

Breeding for Low-Input, Water Use Efficient Wheat

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Summary

A male sterile facilitated recurrent selection (MSFRS) wheat breeding program has been established to meet the needs of the grower whose irrigation water is or will be limited by availability or expense. Utilizing wheat's ability to grow in cool weather for maximum water use efficiency, early December planted wheat is grown with only a preplant irrigation. Yield of Anza, a known water use efficient variety, was 2146 lbs per acre when grown in nitrogen depleted soil with very little spring rain. With adequate residual nitrogen and effective spring rains yields up to 3747 lbs per acre were obtained. The first estimates of yields on MSFRS lines indicate progress in this breeding program.

In many arid and semi-arid areas of the world rainfall may only come in sporadic downfalls. In Arizona there are many areas where irrigation water is or will be limited by availability or expense. A breeding program for development of low-input water-use-efficient wheat with an acceptable agronomic yield, was initiated in 1978. Male sterile facilitated recurrent selection (MSFRS) for superior performance under one-irrigation regimes, with minimal or no added fertilizer has been practised since. Irrigation has been a preplant irrigation of 7 to 8 inches (enough to bring soil to field capacity to a depth of 5 feet or more). Seeding has been December 1 to 15 at 15 to 30 lbs per acre. Normal rainfall expected is 2 to 4 inches. However, for 3 of the 5 years rainfall has exceeded expected and has reduced population selection pressure.

Yield evaluations of Arizona adapted cultivars were made under these same low-input conditions. Excessive rainfall in 1978 and excessive rain with considerable residual soil nitrogen in 1980 extended yields beyond 3000 lbs per acre. Average yields of Anza, Siete Cerros, Cajeme 71, 906R and Gabo have been best and similar for the four-year period 1978-1981. They were used as check cultivars in 1982. Yields of both Anza and Gabo peaked at near 3700 lbs per acre in 1980.

Selection criteria for MSFRS population improvement are earliness, seed size, determinate heading and head size at physiological maturity. The first yield and performance evaluations of selected lines were made in 1982 and are presented in Tables 1 to 5. These test plots received a maximum of 8 inches of preplant irrigation water and 3 inches effective rainfall during the production period. No fertilizer was applied. Anza and Gabo are check varieties in these tests. Yields of several selections and varieties exceeded that of the checks. Test weights were adequate, although not high relative to normal high test weights of Arizona wheat. Little if any shriveled seed was evident. For the most part seed size was small but plump. Progress is indicated.

The first one-irrigation low-input MSFRS durum population was grown in 1982 and will be improved in 1983. Simultaneous with population improvement for both bread and durum wheats, additional studies are planned and underway to; (1) determine the best rate and date of seeding, to make maximum use of initial irrigation and winter rains, (2) evaluate bread wheats for flour quality and feed, (3) evaluate durum wheats for semolina quality and (4) determine practicability of additional, but limited, irrigation.

Table 1. Performance data evaluation summaries of bread wheat grown with only a preplant irrigation, Mesa Experiment Farm, 1982.

(Table 1 A) Hard red varieties and selections.

	Heading date	Physiological maturity date	Plant height in.	Non-vitreous %	Seed weight gms/m	Test weight lbs/bu	Yield ^{1/} lbs/A
Veery #3	4-1	5-2	30.7	8.3	28.0	60.5	2716 a
Veery #2	3-30	5-2	33.1	3.5	27.4	59.0	2648 ab
Super - X	3-29	5-2	32.3	14.8	28.1	53.0	2560 abc
906 - R (check)	3-18	4-28	31.5	3.6	41.6	61.5	2420 bc
Veery #4	3-21	4-27	31.5	2.7	34.1	61.0	2415 bc
Anza (check)	3-28	5-1	29.9	25.7	26.2	60.0	2409 bc
Yecora Rojo	3-20	4-26	25.6	5.5	35.8	62.0	2376 c
RSP - Sel. Plant	3-23	5-1	40.2	15.6	38.6	60.0	2353 c
Veery #1	3-20	4-29	32.7	16.5	34.6	62.0	2350 c
RSP - Large seed	3-21	4-29	38.6	8.0	34.4	61.0	2338 c
Tanori 71	3-19	4-28	31.9	6.8	33.9	62.0	2324 c
RSP - Early	3-18	4-28	34.7	26.8	41.0	60.0	2026 d

^{1/}Yields followed by the same letter are not significantly different at the 5% level of probability using Duncan's Multiple Range Test.

(Table 1 B) Hard white varieties and selections

	Heading date	Physiological maturity date	Plant height in.	Non-vitreous %	Seed weight gms/m	Test weight lbs/bu	Yield ^{1/} lbs/A
Abu Ghraib	3-22	5-1	34.3	9.8	26.3	61.5	2921 a
Sonalika	3-17	4-26	35.1	15.5	44.6	62.5	2797 ab
7702	3-25	4-29	34.7	5.1	39.9	62.0	2772 ab
Yecora 70	3-20	4-27	27.6	7.4	36.4	61.5	2747 ab
M80-64-135	3-23	4-29	36.6	10.7	29.3	59.0	2688 bc
Bob White "S"	3-31	5-2	33.1	5.0	24.7	59.0	2682 bc
Veery #5	3-21	4-29	34.3	9.4	31.6	61.5	2627 bc
Klassic	3-21	4-27	26.0	14.3	39.0	63.0	2574 bcd
M80-68-186	3-30	5-2	34.3	3.7	27.9	59.5	2464 cd
Gabo (check)	3-25	5-2	36.2	1.0	29.5	58.5	2418 cd
Florence Aurora	3-24	5-2	43.7	1.2	41.2	60.0	2337 de
521-W	3-24	4-30	29.2	1.8	23.7	56.0	2137 de

(Table 1 C) Selections, one-irrigation regime.

M80-68-320	3-28	5-2	33.5	.3	30.4	60.0	2834 a
C79-97	3-25	5-1	29.6	7.1	30.7	61.0	2696 ab
C79-281	3-29	5-1	31.9	7.3	30.2	60.0	2572 bc
M80-77-128	3-26	5-2	35.5	6.9	33.9	61.0	2549 bcd
TXLRR-8-37	3-25	4-29	33.1	5.3	31.3	59.0	2541 bcde
M80-77-73	3-26	5-3	32.3	2.7	27.1	58.0	2452 bcde
Anza (check)	3-29	5-1	29.9	14.8	27.7	61.0	2416 cde
C79-127	3-23	4-28	42.9	.4	40.3	63.0	2384 cde
M80-64-161	3-25	4-29	31.9	15.5	30.6	59.0	2296 de
M80-69-4	3-20	4-27	32.3	8.2	30.0	62.0	2295 e
M80-68-7	4-5	5-8	24.8	7.4	25.0	52.0	1862 f
M80-77-89	3-24	4-29	28.8	60.3	30.3	58.0	1848 f

(Table 1 D) Selections, one-irrigation regime

M80-68-243	4-4	5-7	35.1	--	--	60.0	2920 a
M80-12-32-1	3-25	4-28	28.8	11.5	31.3	58.0	2792 ab
M80-74	3-30	5-1	33.9	3.8	29.2	58.5	2728 abc
M80-69-2	3-26	5-2	39.8	20.5	30.7	60.0	2717 abc
M80-12-205	4-5	5-8	23.6	7.2	29.2	59.0	2664 abcd
TXRR-29LRP	3-28	5-1	29.9	16.9	32.2	58.0	2627 abcd
M80-63-149	3-31	5-4	29.9	12.8	22.9	57.5	2572 abcd
M80-67-14	3-28	4-30	31.9	19.6	31.4	58.0	2509 bcde
Anza (check)	3-29	5-1	29.9	17.0	25.9	61.0	2376 cde
M80-67-37	3-26	4-28	39.0	1.3	28.9	55.5	2326 de
M80-75	3-28	5-1	32.7	17.2	35.8	60.0	2210 ef
M80-69-11	3-24	4-26	34.7	14.6	26.9	61.0	1966 f

(Table 1 E) Selections, one-irrigation regime.

M80-12-87	3-30	5-3	34.3	0	34.8	59.5	2925 a
M80-68-12	3-25	4-29	35.5	8.0	27.5	60.5	2819 ab
M80-77-88	3-31	5-1	31.9	3.8	24.0	58.0	2805 ab
M80-79-119	3-25	4-29	37.8	5.0	29.1	57.0	2780 ab
M80-63-159	3-21	4-28	31.9	7.9	29.5	60.5	2748 ab
M80-68-267	4-2	5-4	26.0	8.3	26.1	56.0	2739 ab
SGW-069	3-23	4-28	30.7	.3	32.0	63.0	2714 ab
M80-63-163	3-26	4-28	30.7	7.2	31.7	61.0	2583 ab
Westbred 911 (check)	4-1	5-2	25.2	12.8	28.6	58.5	2541 ab
M80-68-263	3-30	5-1	35.5	11.1	29.9	57.0	2419 bc
M80-77	3-23	4-29	28.8	9.8	37.3	58.5	2066 cd
SGW-012	3-23	4-27	26.8	1.0	35.7	61.5	1914 d

^{1/}Yields followed by the same letter are not significantly different at the 5% level of probability using Duncan's Multiple Range Test.