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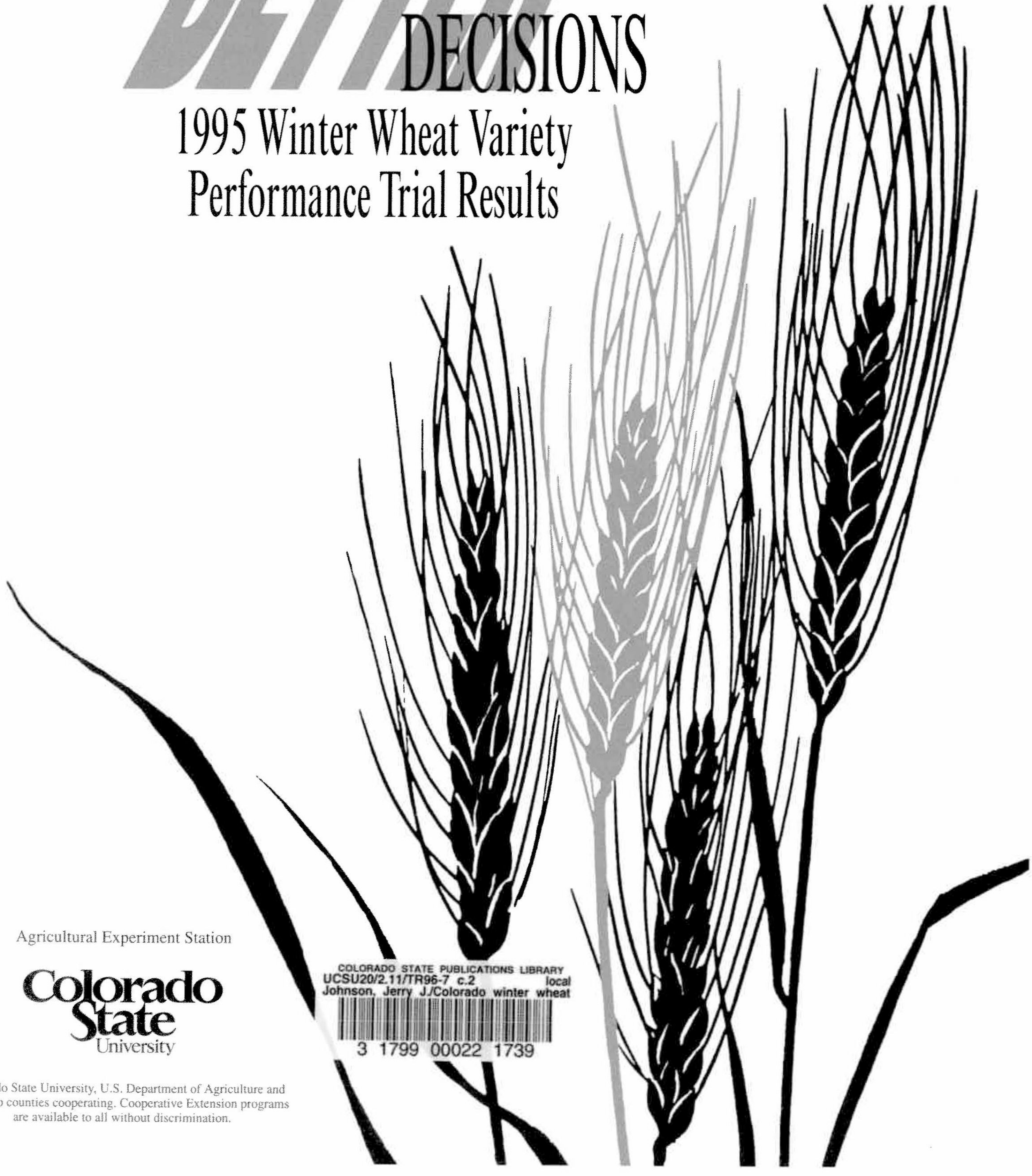
1995 Winter Wheat Variety Performance Trial Results



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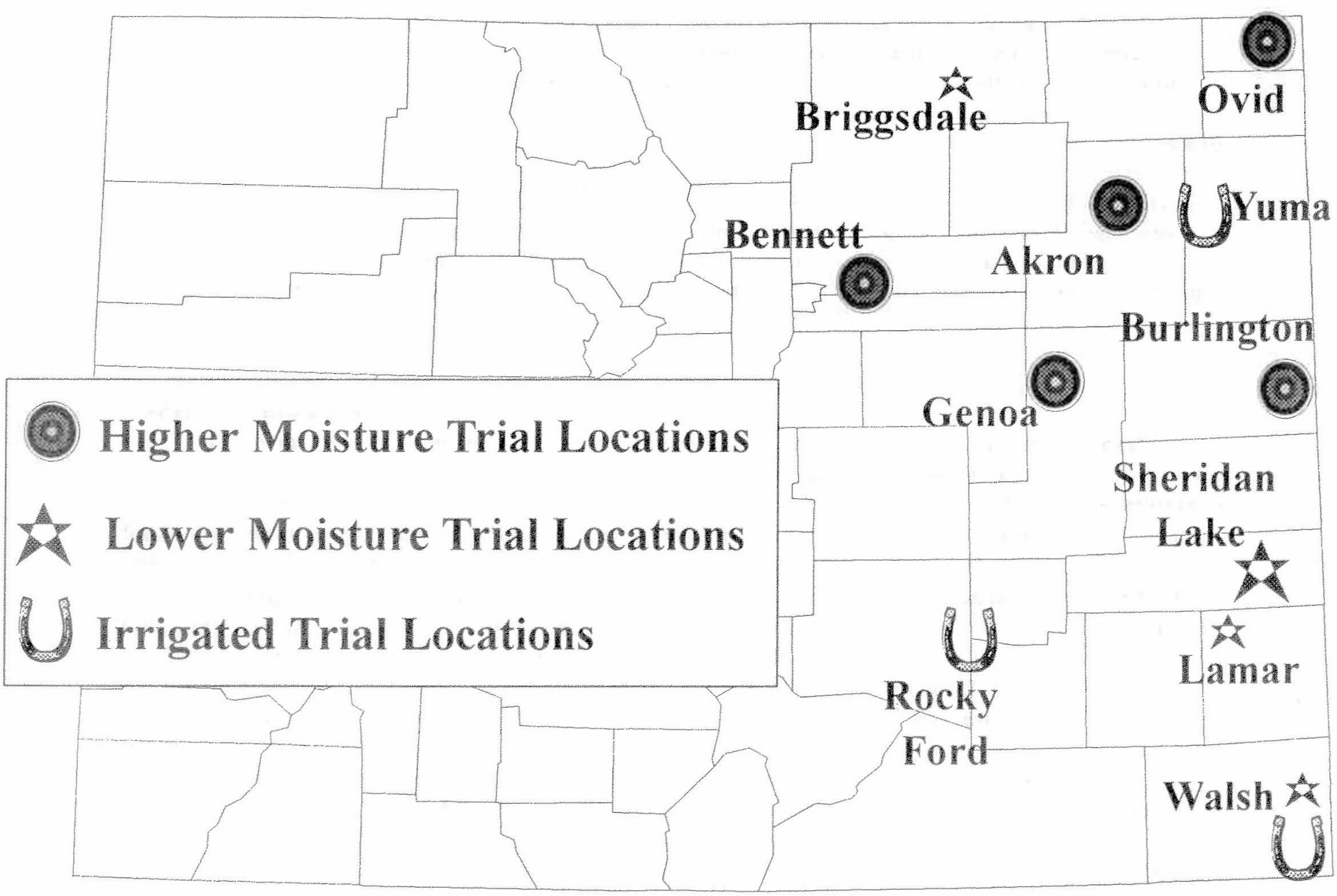
Colorado Winter Wheat Variety Performance Trial Results, 1995



Colorado State University

MAKING BETTER DECISIONS

COLORADO WINTER WHEAT REPORT

1995 VARIETY PERFORMANCE TRIAL RESULTS

J. J. Johnson*, J. S. Quick, and J. F. Shanahan

For Colorado wheat producers, the annual choice of which winter wheat varieties to plant is an important production decision because experience indicates that increases in yield up to 20% or more can result from wise selection of varieties. With wheat prices at record high levels, even small increases in yield can spell the difference between financial success and farm failure and, with seed of most public winter wheat varieties at about equal cost, the producer's variety decision is largely technical.

The theme of this year's wheat report, Making Better Decisions, is founded on the conviction that better use of performance trial results by Colorado wheat producers can lead to better variety selection. We are committed to providing the best information, in an appealing form, and in the most timely manner.

This report is a change in form and content from previous annual wheat variety performance reports. Instead of publishing a hardcopy report in October, we want to provide rapid and widespread access to current trial results to Colorado wheat producers before selection of varieties for fall planting. Variety trial results will be reported as soon after harvest as possible via e-mail to county Cooperative Extension offices and will be put up on DTN (Data Transmission Network) and FarmDayta. Results will also be available on the Soil and Crop Sciences Extension Internet page (http://www.colostate.edu/Depts/SoilCrop/extens.htm), or by FAX to anyone requesting trial results. A hardcopy report like this one will be distributed the following June during the Colorado Wheat Field Days. With contributions from Colorado State University specialists in crop production, breeding, entomology, pathology, irrigation, fertility, marketing, and weed science, the hardcopy report is intended to serve as a wheat production resource, as well as the traditional summary of winter wheat variety performance in eastern Colorado.

Variety Performance Trials

Cooperative Extension and research personnel at Colorado State University annually evaluate winter wheat varieties in eastern Colorado to determine varietal yield and adaptation to Colorado growing conditions. Winter wheat variety trials in Colorado are conducted by moisture group, as **three subsets of locations** with different varieties in each subset except for some varieties that are common to all three subsets. In 1995, **lower moisture** (LM) variety trials were successfully conducted at Lamar, Sheridan Lake, and Briggsdale. Successful **higher moisture** (HM) trials were conducted at Burlington, Bennett, Ovid, and Akron. Two successful **irrigated** (I) winter wheat variety trials were conducted at Yuma and Rocky Ford. A randomized complete block field design with four replicates was used in all trials. Wheat plots were planted and harvested by Colorado State University research personnel with Colorado State University equipment. Grain yields are adjusted to 12% moisture content. Harvest area was approximately 200 sq.ft., consisting of four 12 inch-spaced rows and 50 feet in length. All varieties were seeded at 500,000 seeds/acre for the dryland trials and 600,000 seeds/acre for the irrigated trials. An experiment was also conducted for the second year involving different varieties at three seeding rates (see article by John Shanahan et al., How Much Winter Wheat Seed Should I be Sowing?).

Trials include public, private, and experimental varieties. Testing **Colorado numbered lines** is very important for identification of varieties with wide adaptability to our highly variable growing conditions. Each year, over a million new genetic combinations are created by the wheat breeding team in Fort Collins. After heavy screening, the most promising of these lines are tested throughout eastern Colorado. In 1995, fourteen numbered lines were in their first year of testing, six lines in their second year, three lines were in their third year, and one especially promising line was in it's fourth year of testing.

Table 1. 1995 Variety Performance Trial Information.

Locations	Entries #	Date of Planting 1994	Date of Harvest 1995	Soil Texture	Previous Crop	Fertilization (lbs/A) Nitrogen, N	Phosphorus, P_2O_5	Type of Irrigation
Higher Moisture								
Akron	40	Sept 20	Aug 1	Silt Loam	Fallow	50	0	None
Bennett	40	Sept 20	July 22	Sandy Clay	Fallow	30	0	None
Burlington	40	Sept 13	July 24	Silt Loam	Fallow	75	0	None
Ovid	40	Sept 15	July 26	Silt Loam	Fallow	50	20	None
Lower Moisture								
Briggsdale	40	Sept 22	July 29	Sandy Clay	Fallow	0	0	None
Genoa	40	Sept 21	NA					
Lamar	40	Sept 15	July 10	Silt Loam	Fallow	40	0	None
Sheridan Lake	40	Sept 15	July 17	Silt Loam	Fallow	50	30	None
Walsh	40	Sept 15	NA					
Irrigated								
Rocky Ford	28	Sept 20	July 27	Silty Clay Loam	Fallow	0	0	Furrow
Walsh	28	Sept 19	NA					
Yuma	28	Sept 22	July 28	Sandy Loam	Potato	120	0	Sprinkler

ACKNOWLEDGMENTS

The authors are grateful for the funding received to conduct these trials from Colorado State University, USDA/ARS, Colorado Wheat Administrative Committee, and entry fees from seed companies. The Colorado Wheat Administrative Committee annually provides approximately $75,000 to Colorado State University for wheat research and made a special contribution this year to support the additional costs associated with improving the quality of this report. We are very thankful to John A. Stromberger (Research Associate in the Wheat Breeding program), James P. Hain (Research Associate in the Crops Testing program), Cynthia L. Johnson (Research Associate in the Crops Testing program), Randy Anderson (Central Great Plains Research Station), Frank C. Schweissing (Arkansas Valley Research Center), Kevin Larson (Plainsman Research Center), and Jim Lengel (Yuma Irrigation Research Foundation) for their professional dedication, long hours, and hard work that made these trials and this report possible. We want to recognize valuable assistance provided by the following Cooperative Extension agents (Leonard Pruett and Dick Scott in Prowers County, George Ellicott in Kiowa County, Ron Meyer in Kit Carson County, Gary Lancaster in Sedgwick County, Ron Jepson in Adams County, Jerry Alldredge in Weld County, and Bob Clark in Lincoln County) who work with local producers in all aspects of these trials. We are also thankful for many hours of valuable assistance provided by Thia Walker, Scott Armstrong, and Terri Randolph, who are Research Associates in the Russian Wheat Aphid program led by Frank Peairs, CSU Extension Entomologist. Most importantly, the authors are humbled by the generous cooperation and unselfish contributions of land, labor and equipment made by the following Colorado wheat farmers who consent to having winter wheat variety performance trials conducted on their farms: John Stulp (Lamar, Prowers County), Eugene Splitter (Sheridan Lake, Kiowa County), Barry Hinkhouse (Burlington, Kit Carson County), Jim Carlson (Ovid, Sedgwick County), John Sauter (Bennett, Adams County), Roy Anderson, (Genoa, Lincoln County), and Stan Cass (Briggsdale, Weld County).

Table 2. Winter Wheat Higher Moisture Performance Summary for 1995.

	Location								Averages				
	Akron		Bennett		Burlington		Ovid		1995			2-Yr	3-Yr
Variety*	Yield	Test Wt	Yield	Test Wt	Yield	Test Wt	Yield	Test Wt	Yield	Test Wt	% Yield of TAM 107	1994/95	1993/94/95
	bu/ac	lb/bu	bu/ac	lb/bu	bu/ac	lb/bu	bu/ac	lb/bu	bu/ac	lb/bu		bu/ac	
Jagger	75.4	56.5	39.3	60.7	84.0	51.9	73.4	58.0	68.0	56.8	129	-----	-----
Agripro Ogallala	70.5	58.4	38.5	63.5	79.0	56.3	63.9	59.8	63.0	59.5	120	47.2(4)**	52.0(4)
Vista	71.6	56.6	39.3	61.2	76.0	51.5	59.8	56.6	61.6	56.5	117	48.5(2)	53.7(1)
Arapahoe	76.5	57.9	34.7	61.7	73.0	51.7	59.4	57.6	60.9	57.2	116	47.1(5)	51.8(5)
Quantum 566	69.8	57.0	44.2	62.4	62.9	52.7	63.3	57.5	60.1	57.4	114	49.0(1)	-----
Yuma	70.3	56.7	41.2	60.6	70.1	48.3	58.7	55.7	60.1	55.3	114	48.0(3)	53.0(2)
Agripro Coronado	64.9	58.1	39.9	61.8	71.1	54.4	59.5	57.6	58.9	58.0	112	-----	-----
Alliance	62.4	56.0	41.1	62.1	68.6	53.8	62.3	56.9	58.6	57.2	111	-----	-----
TAM 200	60.6	57.2	36.2	62.2	78.7	50.9	58.0	57.0	58.4	56.8	111	45.2	51.5
Custer	70.9	57.4	36.0	61.7	80.2	53.0	46.1	57.0	58.3	57.3	111	-----	-----
Jules	66.5	53.5	39.4	61.2	64.0	48.5	63.3	53.9	58.3	54.2	111	43.9	50.4
Agripro Longhorn	63.4	57.7	38.4	61.7	72.6	52.9	54.8	57.8	57.3	57.5	109	44.9	50.6
Akron	60.7	55.2	42.4	61.7	60.6	46.6	65.2	57.9	57.2	55.3	109	45.8	52.5(3)
Agripro Hawk	67.1	57.1	37.3	62.0	65.4	50.0	58.7	57.4	57.1	56.6	109	44.8	51.1
Agripro Laredo	62.1	56.8	35.9	62.1	69.3	49.4	58.0	58.4	56.3	56.7	107	45.3	51.4
Arlin	56.6	56.1	35.4	62.1	70.2	53.1	57.3	58.2	54.9	57.4	104	42.2	-----
Halt	59.8	54.1	42.5	60.9	57.1	45.9	59.8	56.1	54.8	54.3	104	43.8	48.9
Vona	60.9	54.9	38.9	61.5	66.0	49.8	52.3	56.9	54.5	55.7	104	44.3	50.6
Ike	61.7	58.3	33.3	62.2	66.1	51.3	56.1	57.8	54.3	57.4	103	44.6	49.2
TAM 107	54.8	55.2	33.6	61.7	70.7	53.8	51.5	58.0	52.6	57.2	100	43.0	49.7
Lamar	56.7	57.7	42.0	62.7	60.7	50.8	48.3	58.4	51.9	57.4	99	41.5	46.6
Karl 92	61.8	57.6	33.0	62.2	58.0	54.2	52.7	58.6	51.4	58.1	98	42.6	-----
Agripro Rio Blanco	53.8	57.0	31.5	62.9	61.8	53.5	50.0	57.3	49.2	57.7	94	39.7	-----
Sandy	56.3	56.0	34.6	61.4	44.8	40.7	46.7	54.7	45.6	53.2	87	38.9	45.6
Scout 66	41.9	55.2	33.9	62.5	42.8	48.3	43.8	58.0	40.6	56.0	77	36.0	42.6
Wichita	33.6	54.1	33.4	63.6	39.8	46.6	42.4	58.7	37.3	55.7	71	33.3	36.7
Means	61.9	56.5	37.5	61.9	65.9	50.7	56.3	57.4	55.4	56.6			

*Varieties ranked by the average yield over four locations in 1995.
**Rank of top five varieties in two- and three- year average yields.

Table 3. Winter Wheat Lower Moisture Performance Summary for 1995.

	Location						Averages				
	Briggsdale		Lamar		Sheridan Lake		1995			2-Yr	3-Yr
Variety*	Yield	Test Wt	Yield	Test Wt	Yield	Test Wt	Yield	Test Wt	% Yield of TAM 107	1994/95	1993/94/95
	bu/ac	lb/bu	bu/ac	lb/bu	bu/ac	lb/bu	bu/ac	lb/bu		bu/ac	
Lamar	24.9	58.5	42.5	55.7	56.1	61.7	41.2	58.6	121	32.8(1)**	32.0(4)
Alliance	27.7	58.6	50.5	56.8	44.0	60.6	40.7	58.6	120	-----	-----
Yuma	26.9	57.7	43.9	54.3	48.7	59.9	39.8	57.3	117	31.8(4)	31.2
Vista	25.8	58.0	45.5	55.2	46.5	60.9	39.3	58.0	116	31.6(5)	-----
Akron	24.6	58.6	49.1	55.5	43.4	60.1	39.0	58.0	115	32.6(2)	32.4(2)
Agripro Hawk	27.6	57.1	44.5	55.6	44.3	60.6	38.8	57.8	114	32.0(3)	32.0(3)
Sandy	24.6	59.8	42.5	54.3	49.0	60.5	38.7	58.2	114	31.5	31.7(5)
Jagger	29.9	57.7	40.4	52.5	42.6	60.2	37.6	56.8	111	-----	-----
TAM 200	22.7	59.7	44.1	53.1	45.0	61.6	37.3	58.1	110	31.5	33.2(1)
Vona	24.2	58.1	43.9	54.4	42.7	60.6	37.0	57.7	109	29.9	30.3
Buckskin	21.3	58.9	40.8	57.5	48.7	60.6	36.9	59.0	109	29.1	-----
Halt	26.3	57.6	37.7	54.8	41.2	59.8	35.0	57.4	103	28.7	-----
TAM 107	19.1	57.4	43.7	54.8	38.8	60.2	33.9	57.5	100	29.2	30.1
Ike	17.3	60.0	45.2	57.8	38.2	61.5	33.6	59.8	99	28.1	-----
Karl 92	20.8	59.8	39.1	55.5	40.4	61.7	33.4	59.0	99	27.5	-----
Baca	16.8	54.7	41.1	56.6	41.6	61.2	33.1	57.5	98	26.7	26.3
Arlin	22.8	59.4	35.8	55.7	36.4	60.6	31.7	58.6	93	27.1	-----
Wichita	19.3	56.0	35.6	53.7	33.3	61.9	29.4	57.2	87	23.4	22.9
KSHW84196	15.8	59.1	36.5	55.9	29.9	60.7	27.4	58.6	81	-----	-----
Means	23.1	58.2	42.2	55.2	42.7	60.8	36.0	58.1			

*Varieties ranked by the average yield over three locations in 1995.
**Rank of top five varieties in two- and three- year average yields.

Table 4. Winter Wheat Irrigated Moisture Performance Summary for 1995.

	Location				Averages				
	Rocky Ford		Yuma		1995			2-Yr	3-Yr
Variety*	Yield	Test Wt	Yield	Test Wt	Yield	Test Wt	% Yield of TAM 107	1994/95	1993/94/95
	bu/ac	lb/bu	bu/ac	lb/bu	bu/ac	lb/bu		bu/ac	
Agripro WX920408	90.8	53.3	70.7	54.8	80.8	54.0	150	-----	-----
Agripro AP 7501	89.4	52.8	60.6	53.6	75.0	53.2	139	-----	-----
Agripro AP 7601	83.0	52.6	56.3	53.8	69.6	53.2	129	-----	-----
Custer	81.3	53.1	46.5	52.8	63.9	53.0	119	-----	-----
Agripro Rowdy	74.8	51.2	45.6	54.7	60.2	52.9	112	-----	-----
Agripro Ogallala	72.0	52.6	47.6	55.6	59.8	54.1	111	59.3(1)**	59.1(2)
Agripro Coronado	65.8	49.5	50.7	53.0	58.2	51.2	108	-----	-----
Yuma	64.2	49.5	51.4	52.2	57.8	50.8	107	57.5(3)	57.5(4)
Halt	66.7	47.6	48.1	51.2	57.4	49.4	106	-----	-----
Karl 92	61.1	52.5	51.5	54.8	56.3	53.6	104	57.9(2)	-----
Agripro Laredo	68.7	54.3	41.7	52.8	55.2	53.5	102	55.1	58.1(3)
TAM 107	64.3	52.4	43.5	53.9	53.9	53.1	100	54.0	56.8(5)
Akron	61.6	50.0	42.9	51.2	52.3	50.6	97	56.4(4)	59.8(1)
Vista	58.9	50.8	44.6	52.1	51.7	51.4	96	55.3(5)	-----
TAM 200	61.0	47.5	34.4	52.2	47.7	49.8	88	52.6	55.5
Agripro Hawk	57.7	48.2	36.0	50.9	46.9	49.6	87	-----	-----
Vona	53.1	47.7	40.1	51.9	46.6	49.8	86	50.5	51.3
Jules	48.5	45.0	38.9	49.3	43.7	47.1	81	45.4	49.3
Means	67.9	50.6	47.3	52.8	57.6	51.7			

*Varieties ranked by the average yield over two locations in 1995.
**Rank of top five varieties in two- and three- year average yields.

Descriptions of varieties in trials

Akron	A 1994 Colorado release from the cross TAM 107/Hail. It is a semidwarf with lax heads.
Alliance	It was developed by Nebraska and the USDA-ARS from the cross Arkan/Colt//Chisholm sib. Alliance is similar to Redland in test weight and protein. It has shown above normal tolerance to crown rot and root rot.
AP7501	New winter wheat hybrid from Agripro.
AP7601	New winter wheat hybrid from Agripro.
Arapahoe	A 1988 Nebraska release. It is similar to Brule, but with higher test weight and one day earlier maturity.
Arlin	A 1992 Kansas release to the American White Wheat Producers Association. It is a hard white winter wheat and is a semidwarf with marginal winter hardiness. It is moderately resistant to Soil Borne Mosaic Virus. Arlin has milling and dough mixing properties similar to Newton and is very sprout susceptible.
Baca	A 1973 Colorado release selected from Scout. Similar to Scout but has a yield advantage in drought stress conditions.
Buckskin	An older, tall Nebraska variety with adaptation to the north central area of Colorado.
Coronado	A 1995 Agripro release and was tested as W91-287.
Custer	A 1994 Oklahoma State release from the cross Chisholm/TAM 105//Romanian line. Medium early and susceptible to Soil Borne Mosaic Virus. It is moderately resistant to leaf rust. It has excellent yield potential, but very questionable quality.
Halt	A 1994 Colorado release resistant to the Russian wheat aphid from the crosses Sumner/CO820026, F1//PI372129, F1/3/TAM 107.
Hawk	A 1981 release from Agripro derived from crosses between Mexican spring wheats and hard winter wheats. Hawk is similar to Vona, but has larger kernels, greater tolerance to leaf rust, and lower late season drought tolerance.
Ike	A 1993 Kansas release, derived from crosses between Colt, Larned, and others. Excellent yields in western Kansas, but susceptible to Wheat Streak Mosaic Virus.
Jagger	A 1994 release that was developed from a cross of a sister-line of Karl by Stephens, a high yielding PNW soft white wheat. It is resistant to Soil Borne Mosaic Virus, spindle streak, tan spot, and speckled leaf blotch. It is moderately resistant to glume blotch, bacterial streak, cephalosporium stripe and wheat streak. It is susceptible to powdery mildew, Hessian fly, greenbugs and Russian wheat aphid. It is a bronze chaffed semidwarf, and with good straw strength. Lower test weights and protein than Karl. Tends to green up early in spring and has marginal winter hardiness.

Jules	A 1993 Colorado semidwarf variety derived from a cross between NE76667 (related to Agate) and Hawk. It is adapted to long season areas of eastern Colorado.
Karl 92	A 1992 Kansas semidwarf release. It is a reselection from 'Karl', similar in most traits, but improved leaf rust resistance, earlier maturity, and higher yielding than Karl.
KS84HW196	A 1986 Kansas release hard white winter wheat. It is similar to Newton in most traits.
Lamar	A 1988 Colorado release derived from a cross of Vona with an experimental line to improve test weight. Drought resistant.
Laredo	A 1992 Agripro release of intermediate height with strong straw, early maturity, and excellent leaf rust resistance.
Longhorn	A 1991 Agripro release derived from NS2630-1/Thunderbird. An awnless wheat with vigorous spring growth.
Ogallala	A 1993 Agripro release.
Quantum 566	A 1994 hybrid wheat release from Hybritech, Inc.
Rio Blanco	A 1989 Agripro hard white winter wheat released by Agripro. Semidwarf height with moderate resistance to sprouting and slightly better winter hardiness than Arlin.
Rowdy	A 1995 Agripro release tested as W91-091.
Sandy	A 1980 Colorado release from crosses between a Mexican semidwarf, Trapper and Centurk. Sandy has excellent stand establishment ability and tolerance to root rot.
Scout 66	A selection from Scout released by Nebraska in 1967. It is resistant to shattering, but some difficulty in threshing.
TAM 107	A 1984 Texas release that has reddish brown chaffed. It is a backcross-derived line from TAM 105. It is similar to TAM 105, but has resistance to stem rust, good winter hardiness, excellent heat tolerance, good emergence ability, good straw strength, and resistance to biotype E greenbug. It has tolerance to some mite vectors, thus reducing Wheat Streak Mosaic Virus infection.
TAM 200	A 1987 Texas release that has white chaffed. It has tolerance to the mite vector of Wheat Streak Mosaic Virus.
Vista	A 1992 Nebraska release derived primarily from Brule and Centurk. Heading time similar to Arapahoe.
Vona	A 1976 Colorado release derived from a cross between Lancer and experimental wheats from Kansas, Colorado and Mexico.
Wichita	A 1944 Kansas release (long-term check variety).
Yuma	A 1991 Colorado release derived from the cross NS14/NS25/2*Vona.

Table 5. Comparison of Winter Wheat Varieties for Seeded Acreage and Agronomic, Pest, and Quality Traits.[1]

Variety	Percent of		Relative					Resistance or Tolerance to				Relative Quality		
	1995[2]	Change from 1994	Ht (in)	Mat	Straw Strgth	Winter Hardy	Coleop length (mm)	Leaf Rust	Stem Rust	Hess. Fly	Wheat Streak Mosaic	Milling	Mixing[3]	Loaf Vol.
Akron	-	-	32	3	2	3	75	1	3	-	6	2	3	2
Arapahoe	0.9	-0.4	39	4	4	2	75	1	1	5	8	2	2	2
Baca	4.7	+0.8	47	2	6	3	120	5	5	-	7	2	3	3
Buckskin	1.5	+0.1	47	4	5	3	120	-	5	-	-	-	-	-
Halt	-	-	30	2	2	3	75	8	1	-	6	2	3	2
Hawk	1.4	-0.9	29	3	4	3	75	7	5	8	6	2	2	3
Jagger	-	-	32	3	2	7	75	1	1	-	-	2	2	2
Jules	-	-	35	4	3	4	75	1	2	-	6	2	2	2
Lamar	5.5	0.0	41	4	4	2	110	7	2	8	6	2	3	2
Laredo	0.7	+0.3	30	3	3	3	80	1	2	-	-	2	2	3
Longhorn	1.2	+1.2	35	3	3	3	110	-	-	-	-	-	-	-
Newton	0.7	-0.2	31	3	4	6	75	7	6	8	6	2	2	2
QT 542	-	-	41	4	4	1	110	7	6	-	-	-	-	-
QT 549	-	-	30	4	3	1	75	5	3	-	-	-	-	-
Rawhide	-	-	32	3	4	3	80	7	2	-	7	2	2	3
Sandy	0.7	-0.5	43	5	5	2	120	3	-	8	-	2	0	4
Scout(s)	3.9	-0.4	47	2	6	3	120	5	5	7	7	2	3	3
TAM 107	63.3	+2.5	31	2	3	3	80	9	1	8	2	2	2	2
TAM 200	2.1	-0.2	27	3	1	8	75	1	1	8	2	3	3	4
Thunderbird	0.7	-0.5	39	3	4	5	110	2	1	8	5	-	-	-
Tomahawk	1.3	-0.2	30	3	2	3	75	3	1	-	7	2	2	2
Turkey	-	-	59	8	9	1	120	8	8	9	7	2	3	2
Vista	-	-	31	3	4	3	70	5	3	5	6	2	3	3
Vona	1.2	-0.5	29	3	3	6	70	7	3	5	8	2	2	2
Wichita	-	-	51	1	8	6	120	5	8	8	-	2	5	4
Yuma	2.7	+0.6	30	3	2	5	70	5	1	-	7	2	2	2

[1]Rated on a scale of 0 to 9; except for maturity (where 0 is earliest and 9 latest), 0 is best and 9 poorest. A dash indicates insufficient data.

[2]Includes most varieties grown on at least 0.5% of acreage for 1995 harvest, based on Colorado Crop & Livestock Reporting Service survey.

[3]A zero rating means exceptionally long mixing time. Varieties with a 0 rating are particularly good for blending with mellow or weak wheats. Mixing time will vary with the environmental conditions under which the varieties are grown.

How Much Winter Wheat Seed Should I be Sowing?

J. F. Shanahan, J. S. Quick, and J. J. Johnson

Past research indicates that optimum seeding density for dryland wheat production in eastern Colorado is about 520,000 seeds per acre, or 40 lb seed/ac for a seed lot containing 13,000 seeds/lb. However, this research was conducted using varieties which are no longer widely grown. We tried to readdress the seeding rate question using varieties in our current variety performance trials.

We used three seeding rates (500000, 600000, and 700000 seeds per acre), and 4 winter wheat varieties (TAM 107, Halt, Yuma, and Lamar), in trials conducted at the nine 1994 and 1995 variety performance trial locations (see map on first page of this report) for a total of 18 location/years of data.

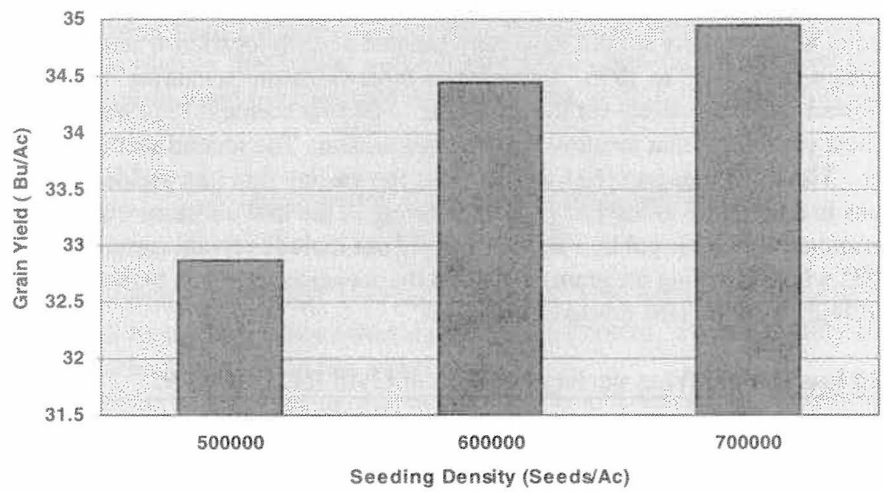


Figure 1 Winter wheat grain yield response to increased seeding density.

Growing conditions were remarkably different in 1994 and 1995. Low moisture conditions characterized the 1994 season and grain yields were low, averaging only 27 bu/ac at the nine trial locations. In 1995, wheat growing conditions were near optimal and yields averaged 42 bu/ac at the nine locations.

Regardless of the large difference in average yields, the seeding rate response was about the same for both years, approximately 2 bu/ac increase in wheat yield from the low to the high seeding density (see Fig. 1). Yield response to increasing seeding density was consistent for all four varieties used in the study. Grain yield response to seeding density appears to be consistent across a wide range of environmental conditions.

The economics of seeding rate response appears favorable. A two-bushel increase in yield, from increasing seeding rate from 500000 to 700000 seeds/ac, should result in a gain of $7/acre and only cost about $1.75 in increased seed cost (about 15 more lb/ac seed). Other benefits from increased seeding rates might include better competition with weeds and perhaps better overwintering stands under difficult conditions.

Making Better Variety Decisions

J. J. Johnson

The 1995 variety performance results indicate that Colorado producers may have lost considerable production by planting 63.3% of winter wheat acreage to TAM 107. In the 1995 low moisture performance trials, Lamar averaged 21% higher yields than TAM 107, and Jagger out yielded TAM 107 by 27% on the average over high moisture locations. Was there any way to have known that TAM 107 would do so poorly by comparison to some other varieties in 1995?

I undertook a study of winter wheat variety performance results from 1992 through 1995, and suspected that I would end up showing that the relatively poor performance by TAM 107 was largely unpredictable-even at our trial locations. It was possible that the 1995 climatic conditions were so abnormal (with all that water!) that it was impossible to have predicted such a poor showing by Colorado's most popular winter wheat variety. I thought however, that I could demonstrate that even if predictability of variety response was low, the information that we do gather in our annual variety trials was economically very important because the winter wheat industry in Colorado is so large i.e., the 1995 Colorado wheat crop was valued at about $420 million. The typical university analysis of variance approach to yield trials, with least significant difference (LSD), is useful for describing past performance, but is a weak technique for prediction. Unfortunately, if predictability for yield is low in actual test locations, then predictability of variety response in farmers' fields (non-test locations) could be expected to be even worse.

In my study I put myself in the shoes of the growers who lend their land for our variety performance trials and tried to predict which variety should have been planted at each location where the small-plot trials had actually been planted from 1993 to 1995. I developed three decision 'scenarios' that might have been used to choose the highest yielding variety for the next year. The first scenario (S1) was to plant the variety that had been the highest yielding at that location the previous season. The second scenario (S2) was to plant TAM 107 every year. The third scenario (S3) was to plant the variety that had yielded the highest, on the average, over locations in a moisture group i.e., highest yielding in the low moisture trials the previous year. I only considered commercially viable public varieties and did not include private varieties nor the numbered CO lines from the CSU wheat breeding program. I applied the scenario approach to the data by location, for example, Julesburg (Ovid) is in the HM group of locations.

Table 6. Yield loss (bu/ac) from variety decision at Ovid (HM) 1993-95.

		Decision Scenario		
		S1	S2	S3
1993	Variety planted fall 1992	Sandy	TAM 107	TAM 107
	Highest yielding variety 1993	Arapahoe	Arapahoe	Arapahoe
	Yield difference or loss 1993	-12.8	-6.9	-6.9
1994	Variety planted fall 1993	Arapahoe	TAM 107	Vista
	Highest yielding variety 1994	Yuma	Yuma	Yuma
	Yield difference or loss 1994	-2.7	-3.5	-1.2
1995	Variety planted fall 1994	Yuma	TAM 107	Yuma
	Highest yielding variety 1995	Akron	Akron	Akron
	Yield difference or loss 1995	-6.5	-13.7	-6.5
Average yield loss over three years		-7.3	-8.0	-4.9

The variety, Sandy, would have been planted in the fall of 1992 by decision scenario, S1, because it was the highest yielding variety at Ovid in 1992. TAM 107 is planted by S2 and it would have been planted by S3 as well because it was the highest yielding variety over high moisture locations in 1992. In 1993, Arapahoe topped Sandy by 12.8 bu/ac, TAM 107 by 6.3 bu/ac, and was planted for S1 at Ovid for the next year. Vista topped the HM location trials in 1993 and would have been planted for S3. Yuma was the highest yielding variety at Ovid in 1994, topping Arapahoe by 2.7 bu/ac, TAM 107 by 3.5 bu/ac, and Vista by 1.2 bu/ac. Yuma was also the highest yielding variety over high moisture locations in 1994 so Yuma would have been planted by S1 and S3 in the fall of 1994. Akron was the highest yielding variety at Ovid in 1995, topping Yuma by 6.5 bu/ac and TAM 107 by 13.7 bu/ac. The average yield losses for each decision scenario are shown at the bottom of Table 6, suggesting that our trial cooperator would have suffered lower yield losses due to variety selection by planting the variety that topped the high moisture trials each year. To assess the repeatability of the Ovid example, the same calculations were made at four other trial locations and summarized in Table 7.

Table 7. Ave. yield losses (bu/ac) from variety decision for 5 locations 1993-95.

	Decision Scenario		
	S1	S2	S3
Akron	-3.0	-9.3	-6.3
Burlington	-9.2	-8.6	-5.9
Bennett	-5.2	-3.6	-1.8
Ovid	-7.3	-8.0	-4.9
Lamar	-3.9	-5.4	-1.5
Average loss	-5.7	-7.0	-4.1

On the average, decision scenario 3 resulted in less yield loss than planting TAM 107 (S2) at every location, and resulted in less yield loss than S1 at four of the five locations. Even though it may not seem like 4.1 bu/ac is much different from 7.0 bu/ac, it has a large potential economic implication for loss of yield due to variety selection. It implies that basing variety selection on moisture group average yields could have resulted in 40% less loss of yield over the past four years than simply planting TAM 107.

Making Better Wheat Marketing Decisions

By D. Hanavan

With U.S. and world wheat stocks at a twenty-year low, U.S. and world wheat production in the 1996-97 marketing year will be the key factor affecting the price of wheat. Price volatility caused by these tight stocks will continue to be a constant in the wheat market.

Insights into historical market period trends may help Colorado producers make better market decisions. Slightly more than twenty-five percent of Colorado's winter wheat production is marketed in July and August, when winter wheat prices are characteristically low. Colorado winter wheat prices averaged only $2.79 per bushel in July during the past ten years, compared to $3.38 per bushel during the highest average month of each year (Table 8). The typical price gain from July to the highest average monthly price was 59 cents per bushel during the ten year period. Forty-nine percent of Colorado's winter wheat production is marketed prior to December, when prices are low, and only thirty percent of the state's production is marketed in the seemingly favorable December-February period.

Based on this history, Colorado wheat producers should make future marketing decisions based upon the cost of holding their production for higher prices. These opportunity costs include storage and lost interest income. Producers should also consider options or futures contracts as a way to manage financial risk.

Table 8. Average wheat prices in Colorado for the period 1985-1995.

Marketing Year	July Average Price/Bu.	Highest Monthly Average Price/Bu.	Price/Bu. Gain	Highest Month
1985-86	2.72	3.01	+.29	April
1986-87	2.09	2.54	+.45	May
1987-88	2.18	3.11	+.93	June
1988-89	3.25	4.08	+.83	April
1989-90	3.73	3.81	+.08	December
1990-91	2.69	2.69	0.00	July
1991-92	2.47	3.88	+1.41	February
1992-93	3.06	3.36	+.30	January
1993-94	2.70	3.58	+.88	January
1994-95	3.02	3.71	+.69	January
10-Year Average	2.79	3.38	+.59	

Breeding RWA Resistant Wheats

J. S. Quick

Since the initial detection of the Russian wheat aphid (*Diuraphis noxia*, Mordvilko) in the Texas Panhandle of the USA in 1986, it has been found in 17 western states of the US and three provinces in western Canada. The economic impact during 1986-1992 in the US has been estimated at more than $850 million. Losses caused by the RWA during 1990-93 were small and variable compared to 1986-1989, but when favorable conditions for the aphid occurred, losses increased dramatically in Colorado in 1994. In the United States, the first significant level of resistance found in wheat was in PI 372129 (Turcikum 57 = T-57) in Colorado.

Cultivar development is proceeding well using the T-57 source. An elite line, CO910927, was released as 'Halt' in August, 1994. Halt is an awned, semidwarf height, white-glumed cultivar which has been most similar to 'Yuma' in appearance at maturity. The spikes are semi-lax, and it is similar in maturity, straw strength, and height to 'TAM 107'. Halt has been similar in grain yield to Yuma and TAM 107 over all eastern Colorado dryland trials in 1994 and 1995. Milling and baking quality have been superior to TAM 107 and equal to 'Lamar'. Halt is the first Russian wheat aphid-resistant cultivar developed in the USA.

At least seven different major genes have been associated with RWA resistance. An understanding of the mechanisms of resistance associated with the major resistance genes, and/or molecular markers associated with them, will be very valuable in developing durable resistance through gene pyramiding and deployment.

Spider Mites in Wheat

F. B. Peairs

The 1996 wheat year was unusual for the many brown wheat mite (BWM) and Banks grass mite (BGM) problems. BWM infestations are normally associated with dry spring weather and usually disappear with the next significant precipitation. BGM mite normally becomes a pest of young wheat when it moves off maturing corn in the Fall.

Brown Wheat Mite

BWM spends the summer in the soil as a white egg that is resistant to hot, dry conditions. In the Fall, as temperature and moisture conditions improve, these eggs start to develop and hatch after 10 days incubation. Females follow in about two weeks. These females lay round, red eggs which give rise to further fall (one or two) and spring (two or three) generations. As summer conditions return, a generation of females is produced that lays only the white over summering egg. Both egg types are placed on soil particles near the base of the wheat plant.

Brown wheat mites feed during the day and spend the night in the soil. Their activity peaks at about mid-afternoon on warm, calm days (the best time to scout). This mite is not affected by cold temperatures, but populations are quickly reduced by driving rains of 1/3" or more.

Banks Grass Mite

Fertilized female BGM move into winter wheat in the Fall as their summer hosts, especially field corn but also other grasses, begin to dry down. These overwintering forms are bright orange in color. With the onset of winter conditions the mites move to the crowns of the wheat plant where they will feed until Spring. In the Spring small pearly white eggs are laid which eventually give rise to pale to bright green male and female adults. There will be continuous generations of mites on wheat and summer hosts until the return to winter wheat in the following Fall. Banks grass mites produce heavy webbing to protect colonies consisting of eggs, immatures and adults. Damaged leaves first become yellow and then brown and necrotic. Heavy populations can kill small plants and reduce kernel size in larger plants.

Treatment Decisions and Recommendations

Because BWM problems are so sporadic, chemical control is the only effective management practice. The BWM treatment thresholds are not well defined. One rule of thumb is to treat if there are more than 200 mites per row foot in the early spring. A more conservative rule is to treat if BWM average more than 10 -15 per leaf. Remember that the best time to get an accurate count is during a warm, calm afternoon. The decision to treat is difficult because BWM is associated with drought stress. If it rains, mite levels will be significantly reduced regardless of the use of insecticides, while if it does not rain crop yield may be so reduced by drought that the crop may not be worth treating. Also, if white eggs are present and red eggs are mostly hatched, the population is in natural decline and treatment is not economically justifiable.

Banks grass mite most commonly damages Colorado wheat in the Fall in areas near maturing field corn. Insecticide applications to the field margin(s) bordering corn are often all that is necessary to prevent economic damage. Little is known about spring infestations since they are not common in our state.

- **BWM alone or with BGM** - Use dimethoate (several formulations are available) at labeled rates. Other products are labeled for this use, but dimethoate was used in most cases this year, with satisfactory results.
- **BWM with Russian wheat aphid** - Use Lorsban 4E-SG or Lorsban 4E-SG in combination with dimethoate. Lorsban 4E-SG has enough BWM activity to be effective in most cases.
- **BWM and BGM with Russian wheat aphid** - Use Lorsban 4E-SG in combination with dimethoate. We do not know how effective Lorsban is against BGM in wheat.
- **BWM and/or BGM with cutworms** - Use Warrior in combination with dimethoate. We do not know how effective Warrior is against mites in wheat.
- **BGM in the Fall** - Use the low rate of dimethoate. In many cases you will need to treat only the field edges.
    - **Use at least 2 gallons per acre**, especially if BGM is present in the Spring.
    - **Use a surfactant.**
    - **Buffer the spray solution**, especially if using dimethoate.
    - **Treat when several hours of temperatures above 50°F are expected**, especially if using dimethoate.

Weed Management in Winter Wheat

P. Westra and T. D'Amato

Kochia can grow taller than wheat and can easily reduce wheat yields by 30-40%. More marked losses can be expected in years of poor wheat stands, in fields with winter-kill problems, or in areas with thin wheat stands. Timely applications of dicamba, bromoxynil, or sulfonylurea herbicides can control many weeds, particularly kochia. Sulfonylurea (SU) herbicide resistant kochia can be managed by addition of a non-SU herbicide to the spray tank. **Winter annual mustards,** such as blue mustard, flixweed, or tansy mustard, germinate in the fall and cause serious wheat yield losses if left unchecked. Most sulfonylurea herbicides such as Ally, Amber, and Finness provide excellent control of mustard weeds. **Jointed goatgrass,** even at densities as low as 1-5 plants per square yard, jointed goatgrass can reduce wheat yields by 5-20%. A single jointed goatgrass plant can produce over 500 seeds a season and can quickly cost wheat producers $15-50/acre. Prevent spread of jointed goatgrass by planting certified wheat seed, or seed that has been carefully cleaned to remove jointed goatgrass cylinders. Small patches of jointed goatgrass should be mowed or sprayed with a systemic herbicide such as glyphosate prior to seed head emergence. There currently are no selective herbicide treatments that effectively control winter annual grasses, such as **downy brome and volunteer rye**, in wheat. One year of fallow is insufficient to effectively manage winter annual grasses in a wheat/fallow rotation. A three or four year rotation, which significantly reduces the soil weed seed bank, is the best management of severe winter annual infestations.

Expanded Karnal Bunt Survey to Take Place in Colorado

W. M. Brown

Karnal bunt is a smut fungus disease of wheat. It is not harmful to humans or animals but attacks the wheat grains and turns them to masses of smelly, microscopic black powdery spores. The spores are seed borne but once introduced into a field can survive in the soil up to 5 years. Karnal bunt is generally considered to be a much more important problem in bread wheats, and as such, could pose a significant problem for Colorado hard red winter wheat areas and the spring wheat area in the San Luis Valley. While the fungus can cause losses in yields and quality, these are frequently minor.

After a confirmed find of Karnal bunt (*Tilletia indica*) in Arizona, on March 11, 1996 the USDA Animal Plant Health Inspection Service (APHIS) stopped all wheat grain and seed exports to 21 countries- countries listing Karnal bunt in their quarantine laws.

Several of the countries have agreed to accept US wheat on condition that comprehensive surveys are undertaken to show that an area is Karnal bunt free. Past CSU surveys have shown no Karnal bunt, flag smut or other diseases of quarantine significance to be present in Colorado but the surveys were limited to field examinations only. An additional sampling and laboratory examination of harvested grain will now be required. CSU, APHIS, and the Colorado Department of Agriculture (CDA) will conduct these surveys beginning in June, 1996.

Fertilizer Requirements of Dryland Winter Wheat

P. N. Soltanpour and J.G. Davis

Our soils are well supplied with all nutrients for wheat growth, with the exception of nitrogen (N) and phosphorus (P). To determine how much N and P to apply, we need to take representative soil samples and test them for available N and P. We recommend at least 20 cores to a depth of one foot for a uniform field with the same management system. The 20 cores should be mixed thoroughly and about one pint of soil saved for analysis of nitrate and organic matter. Soil samples should be air dried on a clean sheet of paper as soon as possible. For phosphorus, follow the same procedure as described above if the laboratory uses the ammonium bicarbonate-DTPA soil test, but change the depth of samples to 4-6 inches if the laboratory uses sodium bicarbonate or other soil tests with large extracting solution-to-soil ratios.

We recommend fall application of fertilizers under our conditions. However, for sandy soils, spring application of N may be more efficient. If you apply N in the spring, apply it before yield potential has been set (before jointing stage). All N sources are equally effective if properly handled. However, fertilizers containing or producing ammonium such as urea-ammonium nitrate, ammonium sulfate, ammonium nitrate, and urea should be incorporated into the soil right after application or else N will volatilize in the form of ammonia gas and your hard-earned dollars are converted to air pollution instead of bushels of wheat. For P, the best method of application is to apply it when seeding with the drill. The amount depends on the soil test level. Use liquid 10-34-0 with a maximum rate of 40 lbs of phosphate (P_2O_5) per acre. If you use anhydrous ammonia (AA), a dual application of AA with liquid 10-34-0 is another good option.

In summary, soil test, do not guess, and give as much pertinent information as available for a good fertilizer recommendation.

Winter Wheat Irrigation
G. E. Cardon

Wheat yields can be increased 5 to 8 fold that of dryland yields by irrigation. However, irrigation management is critical to provide the benefits of increased yield without the detrimental effects of excessive deep percolation or runoff which can negatively impact ground and surface waters. Irrigation scheduling, meeting water requirements in a timely and efficient manner, can be difficult and requires knowledge of the soil water holding capacity, the infiltration rate, the stage of growth, the rooting depth at the growth stage, and the amount of water necessary at each stage of growth.

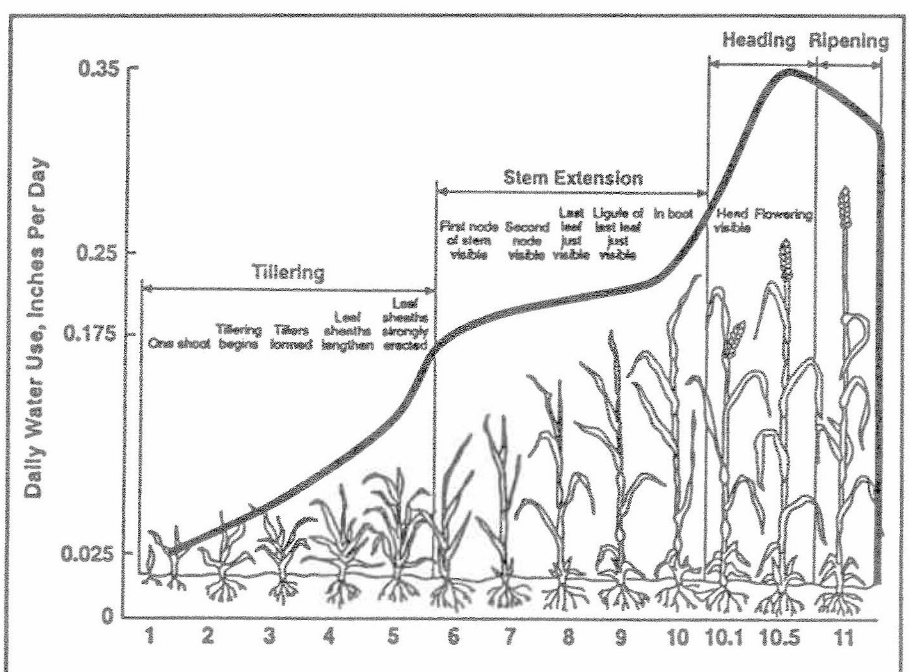
Figure 1 illustrates typical values for the uptake of water by wheat at various growth stages. Water stress before the grain begins to dry down can cause yield reductions. In particular, water stress is most damaging from boot stage to flowering.

In order to schedule irrigations properly one must know the amount of water that is available to the crop at any time. This is done by knowing the available water holding capacity (inches water per inch soil depth) and the rootzone depth at anytime. A simple equation to determine the amount of water available to the crop when the rootzone is fully wetted is:

Depth of available water = Depth of rootzone x Available water holding capacity

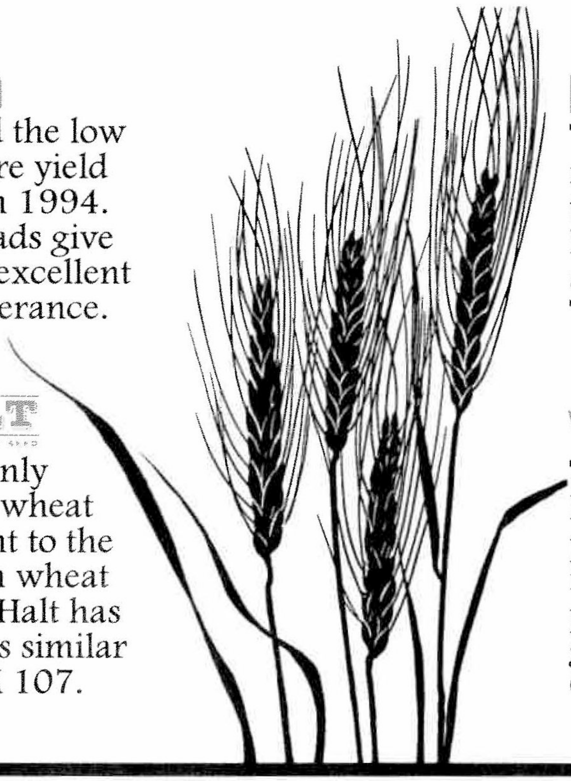
Available water holding capacity is used here as the difference between field capacity and permanent wilting point. The value for your soil can be obtained from the Soil Survey of your area. The next step is to continually "debit" this stored water "account" according to the estimate of daily water use for the appropriate stage of growth. Irrigation water should be applied before 50% of the depth of available water is depleted. As an extra precaution against yield-reducing stress, a value of 40% depletion should be used during the critical growth stages mentioned previously. Irrigation is required even though there is still some "available" water left in the rootzone because more and more energy must be expended by the crop to obtain the water as the soil dries and this energy expenditure occurs at the sacrifice of yield when the soil water level drops below 50% available water.

Water should then be applied only in an amount equal to that used by the crop within the rootzone. Over-irrigation is receiving more and more public attention as pesticides and fertilizers (especially nitrates) have begun to appear in groundwater. Also, make set times correspond to the intake rate of your soil and apply water only as long as it takes for the amount of water needed to infiltrate into the soil.



Source: Dan Rogers, Kansas State University
Extension Agricultural Engineering

Colorado Winter Wheat Varieties for Colorado Conditions



Akron

Topped the low moisture yield trials in 1994. Lax heads give Akron excellent hail tolerance.

PLANT HALT CERTIFIED WHEAT SEED

Is the only winter wheat resistant to the Russian wheat aphid. Halt has features similar to TAM 107.

Lamar

Topped the low moisture yield trials in 1995. Lamar has more straw than TAM 107.

Yuma

Topped the high moisture performance trials in 1994. Yuma's popularity is growing in Colorado.

Jerry Johnson

Jerry Johnson, Extension Specialist Crop Production

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