaluation

Prelim. Yield Trials

Adv. Yield Trials

6-7

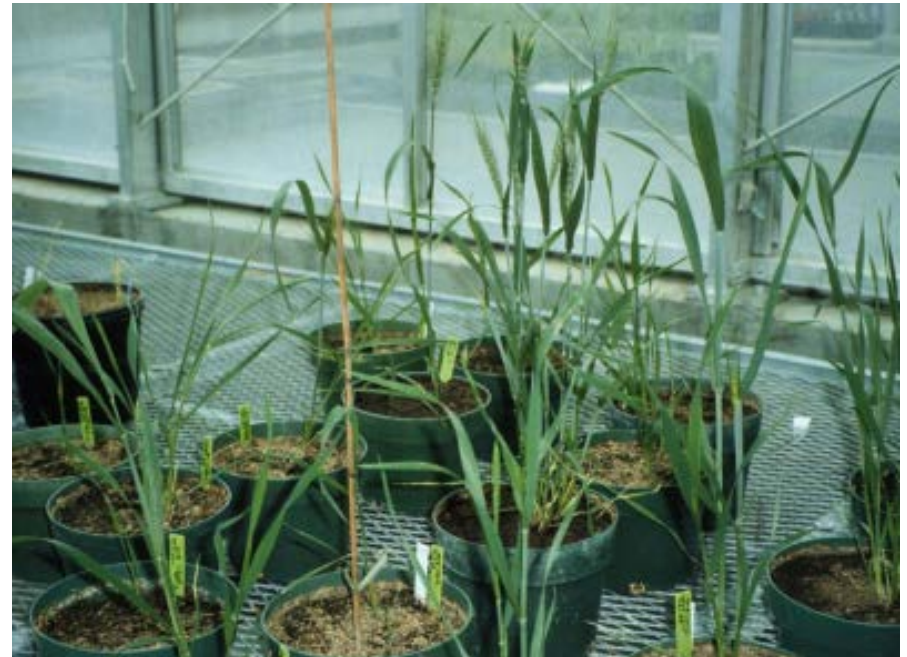
Industry Testing

Pilot Malting

Plant-scale Brewing

8

Release



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Breeding Pipeline

Year

1

Crossing Block

Parents (greenhouse)

2-3

Inbreeding

F1 (greenhouse)

F2 (field)

F3 (greenhouse)

Winter Nursery

4-5

Line Evaluation

Prelim. Yield Trials

Adv. Yield Trials

6-7

Industry Testing

Pilot Malting

Plant-scale Brewing

8

Release

Single row plots



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Breeding Pipeline

Year

1

Crossing Block

Parents (greenhouse)

2-3

Inbreeding

F1 (greenhouse)

F2 (field)

F3 (greenhouse)

Winter Nursery

4-5

Line Evaluation

Prelim. Yield Trials

Adv. Yield Trials

6-7

Industry Testing

Pilot Malting

Plant-scale Brewing

8

Release

F3 plants



Leaf Tissue



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Breeding Pipeline

Year

1

Crossing Block

Parents (greenhouse)

2-3

Inbreeding

F1 (greenhouse)

F2 (field)

F3 (greenhouse)

Winter Nursery

4-5

Line Evaluation

Prelim. Yield Trials

Adv. Yield Trials

6-7

Industry Testing

Pilot Malting

Plant-scale Brewing

8

Release

New Zealand



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Breeding Pipeline

Year

1

Crossing Block

Parents (greenhouse)

2-3

Inbreeding

F1 (greenhouse)

F2 (field)

F3 (greenhouse)

Winter Nursery

4-5

Line Evaluation

Prelim. Yield Trials

Adv. Yield Trials

6-7

Industry Testing

Pilot Malting

Plant-scale Brewing

8

Release

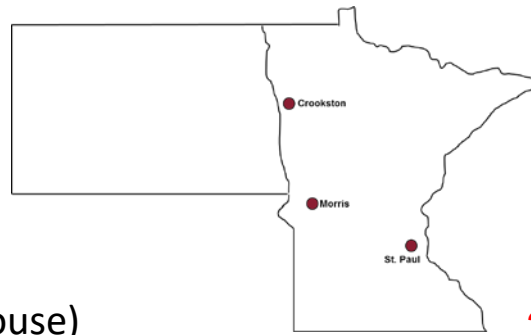
New Zealand



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Breeding Pipeline



Year

1

Crossing Block

Parents (greenhouse)

2 rows, 10' long

2-3

Inbreeding

F1 (greenhouse)
F2 (field)
F3 (greenhouse)
Winter Nursery

4-5

Line Evaluation

Prelim. Yield Trials (3 locations)

Adv. Yield Trials

6-7

Industry Testing

Pilot Malting

Plant-scale Brewing

8

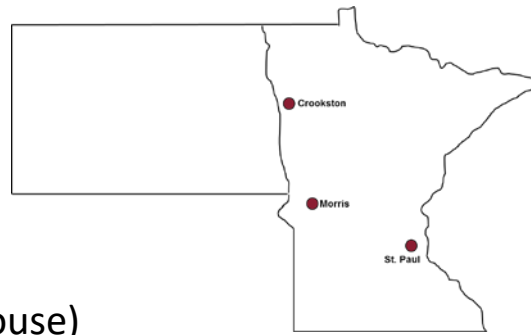
Release



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Breeding Pipeline



Year

1

Crossing Block

Parents (greenhouse)

2-3

Inbreeding

F1 (greenhouse)
F2 (field)
F3 (greenhouse)
Winter Nursery

4-5

Line Evaluation

Prelim. Yield Trials
Adv. Yield Trials

6-7

Industry Testing

Pilot Malting
Plant-scale Brewing

8

Release



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Breeding Pipeline

Year

1

Crossing Block

Parents (greenhouse)

2-3

Inbreeding

F1 (greenhouse)
F2 (field)
F3 (greenhouse)
Winter Nursery

4-5

Line Evaluation

Prelim. Yield Trials

Adv. Yield Trials

6-7

Industry Testing

Pilot Malting

Plant-scale Brewing

8

Release

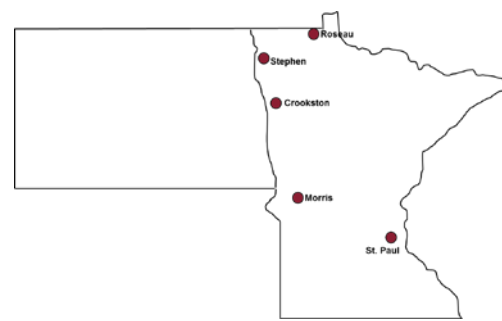
Fusarium Head Blight Nursery



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Breeding Pipeline



5' x 10' plots

Year

1

Crossing Block

Parents (greenhouse)

2-3

Inbreeding

F1 (greenhouse)
F2 (field)
F3 (greenhouse)
Winter Nursery

4-5

Line Evaluation

Prelim. Yield Trials

Adv. Yield Trials (5 locations)

6-7

Industry Testing

Pilot Malting
Plant-scale Brewing

8

Release



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Breeding Pipeline

Year

1

Crossing Block

Parents (greenhouse)

2-3

Inbreeding

F1 (greenhouse)

F2 (field)

F3 (greenhouse)

Winter Nursery

4-5

Line Evaluation

Prelim. Yield Trials

Adv. Yield Trials

6-7

Industry Testing

Pilot Malting

Plant-scale Brewing

8

Release

QUALITY EVALUATION SUBCOMMITTEE

2016 Crop Pilot Scale Program

Midwest Nursery Selections

M160 Unsatisfactory (M139/FEG160-03) This third year selection had slightly high barley protein and slightly low extract. It was rated unsatisfactory in 2015 testing with slightly high wort turbidity. It was satisfactory in 2014 crop testing with slightly high turbidity. *No further testing.*

S6M164 Unsatisfactory (MS10S4021-013/MS10S4058-024) This second year selection had slightly high barley protein and beta-glucan and slightly low extract. It was rated satisfactory in 2015 testing with slightly high beta-glucans. *No further testing.*

S6M166 Unsatisfactory (MS10S4034-018/MS10S4029-013) This second year selection had good extract, and slightly high S/T and beta-glucan. It was rated satisfactory in 2015 testing with good extract and slightly high beta-glucans.

S6M168 Unsatisfactory (MS11S3058-014/MS11S3080-19) This first year selection had high barley protein, wort viscosity and beta-glucans, and low extract and friability.

ND32889 Satisfactory (ND28479/ND25652) This first year selection had slightly high wort viscosity and turbidity.

ND32898 Satisfactory (ND28479/ND25652) This first year selection had slightly high wort viscosity and turbidity.



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Breeding Pipeline

Year

1

Crossing Block

Parents (greenhouse)

2-3

Inbreeding

F1 (greenhouse)
F2 (field)
F3 (greenhouse)
Winter Nursery

4-5

Line Evaluation

Prelim. Yield Trials
Adv. Yield Trials

6-7

Industry Testing

Pilot Malting
Plant-scale Brewing

8

Release



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AMBA Varieties

<http://ambainc.org/>



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Take Home Messages

Variety Selection is important
malting variety
disease resistance
yield potential



Take Home Messages

Malting Contracts

Where/how you will deliver

On-farm storage

DON level

Grain protein

Pre-harvest sprouting



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Questions



Breeding Better Barley for Brewing Better Beer



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