PERFORMANCE OF STANDARD HEIGHT AND SEMIDWARF DURUM WHEAT CULTIVARS UNDER IRRIGATION.

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ABSTRACT

Tall, intermediate and semidwarf durum cultivars and experimental lines (22 in total) were evaluated at two irrigated sites in 1987. Both tall and intermediate height classes out-yielded the semidwarf group by a significant margin. The standard height durums had a protein content in the 15-16% range. Starchy kernel content was low at both sites. Smudge and immature kernels resulted in lower CWAD grades but returns from growing durum would still have been greater than that obtained from a CWRS crop. These preliminary results suggest that there is potential for irrigated production of intermediate height cultivars such as Sceptre, Arcola, and Medora.

INTRODUCTION

The combination of depressed prices for Soft White Spring Wheat (CWSWSW) and higher prices for Canadian Western Amber Durum (CWAD) wheat resulted in a quadrupling of the 1987 durum acreage under irrigation in Central Saskatchewan. The durum acreage in the South Saskatchewan Irrigation District No. 1 increased from 795 acres in 1985 (Hamlin, 1986) to 3150 acres in 1987 (Sask. Water Corp.). Between 1968 and 1983 the amber durum acreage in the same district fluctuated between 0 and 1090 acres (mean = 240 acres).

Amber durum wheat production in Saskatchewan has traditionally been concentrated in the Brown Soil Zones under dryland growing conditions. Cultivars which are recommended for those areas tend to be tall and later maturing. In some instances (e.g. Wascana, Wakooma) cultivars have been bred specifically for improved drought tolerance (Hurd et al., 1972). Semidwarf durum cultivars have been developed for high productivity conditions under which taller cultivars tend to lodge. Durum cultivars with dwarfing (Rht) genes have been developed in the U.S., Italy and by CIMMYT in Mexico (Gale et al., 1981). These cultivars are 30 to 40 cm shorter than their traditional-height counterparts (McClung et al., 1986). Early studies (Joppa, 1973; Deckard et al., 1977) suggested that height reduction had no effect on grain yield while a more recent study (McClung et al., 1986) concluded that the Rht gene was associated with increased yields. Similarly, McClung et al. (1986) concluded that semidwarf lines had lower kernel protein concentrations while Deckard et al. (1977) suggested the reverse is true. Although reduced kernel and test weights have been associated with height reduction (Joppa, 1973; McClung et al., 1986) this relationship does not appear to hold true in all instances.

There does not appear to be any published reports dealing with the potential of either conventional or semidwarf durums under irrigation in Saskatchewan. The objective of this study was to evaluate the potential of nine U.S. semidwarf durums relative to shorter-statured and tall Canadian and U.S. cultivars or experimental lines under irrigation.

MATERIALS AND METHODS

Six Amber Durum cultivars, two U.S. semidwarf durum cultivars and fifteen short-statured (Rht and rht) experimental U.S. lines (Table 1) were grown under irrigation at Outlook (SK) and Enchant (AB). The American durums were developed by Western Plant Breeders (Bozeman, MT) and Nickerson American Plant Breeders (Berthoud, CO). The cultivars Neepawa and Fielder were included as standard Canada Western Red Spring (CWRS) and CWSWS checks.

Trials were seeded on May 19 (Outlook) and May 14, 1987 (Enchant). The Outlook trial received 5.5 kg/ha of actual N (50 kg/ha 11-51-0) at seeding time and 50 kg/ha of actual N (147 kg/ha 34-0-0) at Zadoks' Growth Stage 30. The Outlook site was fertigated during the growing season. At Enchant, 80 kg/ha of actual N (liquid fertilizer) was banded prior to seeding. The seeding rate was ca. 440 seeds/m^2 (Outlook) and 350 seeds/m^2 (Enchant). A randomized complete block design with four replications was used at both sites. The harvested area per plot was 3.8 m^2 at Outlook and 4.0 m^2 at Enchant.

RESULTS AND DISCUSSION

Grain yields of recommended CWAD cultivars were competitive with, if not superior to, those of the CWRS cultivar Neepawa at both locations (Table 2). In a few instances CWAD cultivars performed better than the CWSWS semidwarf cultivar Fielder. The medium (M) height durums yielded 7% more than the two tall (T) cultivars at Outlook but the advantage was not statistically significant. The medium height durums, however, lodged to a significantly lesser degree than the tall cultivars (Table 2) suggesting that lodging resistance gave the medium height durums a yield advantage over tall cultivars. At Enchant, however, lodging was minimal and the M durums yielded approximately 5% less than the T cultivars. This yield difference was, again, not significant. The a-priori height categorization held in 1987, the medium height class being twelve cm shorter than the tall class. The medium height durums were significantly earlier in heading and maturity than Wakooma and Kyle.

The over-all yield performance of the semidwarf (Rht) durums was disappointing (Table 2). At Outlook the Rht durums yielded 33 and 37% less than the tall and medium height classes, respectively. At Enchant the same yield comparisons resulted in smaller differences (8 and 4%, respectively). The yield disadvantage of the semidwarfs was significant at both locations. Higher yielding semidwarfs (WA 885-424, Laker) yielded (on average) 7 and 13% less than T and M durums respectively at Outlook but 3 and 8% more at Enchant. The semidwarfs were markedly shorter than conventional height durums and matured significantly earlier. Lodging was not a problem for the semidwarf lines, however, their lodging resistance was no better than that of M height durums.

Medium height and tall durums did not differ significantly in kernel or test weight (Table 3). The semidwarfs, however, had significantly lower kernel and test weights relative to conventional height durums. A moderate infestation of leaf rust (Puccinia recondita) was evident at Outlook. Leaf rust susceptibility was likely the cause of the light kernels and low test weights which were in turn symptomatic of the low grain yields of semidwarfs at Outlook. In the absence of leaf rust, the semidwarfs performed in a more respectable manner at Enchant (Table 2). The two higher yielding semidwarfs (Laker and WA 885-424) had higher kernel and test weights under disease pressure (Table 3).

The N fertilizer rates used in this study resulted in durum protein levels which were similar to, or better than, those of Neepawa (Table 3). Consequently, proper fertilizer management would appear to result in both high durum yields and protein levels under irrigation. The tall cultivars Wakooma and Kyle had significantly higher protein levels than the medium height cultivars or lines. The semidwarfs (on average) had high protein levels, probably a reflection of their low yields. Particle Size Index (PSI), a measure of kernel hardness, was similar for durum cultivars grown under irrigated and dryland conditions (Table 3).

Starchy (piebald) kernels are undesirable for semolina, and subsequently, for pasta production. More starchy kernels were produced at Enchant (4.0%) than at Outlook (2.1%). These levels, however, fall within the norms for commercially produced CWAD crops. The 1985 and 1986 1 CWAD crops had a mean content of 92% vitreous (i.e. $\leq$ 8% starchy) kernels (Canadian Grain Commission, 1986). Cultivar differences for starchy kernel content were generally quite small (Table 3). These results indicate that at a gross level, irrigated durums appear to have acceptable quality levels.

Grain samples of recommended cultivars and 'Laker' were graded at two elevators and the Canadian Grain Commission (Table 3). The durum cultivars graded between 2 and 4 CWAD due to the presence of smudged and immature kernels. Averaged over recommended cultivars and graders an approximate grade of 3 CWAD was obtained. Approximate grades for Neepawa and Fielder were 2 CWRS and 2 CWSWS, respectively. Based on a 7% yield advantage for the CWAD cultivars relative to Neepawa and an 11% higher 1986-87 total payment (3 CWAD versus 2 CWRS, 13.5%) a producer would have obtained an 18% greater return by growing a durum crop under irrigation.

These results are obviously of a preliminary nature but they do indicate that there is some potential for irrigated durum production. More research is needed to confirm which CWAD cultivars should be recommended for irrigated production as well as some information on yield-optimizing agronomic practices.

SUMMARY

Based on two irrigated trials semidwarf durums yielded significantly less than conventional height lines. On average, medium height lines yielded more than the two tall CWAD cultivars at Outlook but less at Enchant, AB. These yield differences, however, were not statistically significant. As might have been expected, medium height CWAD cultivars adapted to the higher-rainfall areas of Western Canada (i.e. Sceptre, Arcola, Medora) lodged significantly less than the tall cultivars at the higher-yielding location (Outlook). Protein and starchy kernel levels were very good. Due to the presence of smudge and immature kernels, samples from the Outlook site were graded, on average, as 3 CWAD. Despite the downgrading, a producer would have benefitted from growing a CWAD as opposed to a CWRS crop at current wheat prices. Although the U.S. semidwarf genotypes evaluated in this study performed poorly, it should be kept in mind that the introduction of dwarfing (Rht) genes into CWAD cultivars adapted to Western Canadian environments (especially disease pressure) might yield more promising results.

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TABLE 1. DURUM CULTIVARS AND EXPERIMENTAL LINES EVALUATED UNDER IRRIGATED CONDITIONS

Cultivar/Line	Height Category+	Origin
Wakooma, Kyle	tall	ACRS Swift Current, SK
Sceptre, Arcola	medium	U. of Saskatchewan, SK
Medora, Coulter	medium	ACRS Winnipeg, MB
WA885-401, WA885-415, WA885-420, WA885-423, WA883-411	medium	Western Plant Breeders (WPB)
HD81-820, HD85-1805	medium	Nickerson American Plant Breeders (NAPB)
Laker, BZ883-233 BZ883-235, WA885-403, WA885-419, WA885-421, WA885-422, WA885-424	semidwarf	WPB
Stockholm	semidwarf	NAPB

+ Category based on 1985-86 data. A Gibberellin insensitivity seedling assay was used to identify lines carrying the Rht gene.

TABLE 2. PERFORMANCE OF STANDARD HEIGHT AND SEMIDWARF DURUMS UNDER IRRIGATION

	Yield (kg/ha)		Heading (days)	Maturity (days)	Height (cm)	Lodging (1-9)
	OTL	ENC	OTL	OTL	OTL	OTL
1. Wakooma	6096	3932	55	108	120	3.8
2. Kyle	6260	4301	55	111	121	4.5
3. Sceptre	6678	3799	51	110	104	1.0
4. Arcola	7514	4175	52	107	116	2.3
5. Medora	6588	3685	51	111	117	1.0
6. WA885-424	5839	4489	54	108	86	1.3
7. Laker	5668	3997	55	110	90	1.0
8. Neepawa	6065	3754	51	102	106	3.8
9. Fielder	7295	4147	55	114	98	1.0
LSD (.05)	872	606	1	5	5	1
Single degree of freedom contrasts:						
Tall (T)	6178 (2)	4117	55	110	121	4.1
Medium (M)	6598(11)	3925	51	108	109	1.1
Semidwarf (Rht)	4158 (9)	3770	52	106	83	1.3
T vs M	NS	NS	**	NS	**	**
T & M vs Rht	**	*	NS	**	**	**

OTL = Outlook; ENC = Enchant
NS = Nonsignificant; *, ** significant at P<0.05 and P<0.01, respectively.

TABLE 3. KERNEL AND QUALITY CHARACTERISTICS OF IRRIGATED DURUMS

	1000K (g)	Test Weight (kg/hl)	Protein (13.5 mb) (%)	PSI (%)		Starchy Kernels (%)	Grade (OTL)			
	OTL	OTL	OTL&ENC +	OTL&ENC	DRYLAND	OTL&ENC+	EL1	EL2	CGC	COMMENTS
1. Wakooma	38.1	77	16.2±0.6	42.9±1.4	45.6±0.9	1.6±0.3	4CWAD	2CWAD	2CWAD	Red Smudge
2. Kyle	37.7	76	15.8±0.2	42.9±0.8	45.1±0.4	1.4±0.2	4CWAD	2CWAD	2CWAD	Smudge
3. Sceptre	37.1	77	15.1±0.4	43.7±2.4	46.5±1.1	2.7±0.3	4CWAD	3CWAD	2CWAD	Immature, Si
4. Arcola	39.1	77	15.1±0.6	46.2±2.4	44.9±0.5	2.7±1.0	3CWAD	2CWAD	2CWAD	Red Smudge
5. Medora	40.9	78	15.7±0.4	45.0±1.2	43.8±1.0	1.3±0.3	3CWAD	3CWAD	3CWAD	Smudge
6. WA885-424	35.4	76	14.4±0.3	44.7±1.1	- -	3.4±0.2	- -	- -	- -	
7. Laker	36.0	76	15.1±0.4	43.8±0.5	- -	6.2±4.6	4CWAD	4CWAD	2CWAD	Red Smudge
8. Neepawa	32.8	78	14.9±0.3	54.0±2.8	- -	1.5±0.5	3CWRS	2CWRS	1CWRS	
9. Fielder	32.7	77	11.7±0.1	77.3±1.6	- -	100.0	2CWSWS	3CWSWS	2CWSWS	
LSD (0.05)	4.2	6								
Single degree of freedom contrasts:										
Tall (T)	37.9 (2)	76	16.0±0.4	42.9±0.3	- -	1.6±0.3				
Medium (M)	39.5 (11)	77	15.0±0.2	44.7±0.2	- -	3.1±0.1				
Semidwarf(Rht)	31.3 (9)	69	15.8±1.2	44.9±0.8	- -	3.5±2.4				
T vs M	NS	NS								
T&M vs Rht	**	**								

+ Mean (of 2 locations) ± SE.
Dryland PSI determined for Watrous and North Battleford samples.
OTL = Outlook
ENC = Enchant
PSI = Particle Size Index (NIR determination)
EL = Elevator
CGC = Canadian Grain Commission