Wheat Improvement in Arizona

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Wheat improvement research at the University of Arizona in recent years has been with the concept that limited personnel and funds can best serve the public by developing materials which can be rapidly directed to meet the needs of the farmer and the market. We are interested in developing materials which can meet present and future needs of efficient low water use and low energy input. Development of germplasm pools through more efficient breeding methods for exploitation by private and public interests is the prime goal instead of variety releases.

The Arizona wheat project has been instrumental in introducing a new system of breeding to wheat breeders. Male sterile facilitated recurrent selection (MSFRS) population breeding of spring bread wheat was established in 1974 at The Mesa Experiment Station utilizing the genetic male sterility of two Siete Cerros plants, found, sibbed and designated A and B at Mesa in 1972. The breeding system consists of selecting large numbers of male fertile and genetically male sterile plants for adaptability, stiff and short straw, spike length, seed size and number, tillering expression, freedom from disease, and other observed genotypically and physiologically desirable characters. Crosses are made between selected plants, using male steriles as female plants to facilitate hybridization. F_1 populations are increased for bulk harvest in Bozeman, Montana each summer. F_2 generations are grown at Mesa each winter. Again large numbers of male fertile and male sterile plants are selected and crossed. Crosses are made between opposites in plant character combinations to maintain as much population heterozygosity as possible.

The MSFRS system of breeding has versatility. Used on a population basis, its greatest and most immediate utility to breeders is in the rapid development of genetic diversity. Plant pathologists use it in developing non-specific resistance to diseases. Once a population for a particular character or characters is established it is open-end and additional germplasm can be added at any time as feasibility and objectives dictate. An inovative researcher can adapt the system to many objectives. It can be utilized in backcrossing and topcrossing. Record keeping is minimal.

The original MSFRS base population established in 1974 is intercrossed and additional germplasm is added each year for more genetic diversity of agronomically acceptable plant characters. Wheat populations with more specific orientation are being maintained and expanded each year for exploitation. Among these populations are: 1. early harvest, 2. drought escaping or tolerant (grown under limited irrigation), 3. high protein hard red, 4. spring X winter, 5. white, and 6. rust resistant.

MSFRS breeding of both wheat and barley is being utilized by at least one commercial breeding company and a number of public breeders. Plant pathologists are using variations of this method of breeding to develop non-specific or horizontal resistance to a number of pathogens. MSFRS breeding is being utilized in Mexico and South Korea. One Mexican government breeder is using the system extensively for bread wheat variety improvement in yield, agronomic quality and rust resistance.

MSFRS hasn't been established in durum wheat because a suitable genetic male sterile hasn't been found or developed at this time that will perform satisfactorily. The foremost objective in the durum improvement program is to establish MSFRS population breeding. In the meantime conventional breeding methods are being utilized in efforts to improve the 'desert durums' with more semolina color, higher protein and less incidence of yellow berry.

The wheat project is cooperating with CIMMYT (International Maize and Wheat Improvement Center, Mexico) and Western Regional Wheat Workers in evaluation of several yield and observation nurseries. We feel that the advantages are reciprocal. They receive information on their advanced lines and varieties and we have the opportunity to select genotypes suitable for Arizona and utilize their germ plasm for broadening MSFRS composite populations.

Wheat evaluation yield trials are conducted each year at The Mesa and Yuma Experiment Stations as a service to growers and to evaluate the end results of germplasm improvement and agronomic research. Some yield data summaries from The Mesa Station in 1979 are presented here. Although winter rainfall was excessive, near normal production levels of good quality grain were obtained by broadcasting nitrogen fertilizer in split applications between rains.

Table 1. Durum wheat variety yield test data summary from The University of Arizona Mesa Experiment Farm in 1979. This replicated test was seeded December 1, 1978 at the rate of 70 lbs per acre and received 215 lbs N per acre in three applications.

Variety	1978[2/] Quality value	Hard vitreous (%)	Seed wt. (gms/M kernels)	Test weight (lbs/bu)	Lodging (%)	Height (in)	Heading date	Maturity date	Yield[1/] (lbs/acre)
Aldura	-	98.1	52.6	64.5	0	30	3-29	5-26	6318 a
Mexi "S" - Fg "S" (10)	4	97.3	57.7	63.0	2	36	3-29	5-21	5967 ab
RAJ - 911	1	99.8	65.3	64.0	0	36	3-27	5-22	5974 ab
Mexi "S" - Fg "S" (11)	1	98.4	55.9	63.0	0	34	3-27	5-20	5888 ab
Yemen - Cr "S" X PLC-Gier	1	97.5	49.4	62.5	0	34	4-5	5-28	5853 ab
Produra	1	99.2	56.4	64.0	0	35	3-26	5-21	5843 ab
WPB 1000D	1	95.2	48.9	62.0	0	35	4-5	5-26	5823 ab
Mexicali 75	1	100.0	61.6	62.5	0	38	3-24	5-20	5800 b
UC 304	3	98.7	41.1	65.0	0	33	4-10	5-31	5685 bc
Jori 69	1	99.6	62.7	65.0	0	34	3-27	5-24	5655 bc
Bittern "S" (54)	1	97.0	61.7	66.0	0	36	3-28	5-25	5536 bc
Gediz "S"	1	99.3	52.2	64.5	0	37	3-29	5-23	5479 bc
UC 313	3	99.3	44.2	63.0	0	32	4-13	6-1	5251 c
UC 320	3	98.5	42.5	63.5	0	34	4-6	5-28	5167 c

[1/] Yields followed by the same letter are not significantly different at the .05 level of probability.
[2/] Composite of quality date including semolina color 1 is least promising, 4 is most promising.

Table 2. Bread and durum wheat variety yield test data summary from The University of Arizona Mesa Experiment Farm in 1979. This replicated test was seeded December 1, 1978 at 70 lbs per acre and received 195 lbs N in three applications.

Entry	Class	Hard vitreous (%)	Seed wt. (gms/M kernels)	Test weight (lbs/bu)	Lodging (%)	Height (in)	Heading date	Maturity date	Yield[1/] (lbs/acre)
Germains 5003	Durum	79.5	60.1	64.0	0	37	4-7	5-27	7431 a
Germains 3008	HR	99.3	48.3	61.5	0	33	3-29	Early	6535 b
Cajeme 71	HR	99.3	51.3	62.0	0	32	3-28	Early	6509 bc
Germains 5002	Durum	97.2	59.5	64.0	3	32	4-3	5-26	6488 bcd
WPB 1000D	Durum	98.6	43.9	61.0	0	37	4-8	5-29	6295 bcde
Mexicali 75	Durum	97.4	60.5	62.0	0	39	3-28	5-21	6266 bcde
Pavon 76	HW	-	42.9	64.0	0	39	4-3	5-25	6213 bcde
Aim	HR	99.4	36.2	63.5	0	41	3-31	5-23	5852 cdef
Germains 444	HR	96.2	38.5	62.5	0	39	3-27	Early	5824 def
Siete Cerros	HW	-	37.3	62.5	6	42	4-4	5-25	5712 ef
Pima 77	SW	-	31.6	61.0	10	39	4-3	5-23	5686 ef
Super X	HR	84.5	37.0	62.5	0	39	4-7	5-26	5523 f
Germains 3027	HR	99.7	41.1	61.0	1	39	3-30	5-21	5449 f

[1/] Yields followed by the same letter are not significantly different at the .05 probability level.

Table 3. Bread wheat variety yield test data summary from The University of Arizona Mesa Experiment Farm in 1979. This replicated test was seeded December 1, 1978 at 70 lbs per acre and received 215 lbs N per acre in three applications.

Variety	Class	Hard vitreous (%)	Seed wt. (gms/M kernels)	Test weight (lbs/bu)	Lodging (%)	Height (in)	Heading date	Maturity date	Yield[1/] (lbs/acre)
Dougga	HR	86.4	39.4	63.5	0	37	4-4	5-25	5881 a
Pavon 76	HW	-	43.4	64.0	0	37	3-29	5-23	5877 a
Anahauc 77	HR	95.7	44.5	63.0	0	37	3-25	Early	5835 a
Aim	HR	98.4	37.7	63.5	0	39	3-29	Early	5729 a
Moncho "S"	HW	-	45.6	63.0	0	38	4-2	5-23	5678 a
Bluejay "S"	HR	96.6	40.9	62.5	0	34	3-29	Early	5655 a
Cajeme 71	HR	97.6	48.9	62.5	0	31	3-24	Early	5650 a
Probred	HR	100.0	50.7	62.0	0	28	3-22	Early	5648 a
PJ-Bb X Nal	HR	80.1	41.1	63.0	0	37	4-1	5-26	5596 a
Hermosillo 77	HR	100.0	44.0	62.0	0	32	3-20	Early	5575 a
Cocoraque 75	HR	99.7	43.6	63.5	0	32	3-18	Early	5517 a
Anza	HR	67.5	40.1	63.0	0	33	4-3	5-27	5415 a
Macozari 76	HW	-	42.1	62.5	0	35	3-31	5-24	5371 a
Zaragoza [2/]	SR	-	40.3	61.5	0	34	4-5	5-27	6116

[1/] Yields followed by the same letter are not significantly different at the .05 level of probability.
[2/] Was not included in yield analysis because of bird damage.

Table 4. Bread wheat experimentals yield test data summary from The University of Arizona Mesa Experiment Farm in 1979. This replicated test was seeded December 1, 1978 at 70 lbs per acre and received 215 lbs N per acre in three applications.

Variety	Class	Hard vitreous (%)	Seed wt. (gms/M kernels)	Test weight (lbs/bu)	Lodging (%)	Height (in)	Heading date	Yield[1/] (lbs/acre)
195-2	HR	98.1	43.8	61.0	0	30	4-2	6561 a
NK S611	HR	100.1	46.8	61.0	0	30	3-27	6143 ab
233-1	HR	96.8	39.8	61.0	0	32	4-6	6137 ab
Probred	HR	99.2	49.2	62.0	0	28	3-23	6136 ab
73-2	HR	96.7	35.5	61.0	0	31	4-8	6077 ab
WPB 25-45	HR	98.0	49.1	61.5	0	30	3-26	6031 bc
NK S1817	HW	-	50.7	64.0	0	28	3-24	5990 bc
Aim	HR	99.7	38.2	63.5	0	39	3-29	5847 bcd
WPB MT-7	HR	98.4	45.0	62.0	0	28	3-26	5753 bcde
Cajeme 71	HR	98.8	50.1	61.5	0	30	3-25	5847 bcde
WPB 27-45	HR	99.6	48.6	61.5	0	30	3-26	5533 cdef
WPB 15-61	HR	99.0	45.9	63.0	0	36	3-25	5417 def
DK 33S	HR	58.9	44.7	61.5	0	34	3-28	5289 ef
DK 49S	HR	100.0	31.4	61.5	0	33	3-24	5024 f
DK 22S	HR	97.1	39.0	62.0	0	37	3-30	4982 f

[1/] Yields followed by the same letter are not significantly different at .05 level of probability.

Table 5. Drought escaping wheat yield test data summary from The University of Arizona, Mesa Experiment Farm in 1979. This replicated test was seeded December 6, 1978 at 15 lbs per acre in a pre-irrigated seedbed with no additional irrigation. Total rainfall was 8 inches.

Entry	Bloom date	Test weight (lbs/bu)	Yield[1/] lbs/acre
Siete Cerros	4-1	60.3	3374 a
MSFRS Sel Pi-Blk 3rd cycle 1978	3-30	60.0	2842 b
Aim	3-28	61.0	2797 bc
Cajeme 71	3-25	59.5	2704 bc
MSFRS Large Seed 3rd cycle 1978	3-30	60.3	2657 bcd
MSFRS Early 2nd cycle 1978	3-25	61.0	2650 bcde
Gabo (Australian - Dryland)	3-26	59.5	2595 bcdef
Pitic 62 (Wide Adaptation)	3-26	56.3	2491 cdef
Arvand (Mid-East Dryland)	3-30	55.8	2370 def
MSFRS Bulk Seed 3rd cycle 1978	3-30	59.9	2316 ef
MSFRS Base - 1 1978	3-30	61.5	2315 ef
Florence Aurore (Mid-East Dryland)	3-29	61.5	2295 f

[1/] Yields followed by the same letter are not significantly different at .05 probability level.

Table 6. Barley variety and selection yield test data summary from The University of Arizona, Mesa Experiment Farm in 1979. This replicated test was seeded November 17, 1978 at 70 lbs per acre and received 215 lbs N in three applications.

Entry	Test weight (lbs/bu)	Lodging (%)	Heading date	Maturity date	Yield[1/] lbs/acre
Kombar	47.0	0	3-28	5-16	7062 a
NK 2505	48.5	0	3-26	5-16	6945 a
NK 4259 (Sunbar Brand 409)	46.5	0	3-28	5-17	6810 ab
76-15-1	51.0	1	3-26	5-13	6603 abc
76-19-8	46.0	67	3-18	5-14	6363 bcd
Kombyne	48.5	11	3-22	5-13	6320 bcd
76-19-7	49.0	67	3-18	5-14	5960 cd
76-19-8-2	48.0	80	3-16	5-14	5887 d
NK 4161 (Sunbar Brand 400)	48.0	9	3-20	5-11	5796 de
Gus	49.0	10	3-27	5-14	5609 de
76-19-7 (Naked)	60.0	83	3-19	5-14	5443 e
76-19-13 (Naked)	60.0	69	3-18	5-14	5385 e
76-19-13	49.0	73	3-17	5-11	5300 ef
Westbar	47.0	65	3-18	5-12	4994 fg
Bold	49.5	88	3-18	5-14	4753 fg
Arivat	46.5	72	3-16	5-9	4387 g

[1/] Yields followed by the same letter are not significantly different at .05 probability level.

Table 7. Small grain clipping study data summary from The University of Arizona Mesa Experiment Farm in 1979. This replicated test was seeded October 19, 1978 at 100 lbs per acre and received 200 lbs N in four applications.

Entry	Average yield in pounds dry material per acre				
	Grain	Rank	Forage[1/]	Rank	Grain & Forage[2/]
Gus barley	6320	(1)	4703	(3)	11,203
Harlan II Barley	5092	(5)	5719	(1)	10,811
1000 D Durum Wheat	5912	(3)	4528	(4)	10,440
Zaragoza Wheat	5945	(2)	4351	(5)	10,296
Aim Wheat	5462	(4)	3646	(7)	9,108
Mesa Oats	3245	(7)	5143	(2)	8,388
Bacum Triticale	4282	(6)	3894	(6)	8,176
Nora Oats	2369	(8)	3243	(8)	5,612

1/Three vegetative clippings at 12-15 inches simulating pasture conditions.
2/Assumption was made that high quality pasture forage dry matter is equal in value to grain. Straw from combine harvest was not included in forage yields.

Table 8. Small grain clipping study data summary from The University of Arizona Mesa Experiment Farm in 1979. This replicated test was seeded October 19, 1978 at 100 lbs per acre and received 175 lbs N in three applications.

Entry	Average yield in pounds dry matter per acre				
	Grain	Rank	Forage[1/]	Rank	Grain & Forage[2/]
Bacum Triticale	4804	(5)	4578	(1)	9,382
1000 D Durum Wheat	5739	(1)	3606	(6)	9,345
Gus Barley	5600	(3)	3650	(5)	9,250
Zaragoza Wheat	5663	(2)	3351	(7)	9,014
Aim Wheat	5273	(4)	3724	(4)	8,997
Harlan II Barley	3243	(6)	4149	(2)	7,392
Mesa Oats	3133	(7)	3958	(3)	7,091
Nora Oats	2668	(8)	1881	(8)	4,555

1/Clipped once as green chop mid-January.
2/Although dry matter value of forage probably does not equal that of grain, for purposes of this summary that assumption was made. Straw from combine harvest was not included in forage yields.

Table 9. Barley variety yield data summary for three planting dates at The University of Arizona Mesa Experiment Farm in 1979.

Entries (in order of maturity)	Planted Nov. 17			Planted Dec. 28			Planted Feb. 3		
	yield		test	yield		test	yield		test
	lbs per A	% of max	weight lbs/bu	lbs per A	% of max	weight lbs/bu	lbs per A	% of max	weight lbs/bu
AC Early Selection	4923	97	48.0	4578	80	51.5	4041	100	47.5
California Mariout	4669	92	49.0	4115	72	49.5	4024	100	47.5
Arivat	4289	84	46.5	4262	75	46.0	3773	93	44.0
Gus	5095	100	48.5	5709	100	48.5	3465	86	45.0
Late varieties (average)	4393	86		4099	72		3543	88	
(Harlan II)	3572		47.0	3386		47.5	3719		46.5
(Sutter)	5247		48.0	4114		47.5	3803		43.0
(Steptoe)	4181		48.0	4797		48.5	3108		46.5