Building the Oregon (Craft) Malting Barley Brand



Rationale:

- Oregon and the PNW lead the world in craft brewing and distilling.
- Currently, most Oregon craft beers and spirits are brewed/distilled from malt made from barley grown somewhere besides Oregon.
- Oregon farmers could profit from the demand for Oregon-grown malting barley with craft quality.

Objectives:

 Determine Oregon's potential for producing high quality malting barley barley by generating data on agronomic performance and quality –in terms of malt and beer.

Procedures:

- Assess the effects of nitrogen management on agronomic performance and quality profiles of commercial varieties in representative production environments.
- Make malts, brew beers, and assess beers with sensory panels.
- Make the research findings widely available.
- Establish the foundation for ongoing Oregon barley development and production.

Funding:

Oregon Wheat Commission, Great Western Malting, Limagrain, Malteurop, Secobra

Experimental Design

- 5 varieties:
 - Copeland, Expedition, Explorer, Full Pint, Genie
- Randomized Complete Block Design
- 4 replications (16 Klamath)
- 3 nitrogen treatments (4 at Klamath):
 - Targeting low, medium and high nitrogen fertility levels based on available N by soil test
 - Additional 0 treatment at Klamath
- Large plot size (200 sq ft) in order to maximize grain production – goal of 200 lbs. per variety/N treatment/rep (except Klamath where more reps of small plots were used)

Varieties and sources

All varieties in this experiment are spring two-rows.

- Copeland: Developed by the Crop Development Center, University of Saskatoon. Widely available. Sponsored by Great Western Malting. Contact: <u>Kevin Anderson</u>
- Expedition: Malteurop. Contact: <u>Mary-Jane Maurice</u>
- Explorer: Secobra. Contact: <u>Jarislav VonZitzewitz</u>
- Full Pint: Developed by The Barley Project, Oregon State University. Contact: <u>Pat Hayes</u>
- Genie: Limagrain. Contact: Frank Curtis

Willamette Valley, OR 2015

Herb Farm; Lebanon, OR

Managed by Scott Fisk, Pat Hayes, Dustin Herb, Matt Herb, and Clare Sullivan

ANOVA for Willamette Valley

		Grain Yield Ib/acre	Protein %	Plump %	Test Weight Ib/bu
Source of Variation	df		P va	lues	
Block	3	0.0037	0.0006	0.0002	0.0610
Variety	4	0.0012	0.0000	0.0327	0.0000
N Level	2	0.0000	0.0000	0.0000	0.0461
Variety*N Level	8	0.8075	0.7527	0.1382	0.4259

- Varieties differ significantly for all traits
- Nitrogen levels differ significantly for all traits
- There are no significant interactions

Means for Varieties

Variety	Grain Yield Ib/acre	Protein %	Plump %	Test Weight Ib/bu
Copeland	5566	8.95	88.92	51.29
Expedition	6058	9.04	92.25	53.66
Explorer	6432	8.99	90.67	51.98
Full Pint	5717	10.22	88.50	52.97
Genie	5741	9.07	88.67	52.82
Mean	5903	9.25	89.80	52.55
LSD (0.05)	420	0.46	2.71	0.68
CV%	8.64	6.01	3.67	1.56

Response to Nitrogen

Nitrogen Regime	Grain Yield lb/acre	Protein %	Plump %	Test Weight Ib/bu
Low N	5522	8.85	92.95	52.73
Medium N	5749	9.15	88.65	52.16
High N	6438	9.76	87.80	52.75
Mean	5903	9.25	89.80	52.55
SE	114	0.12	0.74	0.18
		F values		
N Linear	32.30**	26.75**	24.47**	0.01
N Quadratic	2.72	1.03	3.66†	6.62*

Levels of significance (α): + = 0.10, * = 0.05, ** = 0.01

Barley Grain Yield – Willamette Valley

Grain Yield lb/acre



Grain Protein – Willamette Valley

Plump Grain – Willamette Valley

Test Weight – Willamette Valley

Correlations at each N level

			Nitrogen Level	
Trait 1	Trait 2	Low	Medium	High
Yield	Protein	0.14	-0.01	0.34
Yield	Plump	0.13	0.12	0.12
Yield	Test Wt	-0.14	0.11	0.26
Protein	Plump	-0.11	-0.31	-0.47*
Protein	Test Wt	0.33	0.06	0.00
Plump	Test Wt	-0.37	0.64**	0.53*

Levels of significance (α): * = 0.05, ** = 0.01

The Willamette Report - 2015

- On average Explorer had the highest yield (6432 lb/acre) and Copeland the lowest yield (5566 lb/acre); other varieties had comparable yields.
- Grain protein values were low to acceptable, on average.
- Average % plump values were acceptable to nearly acceptable.
- Test weights were excellent.
- Increasing N increased grain yield and protein content but had no effect on test weight.
- This "high rainfall" environment with no irrigation should be a suitable growing area for all craft malting barley varieties tested.

Grande Ronde, OR 2015

H.E.Bull Farm/TRICO; Summerville, OR

Conceived and managed by Darrin Walenta, Tom Hutchison,

Valtcho Jeliazkov, and Karl Rhinhart

ANOVA for Grande Ronde

		Days to Heading	Plant Height inches	Grain Yield Ib/acre
Source of Variation	df		P values	
Block	3	0.0006	0.2175	0.5504
Variety	4	<0.0001	0.0429	<0.0001
N Level	2	<0.0001	<0.0001	<0.0001
Variety*N Level	8	<0.0001	0.7903	0.0843

- Varieties differ significantly for all traits
- Nitrogen levels differ significantly for all traits
- There were significant interactions for days to heading

ANOVA for Grande Ronde

		Protein %	Plump %	Test Weight Ib/bu
Source of Variation	df		P values	
Block	3	0.2540	0.0211	0.0564
Variety	4	<0.0001	0.0034	<0.0001
N Level	2	<0.0001	0.0374	0.0020
Variety*N Level	8	0.0056	0.0861	0.1505

- Varieties differ significantly for all traits
- Nitrogen levels differ significantly for all traits
- There were significant interactions only for protein %

Means for varieties

Variety	Days to Heading	Plant Height inches	Grain Yield Ib/acre
Copeland	79.00	32.92	4457
Expedition	71.75	32.58	4657
Explorer	74.39	31.08	5169
Full Pint	67.00	30.17	4822
Genie	75.25	32.50	4968
Mean	73.51	31.85	4799
LSD (0.05)	0.77	2.04	254
CV%	1.26	7.77	6.42

Means for varieties

Variety	Protein %	Plump %	Test Weight Ib/bu
Copeland	10.52	98.25	51.78
Expedition	10.08	98.25	52.09
Explorer	9.68	99.17	51.81
Full Pint	10.71	98.58	53.32
Genie	9.74	98.92	53.22
Mean	10.14	98.63	52.44
LSD (0.05)	0.22	0.54	0.32
CV%	2.66	0.66	0.73

Response to Nitrogen

Nitrogen Regime	Days to Heading	Plant Height inches	Grain Yield Ib/acre
Low N	75.70	29.35	3527
Medium N	73.60	32.50	5054
High N	71.14	33.70	5863
Mean	73.51	31.85	4799
SE	0.21	0.55	69
	Γ να	alues	
N Linear	232.68**	30.93**	555.46**
N Quadratic	0.51	2.07	17.94**

Levels of significance (α): * = 0.05, ** = 0.01

Response to Nitrogen

Nitrogen Regime	Protein %	Plump %	Test Weight Ib/bu
Low N	10.14	98.45	52.23
Medium N	9.77	98.50	52.42
High N	10.53	98.95	52.69
Mean	10.14	98.63	52.44
SE	0.06	0.15	0.09
	F va	lues	
N Linear	20.36**	5.87*	14.35**
N Quadratic	58.98**	1.25	0.11

Levels of significance (α): * = 0.05, ** = 0.01

Grain Yield – Grande Ronde

Grain Yield lb/acre

Grain Protein – Grande Ronde

Plump Grain – Grande Ronde

Test Weight – Grande Ronde

Plant Height – Grande Ronde

Correlations at each N level

Trait 1	Trait 2	Low N	Medium N	High N
Heading	Height	0.11	0.34	0.36
Heading	Yield	-0.24	-0.06	-0.20
Heading	Protein	0.25	-0.37	-0.23
Heading	Plump	0.09	0.20	-0.46*
Heading	Test Wt	-0.53*	-0.53*	-0.26
Height	Yield	0.23	0.16	-0.33
Height	Protein	-0.23	-0.05	-0.15
Height	Plump	0.20	0.20	-0.28
Height	Test Wt	-0.19	-0.14	-0.17

Levels of significance (α): * = 0.05, ** = 0.01

Correlations at each N level

Trait 1	Trait 2	Low N	Medium N	High N
Yield	Protein	-0.37	-0.57**	-0.41
Yield	Plump	0.34	0.30	0.52*
Yield	Test Wt	-0.19	0.10	0.31
Protein	Plump	-0.46*	-0.30	-0.24
Protein	Test Wt	0.18	0.30	0.11
Plump	Test Wt	-0.15	-0.24	0.41

Levels of significance (α): * = 0.05, ** = 0.01

The Grande Ronde Report - 2015

- On average, Explorer had the highest average yield (5169 lb/acre) and Copeland the lowest (4457 lb/acre). Other varieties had comparable yields.
- Grain protein levels were, on average, in the target range.
- Average % plump values were excellent.
- Test weights were excellent.
- The response to N was curvilinear for grain yield.
- There were significant nitrogen x variety interactions for days to heading and grain protein %.
- There was a linear decrease in days to heading and an increase in plant height with increasing N levels.
- This irrigated environment should be a suitable growing area for all craft malting barley varieties tested.

Klamath Basin, CA 2015

UC-IREC; Tulelake, CA

Managed by Rich Roseberg, Tom Silberstein, Darrin Culp, and Rob Wilson

ANOVA for Klamath

		Plant Height inches	Grain Yield Ib/acre
Source of Variation	df	P va	lues
Block	15	0.0007	<0.0001
Variety	4	<0.0001	<0.0001
N Level	3	<0.0001	< 0.0001
Variety*N Level	12	0.5022	0.0927

- Varieties differ significantly for all traits
- Nitrogen levels differ significantly for all traits
- There are no significant interactions

ANOVA for Klamath

		Protein %	Plump %	Test Weight Ib/bu
Source of Variation	df		P values	
Block	3	0.3074	0.5094	0.0868
Variety	4	<0.0001	<0.0001	<0.0001
N Level	3	<0.0001	0.0222	<0.0001
Variety*N Level	12	0.2829	0.1511	0.1987

- Varieties differ significantly for all traits
- Nitrogen levels differ significantly for all traits
- There are no significant interactions

Means for Varieties

Variety	Plant Height inches	Grain Yield Ib/acre	Protein %	Plump %	Test Weight Ib/bu
Copeland	33.52	5567	12.02	94.1	50.50
Expedition	28.27	5631	12.04	88.7	49.73
Explorer	25.34	5842	11.98	94.2	49.91
Full Pint	26.00	5131	13.12	83.2	48.80
Genie	26.91	5356	11.73	92.4	49.12
Mean	28.01	5506	12.18	90.5	49.61
LSD (0.05)	0.89	279	0.45	2.1	0.61
CV%	9.15	14.58	5.27	3.22	1.74

Response to Nitrogen

Nitrogen Regime	Plant Height inches	Grain Yield Ib/acre	Protein %	Plump %	Test Weight Ib/bu
0 N	25.21	4899	11.84	89.00	48.67
Low N	27.86	5500	11.76	91.80	49.93
Medium N	29.14	5728	12.39	91.00	49.90
High N	29.81	5896	12.73	90.25	49.96
Mean	28.01	5506	12.18	90.50	49.61
SE	0.29	90	0.14	0.65	0.19

Polynomial Contrasts for N Response

Contrast	Plant Height inches	Grain Yield Ib/acre	Protein %	Plump %	Test Weight Ib/bu		
F values							
N Linear	138.55**	64.26**	26.23**	1.13	19.74**		
N Quadrati	c 11.89**	5.82*	2.09	7.63**	9.60**		
N Cubic	0.37	0.61	2.46	1.61	2.54		

Levels of significance (α): * = 0.05, ** = 0.01

- Height, yield, and test weight showed a curvilinear response to increasing N fertilizer.
- Nitrogen response for protein % was linear.
- Only the quadratic effect was significant for plump %.

Grain Yield - Tulelake

Grain Yield lb/acre

Grain Protein - Tulelake

Plump Grain – Tulelake

Test Weight – Tulelake

Plant Height - Tulelake

Plant Height (Inches)

Correlations at each N level

Trait 1	Trait 2	0 N	Low N	Medium N	High N
Height	Yield	0.71**	-0.02	0.48*	-0.09
Height	Protein	0.17	-0.33	-0.31	-0.27
Height	Plump	0.30	0.05	0.22	0.31
Height	Test Wt	0.65**	0.32	0.63**	-0.01
Yield	Protein	-0.07	-0.48*	-0.55*	-0.48*
Yield	Plump	0.47*	0.55*	0.59**	0.53*
Yield	Test Wt	0.63**	0.63**	0.52*	0.77**
Protein	Plump	-0.55*	-0.39	-0.53*	-0.51*
Protein	Test Wt	-0.03	-0.49*	-0.15	-0.58**
Plump	Test Wt	0.68**	0.54*	0.57**	0.70**

Levels of significance (α): * = 0.05, ** = 0.01

The Klamath Report- 2015

- Explorer had the highest average yield (avg. 5842 lb/acre), Full Pint the lowest yield (5131 lb/acre); other varieties had comparable yields.
- Grain protein levels were, on average, moderate to high.
- Average % plump values were acceptable to nearly acceptable, except of Full Pint.
- Test weights were good, except for Full Pint at 0 N.
- Increasing N increased plant height, grain yield, protein content, and test weight. The increase in protein % was linear across N levels, but other traits showed a curvilinear response.
- This irrigated environment could be a suitable growing area but nitrogen management and variety choice will be key considerations.

Overall conclusions – 2015 harvest

- Oregon can produce top quality malting barley in terms of agronomic performance and grain quality parameters - for the craft brewing and distilling industries.
- The choice of variety will be for the farmer, maltster, and brewer/distiller to decide based on target product, premium, and predicted production and grain quality.
- In general, the five varieties tested had similar and acceptable grain yields and grain quality parameters.
- Explorer was a top-performer. In general, the older North American varieties – Copeland and Full Pint – did not fare as well as the newer European imports: Expedition, Explorer and Genie.
- In general, varieties responded positively to increasing nitrogen applications and remained within craft brewing specifications, except at Klamath where grain protein levels exceeded specifications for at higher N levels.

Agronomics are Chapter 1 – Chapter 2: malting and brewing

The proof will be in the glass

 Malting and brewing trials will assess the effects of variety, nitrogen fertilization, and location on malting and brewing quality.

Effects of variety, grain protein, and environment on malting quality

 Micro-malts of each of the 45 variety/N treatment/environment combinations at Great Western and Malteurop.

Chapter 2: malting and brewing

Effects of variety, grain protein, and environment on barley contributions to beer flavor

- 20 lb malts of each of the 45 variety/N treatment/environment combinations (Big Sky Malting).
- 2 gallon zymatic picobrews with Big Sky malts.
- Canning at Bozeman Brewing.
- Sensory assessment of single can picobrews brewery panels and Beer Judge Certification Program (BJCP) panels.

Effects of variety and degree of modification on barley contributions to beer flavor

- Copeland and Full Pint pilot malts and pilot brews at Canadian Malting Barley Technical Center (CMBTC).
- Under-modified, modified, and over-modified malts of each variety.
- CMBTC and brewery panel sensory assessments.

Next steps – 2016 harvest

Buy another round: more data are needed

- We propose to repeat the same "core" varieties, nitrogen rates, and environments in 2016.
- New varieties, treatments, and environments can be added to the "core" set – given interest and support.

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