Winter Durum Response to Nitrogen Over Locations

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Introduction:

High-quality durum wheat often sells at a premium price as compared to soft white wheat and is sought after in both domestic and export markets. Oregon wheat growers could significantly benefit from production and marketing of winter durum as an alternative to soft white wheat. First, however, winter durum varieties must be developed that are well adapted to Oregon's production conditions with high yield potential and adequate winterhardiness. Durum varieties must also possess superior grain quality attributes and protein content to making them attractive in the domestic and international marketplace. A two-year study was started last fall in order to evaluate adaptation, production, and quality of six elite winter durum lines developed at OSU. These lines were planted in replicated yield trials, along with a durum check (CONNIE) and a SWW check (STEPHENS) at each of six locations. Testing sites were selected to represent a wide range of growing conditions and were located near Moro (Sherman Co.), Arlington (Gilliam Co.), Echo, Pilot-Rock and Pendleton (Umatilla Co.), and at La Grande (Union Co.). This study was designed to identify areas or management systems in Northeastern Oregon which are most favorable for high quality durum grain production. Three nitrogen fertility treatments were included at each site to determine N levels required to consistently meet industry requirements for grain protein content. Grain samples from these trials will be evaluated for an array of pasta quality attributes, with the emphasis on achieving superior protein content and quality, pasta color and low ash content attractive in durum marketing efforts.

Study Objectives:

1- Evaluate the yield potential, adaptation, and end-use quality of elite OSU winter durum wheat lines grown in diverse environments and management systems in Oregon.

2- Identify specific areas and/or management systems that are conducive to producing high quality winter durum wheat as a viable alternative to soft white winter wheat.

3- Develop information on winter durum N requirements and management options such that growers can consistently produce grain protein levels that meet industry specifications.

4- Evaluate pasta quality of winter durum varieties in relation to domestic and export market demands.

We would like to thank the Oregon Wheat Commission (OWC) and the Oregon Economic Community Development Department (OECDD) for funding this research. We also extend our gratitude to cooperating land owners (Chris and Larry Kaseberg near Moro, Eric Anderson near Arlington, Kent Madison near Echo, Cliff Hoeft near Pilot-Rock, Quentin Ruggs and Larry Williams near Pendleton and John Cuthbert near La Grande). Appreciation is extended to Pendleton Flour Mills for providing grain protein analyses. We would also like to thank both Gordon Cook and Scott McDonald for their assistance in managing the experimental site in La Grande and to Donald Wysocky for his help with the trials at Pendleton.

Multi-Location Evaluation of Elite Lines:

This study was designed as a two-year research effort establishing the potential for durum wheat production in Northeastern Oregon. At this time, the first year of field evaluations are complete and the trial has been planted again this fall for evaluation in 2001.

Ten wheat varieties were included in the experiment. Six winter durum 'elite' experimental lines representing the most promising lines from the OSU breeding program were included in the trial. These lines possess a level of winter hardiness that is substantially greater than that of the new OSU durum variety 'Connie'. The Soft White Winter wheat 'Stephens' and the durum variety 'Connie' were included as checks for comparisons of adaptation and yield potential. Two Hard White Winter (HWW) elite lines (OR 493575 and OR 492496) were also included in the experiment and will be used in separate analyses for Asian noodle product quality. A brief description of the winter durum lines tested in the 2000 study is shown in Table 1.

Table 1: Attributes of durum wheat lines included in 2000 multi-location study.

LINE	Yield Potential (% Stephens)	Winter-hardiness [d]	Grain Quality & Milling [e]	Gluten Strength	Yellow Color
CONNIE	98 [a]	8.8	Excellent	Excellent	Good
OR 948927	89 [b]	3.0	Good	Good	Good
OR 949027	90 [b]	3.3	Acceptable	Excellent	Excellent
OR 971856	92 [c]	2.8	Acceptable	Good	Excellent
OR 971881	80 [c]	2.5	Acceptable	Excellent	Good
OR 971896	92 [c]	1.3	Good	Excellent	Excellent
OR 971897	83 [c]	1.5	Good	Excellent	Excellent

[a]: Average of 3 years in replicated yield trials (1996-98). 1999 CONNIE plots were not harvested due to complete winter-kill.
[b]: Average of 4 years of replicated yield trials (1996-99).
[c]: Average of 2 years replicated yield trials (1998-99).
[d]: Score from 1 (no visible damage) to 9 (complete winter kill) observed at the Rugg's site in the winter of 1999. STEPHENS scored 1.0.
[e]: Assessment based on seed size, protein content, ash content and milling properties.

Six sites were selected to represent a wide range of growing conditions as determined by different rainfall levels, soil types and depth, as well as rotations and farming systems. A description of these sites is presented in Table 2.

Table 2: Experimental Site Descriptions included in 2000 multi-location study.

SITE	Collaborator	Rainfall (inches)	Management System	Rotation	Soil Type	Seeding Density*
MORO	C. Kaseberg	10-12	Dryland	Summer-fallow	Silt-loam	20
ARLINGTON	E. Anderson	8-10	Dryland	Summer-fallow	Silt-loam	20
ECHO	K. Madison	10-12	Irrigation	Annual Cropping	Sandy	30
PILOT ROCK	C. Hoeft	16-20	Dryland	Summer-fallow	Silt-shallow	20
PENDLETON	L. Williams	16-20	Dryland	Re-crop	Silt-loam	26
LA GRANDE	J. Cuthbert	20-25	Irrigation	Annual Cropping	Sandy	30

**: Number of plants/square foot*

Experiment Design:

The experiment is a split-plot design with four replications, using nitrogen treatments as main-plots and lines as sub-plots. Plots were 20 ft long and consisted of four rows (14" spacing) near Moro, Arlington and Pilot-Rock, seven rows (7" spacing) near Pendleton and Echo, and five rows (12" spacing) in La Grande. Nitrogen requirements were calculated using theoretical values derived by Dr. Russ Karow, and based on the desired grain protein level and yield potential for each site. Level 0 was that required to produce a SWW wheat with 10% grain protein, and represented the "standard practice" or control treatment. Level 1 was that required to produce a 13% protein durum at the same yield level of a SWW wheat. Level 2 represents the nitrogen requirement for level 1 plus 25%. Actual nitrogen amounts applied at each site were determined by subtracting the nitrogen present in the soil profile at planting time from the total nitrogen requirement for each level. Nitrogen applications were made shortly after planting at the dryer sites (Arlington and Moro) while a 50-50 split application at planting and at the end of tillering (early spring) is used at all other sites.

Accomplishments thus far:

In 2000, the first year of the study, marginal soil moisture conditions resulted in sparse stands and limited fall growth at the dryer sites (Arlington, Moro and Pilot Rock). Adequate planting conditions at Echo, Pendleton, Hermiston, and La Grande resulted in full stands and vigorous fall growth for all lines. There was no significant winter-injury at any of the sites and foliar diseases had little influence on the trials. First year yield data for each of the six locations is summarized in Table 3. Grain yields varied significantly over the locations, largely due to variations in available moisture throughout the season. Yield comparisons were confounded somewhat by infestations of cheatgrass (*Bromus tectorum*) at the Kaseberg, and Condon sites. Averaged over locations, Stephens and the two hard white common wheats significantly out yielded Connie and the durum experimental lines by over 10 bu/a. The differences in yield potential were most evident at the Kaseberg and La Grande sites. At the remaining sites, the durum lines showed grain yields comparable to the common wheats. Considering the premium price for durum, grain yields at 90% of Stephens would likely be acceptable and profitable for growers.

Table 3: Yield Data and summary for each of the Experimental Sites included in 1999-2000 multi-location study.

		Arlington		Hermiston		LaGrande		Pilot Rock		Kaseberg		Pendleton		Overall Mean****	
Line	Seed Class*	Yield**	Rank***	Yield	Rank	Yield	Rank	Yield	Rank	Yield	Rank	Yield	Rank	Yield	Rank
STEPHENS	SW	45.2	22	120.3	47	138.4	29	55.6	58	75.7	14	121.6	46	92.8	20
OR 943575	HW	41.0	41	122.4	44	142.0	26	52.4	65	72.4	21	130.3	23	93.4	18
OR 942496	HW	43.7	31	116.0	65	150.3	17	53.4	62	71.0	23	117.9	50	92.0	21
CONNIE	DU	32.5	81	121.8	43	65.5	103	53.9	62	43.8	89	114.0	64	71.9	93
OR 948927	DU	33.9	75	111.7	75	100.5	66	52.5	65	44.1	91	107.0	85	74.9	83
OR 949027	DU	38.6	50	112.8	69	91.9	77	55.2	53	56.7	48	119.6	51	79.1	63
OR 971896	DU	31.7	83	111.2	67	86.9	81	55.4	54	48.0	78	114.3	62	74.6	79
OR 971897	DU	31.4	87	120.9	47	91.1	80	55.5	56	47.6	77	110.7	70	76.2	76
OR 971856	DU	30.8	83	108.1	84	109.8	56	54.1	63	42.7	98	109.8	75	75.9	77
OR 971881	DU	37.9	53	112.3	66	96.7	70	52.6	67	51.3	67	110.6	79	76.9	74

**: Seed Class, SW-Soft White, HW-Hard White, DU-Durum.*
***: Yield values (bu/a) represent an average of the four replicated plots at each location and N level.*
****: Average rank value across replications and Nitrogen levels*
*****: Averages over all reps, locations and Nitrogen levels*

The goal for marketing high quality durum is a grain protein content of 13.5%. Grain protein data was available only for three locations at this time (Table 4a, b). For durum lines grown at Arlington and Pilot Rock, protein levels of 13.1 to 14.0% were achieved with the addition of N beyond that used for production of soft white wheat (i.e., treatments N1 and N2). However, at the Pendleton site, which had significantly higher grain yields, durum protein levels were under 12% for all N treatments. The preliminary data suggests that durum production may be a viable alternative for Oregon growers, but that additional research on production and N management will be critical for producing consistently high quality and high protein durum grain.

Table 4a. Significant tests for the Multi-Location Trial.

Source	DF	Pendleton	Pilot Rock	Arlington
Entry	9	*	*	*
Nitrogen	2	*	*	*
Entry x Nitrogen	18	*		*

Table 4b. Protein Values for each check experimental durum lines and hard whites by Location and Nitrogen level.

Location	N Level	Stephens	Connie	Mean of 6 Durum Lines	Mean of 2 Hard White Lines
Pendleton	N0	8.70	9.47	9.20	9.47
	N1	10.10	10.28	10.55	9.93
	N2	11.39	11.22	11.56	10.60
Pilot Rock	N0	11.72	13.94	12.79	12.74
	N1	11.57	14.01	13.33	12.70
	N2	12.11	13.63	13.67	12.56
Arlington	N0	12.13	12.84	12.85	12.35
	N1	12.42	13.33	13.06	12.67
	N2	12.10	13.56	13.29	13.16

The durum lines are currently being submitted to the California Wheat Commission Lab in Woodland, CA where they will undergo a complete evaluation of their grain characteristics, semolina quality and pasta-making properties. By conducting this comprehensive field and end-use quality research project, we will document the major production and management influences on durum yield and quality, develop information needed for domestic and export market development, and determine the economic viability of durum as an alternative to soft white production in the Pacific Northwest.