EVALUATION OF WAXY WHEAT CULTIVARS PLANTED IN THE FALL AND THE SPRING

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Introduction

Sustainable wheat production throughout the Pacific Northwest (PNW) is important to the economic viability of the region. One method of increasing the value of wheat and the potential return to growers is through the introduction of high value traits. Waxy starch is such a trait. Waxy starch absorbs more water, swells to a larger volume, and is crispier when baked than normal starch. Because of these characteristics the snack food industry may prefer waxy starch for the production of items such as "power bars" and breakfast foods.

Normal wheat starch has two components, amylopectin (75 percent) and amylose (25 percent). Amylose is an essentially linear molecule of α-(1→4)-linked glucose, while amylopectin is a highly branched molecule of α-(1→4)-linked glucose chains connected by α-(1→6)-linkages (Fig. 1). A full waxy wheat has no amylose. Partially waxy wheat has a mix of amylose (1-24 percent) and amylopectin (76-99 percent). Currently there are some cultivars of waxy wheat in commercial production. However, little is known about how these and other experimental waxy wheat lines will perform in the Treasure Valley of Oregon and Idaho.

A research project was initiated in the fall of 2006 to evaluate the agronomic performance and characteristics of several waxy wheat varieties under irrigation. Similar research under dryland conditions was conducted at the Columbia Basin Agricultural Research Center (CBARC) under the direction of Steve Petrie, and will be reported in their Special Report for 2007.

Methods

The study was established in the fall of 2006 at the Malheur Experiment Station in Ontario, Oregon. The soil type at the site was an Owyhee silt loam. The field was fallow the previous year. Seedbed preparation included disking, cultivating, and furrowing. Soil samples were collected prior to fall tillage and showed 128 lb/acre nitrogen (N) in the top 2 ft of soil. Urea was applied in the spring at 75 lb/N per acre on February 23, 2007. The wheat was planted with a plot drill on 30-inch beds with 3 rows per bed. Plot size was 5 by 20 ft.

The treatment design was a split-plot design. Three planting dates were the main plots and consisted of October 19, 2006 (normal fall seeding), November 10, 2006 (dormant seeding), and March 6, 2007 planting dates. The subplot treatment was wheat variety and consisted of 14 wheat varieties. These 'Waxy Pen', 'IDO629', 'IDO630', seven hard red advanced lines from Nebraska (Robert Graybosch, ARS; '459', '114', '115', '205', '315', '395', and '489'), and the check varieties 'Stephens', 'Goetze', 'Alturas', and 'WB936'. The experimental design was a randomized complete block design with three replications.

Field management included furrow irrigations on October 30 (Oct. 19 planting only), April 19, May 10, May 24, June 5, June 19, and July 5 (Mar. 6 planting only). Weeds were controlled with Buctril® at 1 qt/acre on March 15 and Bronate® at 1 qt/acre on April 3.

Agronomic characteristics measured were emergence, spring plant vigor, plant height, and lodging. Emergence data were collected by counting plants in a 3-ft section of the middle row in the bed on November 21, March 2, and March 23 for the October 19, November 10, and March 6 plantings, respectively. Spring plant vigor was evaluated on April 27 using a scale of 1-10, with 10 being excellent. Plant height was measured in four places in the plot using a measuring stick on June 13. Lodging was estimated on July 12 by determining the percentage of the plot leaning more than 45 degrees.

Plots were trimmed to size with a sickle bar mower to help eliminate border effects after heading. At maturity, wheat was harvested using a Hege combine on July 20. Response variables were compared using ANOVA and least significant differences at the 5 percent probability, LSD (0.05). Differences between response variables should be equal to or greater than the corresponding LSD (0.05) value before any variety is considered different from another in this trial.

Results

Data, averaged over all planting dates, were analyzed and a significant planting date by variety interactions were found. Therefore, each planting date was further analyzed individually.

"Normal" Fall Seeding, October 19

Stephens, a soft white winter check variety, had the highest average yield, 154.3 bu/acre (Table 1). It was significantly higher than all the other varieties and lines evaluated at this planting date. Among the waxy wheat varieties, IDO630, IDO629, Waxy Pen, and the experimental lines 459, 114, and 315 all performed well. IDO630 had the highest waxy wheat yield at 124.5 bu/acre. While these waxy varieties and lines performed well, they did have significantly less yield than Stephens, 29.8-42.3

bu/acre less. Similarly, the waxy wheat varieties also showed no yield advantage compared to the winter check variety Goetze or the spring check variety Alturas.

Dormant Seeding, November 10

Goetze, a soft white winter wheat check variety, had the highest average yield at 141.3 bu/acre (Table 2). The varieties Stephens, Alturas, and Waxy Pen all had similar yields compared to Goetze. Among the waxy wheat varieties and lines, only Waxy Pen, IDO630, and IDO629 performed well. The winter waxy lines from Nebraska did not perform well in this planting and several also had severe lodging due to their height.

Spring Seeding, March 6

Waxy Pen had the highest average yield at 123.9 bu/acre (Table 3). However, the spring check varieties Alturas and WB936 had similar yields compared to Waxy Pen. Both IDO629 and IDO630 performed poorly compared to the other varieties.

When comparing waxy varieties, one thing to keep in mind is that Waxy Pen, like it's parent 'Penawawa', is susceptible to stripe rust. IDO630 and IDO629 are considered moderately resistant to stripe rust. If a producer was planting in the spring, Waxy Pen would be the waxy variety of choice if stripe rust is not a problem. If it is a concern, IDO629 or IDO630 would be a better choice for a waxy wheat variety.

Conclusion

Waxy wheat can be successfully grown in the Treasure Valley region of Oregon and Idaho. Among the waxy wheat varieties evaluated, Waxy Pen and IDO630 performed the most consistently across the planting dates. However, Waxy Pen like its parent Penawawa, is susceptible to stripe rust. This makes IDO630, which is moderately resistant to stripe rust, a better overall waxy wheat variety for this region.

There was a significant yield reduction when fall planting IDO630 waxy wheat compared to the soft white winter check variety Stephens. Yield reductions ranged from 29.8 bu/acre in the "normal" fall planting to 5.7 bu/acre in the dormant fall planting. The lower yields of waxy wheat imply that there must be a premium for waxy wheat before growers will choose to plant it. Fall planted spring wheat also increases risk and needs compensation. Planting IDO630 as a dormant seeding improved spring vigor rating and increased yield 5 bu/acre over the October planting. Many acres in the Treasure Valley in eastern Oregon are often dormant seeded as irrigation water is turned off and soils are typically very dry at planting.

In the spring, yield reductions for IDO630 and IDO629 compared to spring check variety Alturas were 13.3 and 9.1 bu/acre, respectively.

Further research needs to be conducted to confirm these results. For waxy wheat to be at its full potential in this region, a high yielding, disease resistant winter waxy wheat needs to be developed.

Acknowledgements

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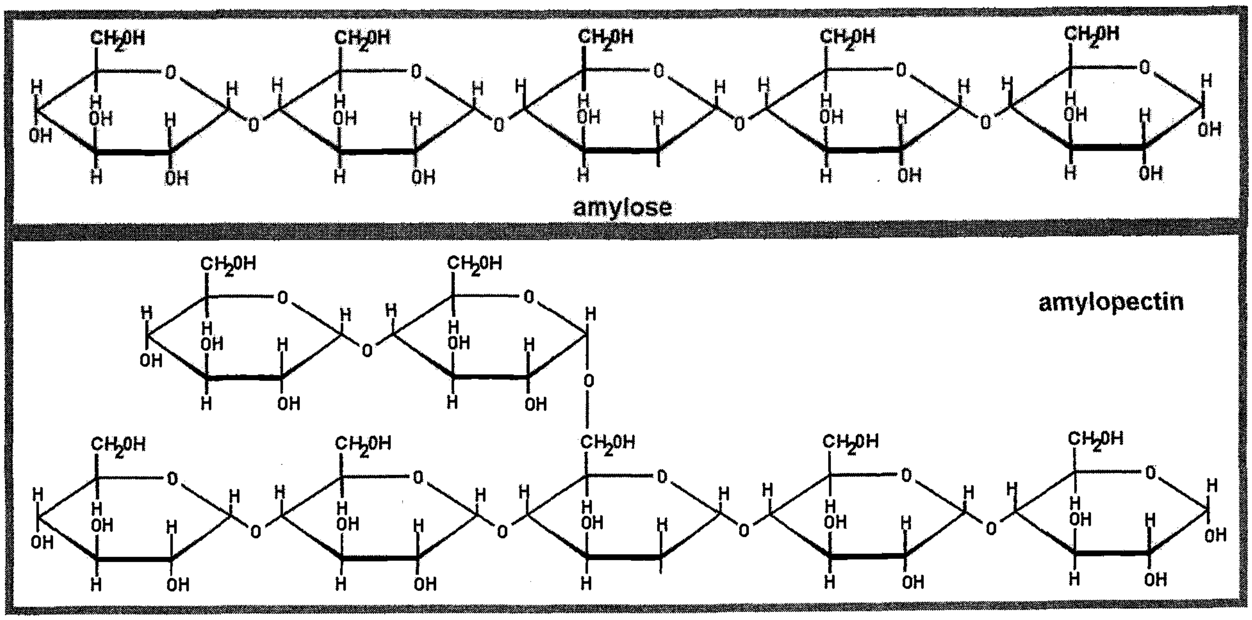

Figure 1. Molecular arrangement of amylose and amylopectin in wheat starch.

Table 1. Yield, protein, test weight, 1,000-kernel weight, and lodging of waxy wheat varieties and advanced lines seeded on October 19, 2006 at the Malheur Experiment Station, Oregon State University, Ontario, OR, 2007.

Variety	Harvestable yield	Grain protein	Test weight	Kernel weight	Lodging	Population at emergence	Head density	Plant vigor on 4/27/07	Plant height	50% heading date
	bu/acre	%	lb/bu	g/1,000 kernels	%	plants/acre	head no./ft^2	rating 1-10	inches	May
Stephens	154.3	10.1	61.3	54.3	0.0	737,000	51	10.0	35.4	17
459	122.7	11.1	63.6	37.4	11.7	1,237,000	76	9.0	37.0	12
114	115.6	12.3	63.3	36.6	21.7	1,144,000	75	9.7	42.2	13
115	97.9	11.7	62.3	39.6	71.7	1,179,000	85	9.0	40.8	13
205	89.1	13.9	61.2	33.3	3.3	1,179,000	63	9.7	41.4	15
315	112.0	10.7	63.1	38.9	0.0	1,155,000	79	8.5	34.9	15
395	108.5	12.0	61.8	34.9	0.3	998,000	64	8.5	36.2	11
489	107.0	10.9	61.1	36.6	11.7	1,028,000	74	9.3	40.4	15
Waxy Pen	112.8	9.8	63.3	41.7	0.0	987,000	68	6.5	31.2	13
IDO629	118.6	9.6	63.5	44.1	0.0	1,202,000	55	6.7	33.4	14
IDO630	124.5	10.4	63.1	42.3	0.0	1,138,000	64	6.3	32.1	13
Goetze	135.2	10.1	60.9	45.2	0.0	981,000	53	9.5	32.1	14
Alturas	115.1	10.2	63.3	43.4	0.0	1,266,000	72	7.0	34.0	14
WB936	102.0	12.5	63.7	47.7	0.0	964,000	60	6.2	30.9	13
Avg.	115.4	11.1	62.5	41.1	20.1	1,165,000	67	8.2	35.9	14
LSD (0.05)	13.4	0.5	0.5	3.4	12.8	256,000	18	1.3	1.9	2

Table 2. Yield, protein, test weight, 1,000-kernel weight, and lodging of waxy wheat varieties and advanced lines seeded on November 10, 2006 at the Malheur Experiment Station, Oregon State University, Ontario, OR, 2007.

Variety	Harvestable yield	Grain protein	Test weight	Kernel weight	Lodging	Population at emergence	Head density	Plant vigor on 4/27/07	Plant height	50% heading date
	bu/acre	%	lb/bu	g/1,000 kernels	%	plants/acre	head no./ft^2	rating 1-10	inches	May
Stephens	135.2	10.7	61.1	55.1	0.0	836,000	59	8.0	38.7	26
459	105.0	11.5	63.4	38.6	3.3	1,004,000	85	9.3	42.0	17
114	92.6	13.3	62.7	36.6	37.7	1,045,000	62	10.0	44.9	18
115	88.5	12.8	61.5	36.7	82.0	1,097,000	83	10.0	45.2	18
205	86.1	14.1	61.1	32.7	13.3	1,016,000	73	9.7	44.1	19
315	112.8	11.5	63.3	37.8	0.0	1,051,000	73	9.5	38.2	19
395	111.7	12.6	61.5	34.0	1.7	1,057,000	67	9.7	38.4	15
489	100.8	12.0	60.6	33.7	41.7	946,000	78	9.8	42.9	19
Waxy Pen	131.8	9.9	62.6	42.2	0.0	1,103,000	75	8.3	34.5	15
IDO629	121.2	9.9	62.8	41.3	3.3	1,161,000	77	9.0	38.4	17
IDO630	129.5	10.1	63.0	50.8	0.0	1,173,000	72	8.0	33.8	16
Goetze	141.3	10.5	61.0	42.3	0.0	946,000	58	9.7	35.1	20
Alturas	135.8	10.4	63.5	45.2	0.0	1,295,000	77	10.0	35.9	14
WB936	126.0	14.1	63.5	53.4	0.0	784,000	57	9.7	32.9	13
Avg.	115.6	11.7	62.3	41.5	26.1	1,036,000	71	9.3	38.9	18
LSD (0.05)	11.2	0.6	0.7	4.7	22.9	NS	NS	1.4	2.5	2

Table 3. Yield, protein, test weight, 1,000-kernel weight, and lodging of waxy wheat varieties and advanced lines seeded on March 6, 2007 at the Malheur Experiment Station, Ontario, OR, 2007.

Variety	Harvestable yield	Grain protein	Test weight	Kernel weight	Lodging	Population at emergence	Head density	Plant vigor on 4/27/07	Plant height	50% heading date
	bu/acre	%	lb/bu	g/1,000 kernels	%	plants/acre	head no./ft^2	rating 1-10	inches	May
Waxy Pen	123.9	10.1	63.4	41.6	0	842,000	46	9.7	34.1	26
Alturas	121.8	10.5	63.4	44.0	0	993,000	46	9.7	35.4	22
IDO629	112.5	10.6	63.1	42.6	0	1,184,000	47	9.5	37.5	27
IDO630	108.2	11.0	63.4	47.9	0	1,033,000	47	10.0	35.2	26
Goetze	109.4	10.6	59.1	39.0	0	1,010,000	44	9.7	32.3	32
WB936	115.2	13.6	63.7	49.3	0	1,196,000	40	9.7	31.7	20
Avg.	115.2	11.1	62.7	44.1	0	1,043,000	45	9.7	34.4	26
LSD (0.05)	10.2	0.5	0.6	4.1	NS	NS	NS	NS	2.5	2
LSD (0.05)[a]	18.2	NS	0.2	NS	NS	NS	16	2.0	4.2	1
LSD (0.05)[b]	29.8	0.9	1.2	6.5	NS	362,600	NS	2.7	NS	5

[a]LSD to compare between planting dates for tables 1, 2, and 3.

[b]LSD to compare between varieties and planting dates for tables 1, 2, and 3.