IMPROVING WHEAT VARIETIES FOR NEBRASKA

1993 STATE BREEDING AND QUALITY EVALUATION REPORT

Report to the

NEBRASKA WHEAT DEVELOPMENT, UTILIZATION AND MARKETING BOARD

P. S. Baenziger, B. Moreno-Sevilla, D. R. Shelton, and D. D. Baltensperger

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I. INTRODUCTION

Wheat variety development research in Nebraska is cooperative between the Agricultural Research Division, IANR of the University of Nebraska-Lincoln, and the Agricultural Research Service/USDA, Northern Plains Area. Winter wheat breeding, which includes variety, line and germplasm development, is a major component of the state wheat improvement research. This report will deal only with the state portion of the total wheat breeding effort. The basic project is located in the Department of Agronomy at the University of Nebraska-Lincoln. Very important contributions come from state and federal researchers in the department and at the Nebraska research and extension centers, from researchers in the Department of Plant Pathology (both state and federal), from plant pathologists located at the USDA Cereal Rust Laboratory, St. Paul, Minnesota, and USDA entomologists at Manhattan, Kansas. All of these invest time and funds in this program. Grants from the Nebraska Wheat Development, Utilization and Marketing Board provide key financial support for this research. Without the Wheat Board's Support, much of the state breeding efforts would be curtailed and many of the wheat quality analyses to evaluate our breeding material would not be available.

II. THE 1993 NEBRASKA WHEAT CROP

1. Growing Conditions

As seems common in recent years, the state wheat crop was highly variable with production estimated at 73.5 million bushels harvested from 2.1 million acres and with a state average yield of 35 bushels per acre. This represents a below average crop, but very much better than the 1992 crop which was 55.5 million bushels harvested from 1.85 million acres and with a state average of 30 bushels per acre. The major factors affecting the wheat crop in 1993 were 1. a cooler than normal growing season, 2. above average rainfall throughout most of the state leading to higher foliar disease incidence than normal in eastern Nebraska and some field abandonment due to scab, 3. a higher than normal incidence of wheat streak mosaic virus in western Nebraska, and 4. a higher than normal incidence of barley yellow dwarf mosaic virus in eastern Nebraska. The cooler growing season and higher than normal rainfall were beneficial in western Nebraska to reduce the effects of wheat streak mosaic virus and increase yield as water is usually the most limiting factor for wheat production.

The extremely variable environmental and disease conditions allowed different wheat varieties to perform well in different areas. In southeastern and southcentral Nebraska, disease resistant varieties like Arapahoe and 2163 performed well. In the southwestern district Karl 92 and Redland performed well. While in the Panhandle, TAM107, Jules, and Vista performed well. There are large differences among these lines for their maturity and disease resistance, hence it appears that each district had distinct characters that were advantageous. As was the case in 1992, many wheats with previously good performance and with previously poor performance did not perform as they had in the past which makes variety recommendations and experimental line selection difficult.

2. Diseases

Foliar diseases are highly dependent on moisture for their development and spread. Leaf rust and scab were prevalent mainly in eastern Nebraska. The races of leaf rust may have changed or the genes for resistance been impacted by the cool weather (some genes for resistance are temperature sensitive) in that more leaf rust was prevalent on Karl than seen in previous years. The leaf rust resistance (Lr3 and Lr16) found in Arapahoe, Redland, and Vista continues to be effective in Nebraska though the genes are becoming more widely used in Texas and already reports of new races affecting them are being made from the southern Great Plains. Barley yellow dwarf virus was also prevalent in eastern Nebraska. Unfortunately there is little effective resistance to barley yellow dwarf virus in wheat. Stem rust was also

present in some fields in eastern Nebraska, but probably did not reduce yield. All of the recent Nebraska releases are resistant to this stem rust. However, the stem rust resistance (Sr36) in Vista will tend to breakdown late in the season and in some late maturing fields, more stem rust was found than expected. In western Nebraska, the main disease was wheat streak mosaic virus. Redland remains a wheat with above average tolerance, though still susceptible. The new release, Vista, appears to have some tolerance, but will need further field confirmation. In general, leaf blotch diseases were absent. All of these diseases can be extremely destructive under the appropriate conditions and will continue to need close monitoring.

3. Insects

In general, most insects pests were at low levels on wheat in 1993. Russian wheat aphid caused losses in some fields. Russian Wheat Aphid would be considered the main insect pest of wheat in 1993, but was less important than during the serious infestation of 1990. Cinch bugs, generally assumed to have relatively little effect on wheat but severely damaging on sorghum, were present at low levels in southeast Nebraska. Wheat curl mite, the vector for wheat streak mosaic virus, and aphids, the vectors for barley yellow dwarf virus were important insects pest because they carried devastating diseases.

4. Wheat Production

The wheat production for Nebraska is 73,500,000 bushels from 2,100,000 harvested acres. The average yield was 35 bushels/acre. The poorest crop in last five years was the 1989 crop when the wheat yield for Nebraska was 27 bu/a from 2,050,000 acres for a total production of 55,350,000 bushels.

Planted and harvested acres increased as a result of farm programs. Quality determinations by Doty Laboratories Inc. were as follows:

1993 DATA:

Nebraska	1993 Wheat Protein Content (12% moisture basis) %	Five Year Average Wheat Protein Content (12% moisture basis) %
Northeast	12.0	12.3
Southeast	12.1	12.8
Northcentral	12.1	12.7
Southwest	11.8	12.9
Panhandle	11.8	12.3

Quality standards are being impacted by no-time baking methods and high speed mixers. These procedures require stronger gluten proteins (longer dough mixing times and tolerances). Drought and heat stress can reduce mixing time and tolerance which may have reduced the quality of the crop. Of the quality characteristics that growers are paid for, test weight was the most significant trait adversely affected by diseases, drought, frost, or cool growing conditions.

5. Cultivar Distribution

A variety survey was done in 1993, however, no variety survey was done in 1992 so that year is missing. Arapahoe has been quickly accepted by the growers and became the most widely grown variety (28.6% of the state) in 1993. To put Arapahoe's acceptance in perspective, it was grown on more acres than varieties developed by other states and by commercial

seed companies combined in Nebraska. Thunderbird was the second most widely grown variety followed by Redland (a selection from Brule) and Brule, Centura and Siouxland. The acreage of Siouxland and TAM wheats continued to drop which will improve the reputation of Nebraska as a provider of quality wheat grain. While no wheat listed below has all of the characteristics of an ideal wheat, the diverse wheats provide the grower an opportunity to choose high yielding, high quality wheats that have resistance or tolerance to the diseases or insects prevalent in his or her region.

NEBRASKA--WHEAT VARIETIES
ESTIMATED PERCENTAGES PLANTED TO EACH VARIETY, 1987-1993

Percent

Variety	1987	1988	1989	1990	1991	1993
Brule	22.5	17.1	12.0	9.4	5.4	3.1
Siouxland	17.0	21.3	20.5	18.7	14.5	8.2
Centura	14.3	11.9	12.4	9.6	10.4	8.5
Centurk & Centurk 78	12.4	9.8	4.6	4.4	3.3	1.6
Agripro Thunderbird	0.7	4.0	7.2	10.7	12.8	12.4
Redland	---	4.0	10.0	15.2	14.9	7.9
Cody	---	1.2	2.9	2.4	1.8	---
Buckskin	3.8	2.8	2.2	1.9	2.2	4.7
Scout & Scout 66	3.5	2.7	2.6	2.2	2.4	2.8
AgriPro Hawk	3.4	3.9	2.9	4.4	1.5	---
AgriPro Rocky	1.7	1.1	---	---	---	---
Agripro Abilene	---	---	1.0	5.5	6.3	6.2
All TAM wheats	1.1	1.0	3.8	6.0	8.0	3.4
Arapahoe	---	---	---	1.8	8.5	28.6
Rawhide	---	---	---	---	---	2.1
Karl	---	---	---	---	---	2.1
Agripro Victory	---	---	---	---	1.7	1.3
Other Public Varieties	3.9	4.6	4.3	4.0	4.3	4.2
Other Private Varieties	5.8	6.7	6.0	3.1	2.0	1.9

6. New Cultivars

Alliance (P. I. 573096, also known as NE88595) was released to certified wheat producers in 1993 and is currently going through the formal release channels. The releasing agencies are the Nebraska Agricultural Experiment Station, the South Dakota Agricultural Experiment Station, and the Northern Plains Area, Agricultural Research Service, U. S. Department of Agriculture. Alliance was developed cooperatively by the Nebraska Agricultural Experiment Station and the Northern Plains Area, Agricultural Research Service, U. S. Department of Agriculture. The name was chosen to honor the 40th anniversary of the founding of the Nebraska Wheat Board; the support of Nebraska Wheat Growers' Association, Nebraska Crop Improvement Association, and the Nebraska Foundation Seed Division; and the interdisciplinary and interstate cooperative research efforts needed to develop this cultivar.

Alliance is an increase of a hard red winter wheat F_3-derived line from the cross Arkan/Colt//Chisholm sib which was made in 1982 by Dr. J. W. Schmidt. Alliance was identified as a line in 1988 and tested as NE88595 in Nebraska yield nurseries starting in 1989, and in the Southern Regional Performance Nursery starting in 1991 and the Northern Regional Performance Nursery in 1993. The current breeder seed originated from a purification program in 1991-1992 and 1992-1993 designed to remove off-types by roguing.

Alliance is a white chaff, awned, semidwarf wheat with medium maturity. In Nebraska, it is 1.5 days later than TAM107 and 1.5 days earlier than Arapahoe and Redland. It is similar in plant height to Arapahoe and Redland, taller than Vista, and has moderate straw strength.

The straw strength of Alliance is less than Redland, Siouxland, TAM107, Abilene, and Thunderbird. Alliance has exhibited moderate resistance to stem rust (contains Sr17 which is no longer effective and other genes which are effective). In field tests by the USDA Cereal Rust Laboratory, the adult plant reaction of Alliance to stem rust is less infection than TAM 107 which is adequate for Nebraska conditions. Alliance has a heterogeneous reaction to the Great Plains Biotype of Hessian fly which may indicate it contains the Marquillo-Kawvale gene for resistance or is heterogeneous for H3 from Arkan. Alliance is susceptible to leaf rust and soilborne mosaic virus. Its reaction to wheat streak mosaic virus needs further testing, however, in the greenhouse it appears to be less susceptible than many Nebraska released cultivars, similar to Redland, and less tolerant than Vista. When crown rotting diseases are present, Alliance appears to have more tolerance than the majority of Nebraska cultivars. The winterhardiness of Alliance is similar to Scout 66, superior to Vona, TAM 200, and Rawhide, and adequate for Nebraska growing conditions. Alliance is a genetically lower test weight wheat, superior to Redland and similar to Arapahoe.

The recommended growing area for Alliance, based on current information, is the dryland wheat production areas of the Panhandle of Nebraska. Using data from the Nebraska Fall Sown Cereal Variety Trials from 1992 and 1993 (22 location-years), Alliance is 8% higher yielding than Arapahoe and TAM107, and 4% higher yielding than Redland and Vista. In the Panhandle (7 location-years), Alliance is 3% higher yielding than Vista, 4% higher yielding than TAM107, 12% higher yielding than Redland, and 14% higher yielding than Arapahoe. Similar results were obtained from the Nebraska Intrastate Nursery grown from 1990 to 1993 (18 location-years). Alliance was 5%, 8%, 8%, and 19% higher yielding than Redland, Vista, Arapahoe, and TAM107 respectively. In the Southern Regional Performance Nursery (53 location-years), Alliance was 4% lower yielding than TAM107. However, in the northern high plains cluster of locations which includes the Nebraska Panhandle, NE88585 was 8% higher yielding than TAM107 (8 location years). Alliance has a short coleoptile similar to Vista, Abilene, and TAM 200, hence care should be taken for planting it too deep in dry years. For dryland wheat production, Alliance may be used as a replacement cultivar for Abilene, Colt, TAM 107, and TAM 200. As Colt is one of the parents of Alliance, Alliance and Colt should be considered genetically similar.

The milling and baking properties of Alliance were determined using five years of testing by the Nebraska Wheat Quality Laboratory with Arapahoe and Scout 66 as check cultivars. The average wheat and flour protein content of Alliance is lower than Arapahoe and similar to Scout 66. The dough mixing properties were similar to Arapahoe and stronger than Scout 66. While the baking absorption of Alliance was less than Arapahoe and Scout 66, average loaf volumes were greater than the two check cultivars. The external appearance and internal attributes of the baked bread loaf indicated generally acceptable quality characteristics.

The Nebraska Foundation Seed Division, Department of Agronomy, University of Nebraska-Lincoln, Lincoln, NE 68583 will have foundation seed available to qualified certified seed producers in 1993. The U.S. Department of Agriculture will not have seed for distribution. The seed classes will be breeder, foundation, registered, and certified. Alliance will be submitted for registration and plant variety protection under P. L. 910577 with the certification option.

In addition, the Nebraska Agriculture Experiment Station has recommended co-release of 'Ike' (formerly KS89H48-1) which was developed primarily by Dr. Joe Martin, Kansas State University at Hays, Kansas. Ike is a high yielding, good test weight, high quality hard red winter wheat with good disease resistance that has performed well in Nebraska, particularly southwestern Nebraska.

'Vista' which was released in 1992 had a good first year with generally good production in certified fields. Surprisingly no adverse comments were heard concerning the variety.

III. FIELD RESEARCH

1. Increase of New Experimental Lines

Three experimental wheats were advanced to large scale increase. They are NE89522

(TAM105*4/Amigo//Brule), NE89526 (Lancota sel/Siouxland//TAM103/KS73167), and N87V106 (Centurk/3/Atlas66/Comanche //TX2607-6). N87V106 was developed primarily by the USDA-ARS as part of their high protein wheat improvement efforts and will be discussed in their report. In addition, seed of NE88427 (TAM107/Bennett) which was increased in 1993 was saved for possible release in 1994.

NE89522 is a moderately early semidwarf wheat that is similar in height to Arapahoe and Redland. It is susceptible to leaf rust, Hessian fly, and soil borne mosaic virus. In greenhouse tests, it appears to slightly less tolerant to wheat streak mosaic virus than Redland. It is heterogeneous for the Amigo translocation (1A/1R) which is reported to convey a non-preference for wheat curl mite, the vector of wheat streak mosaic virus. Hence in the field, the line may have both some tolerance to the virus and non-preference to the virus vector. NE89522 is moderately resistance to stem rust (contains genes Sr6 and is heterogeneous for the Amigo gene). NE89522 has adequate test weight characteristics (less than Scout 66, similar to Arapahoe, and superior to Redland). The straw strength is adequate (superior to Arapahoe, but less than Redland). The milling and baking quality of NE89522 would be considered as adequate. The recommended growing region needs further refinement but is probably northern Nebraska and the panhandle where its winterhardiness, tolerance for cooler weather, and disease resistance are most effective.

NE89526 is a medium height semi-dwarf wheat (slightly taller than Vista and similar to TAM107). It is moderately resistant to leaf rust (contains genes Lr3 and Lr16, the same genes in Redland, Vista, and Arapahoe) and stem rust (contains gene Sr17 which is no longer effective and Sr24 which is effective). It exhibits the heterogeneous reaction to Hessian fly which may indicate it has the Marquillo-Kawvale resistance that is common in many Nebraska wheats. NE89526 is susceptible to wheat steak mosaic virus and soil borne mosaic virus. NE89526 has good test weight characteristics (similar to Centura and superior to Arapahoe and Redland). Straw strength is very good (similar to Redland, superior to Arapahoe and Vista). The milling and baking quality of NE89526 are good (similar to slightly better than Arapahoe). The recommended growing region for NE89526 needs further refinement, however it appears to do well in southern Nebraska where its straw strength and disease resistances are advantageous.

NE88427 is a medium height semi-dwarf wheat (slightly taller than Vista and similar to TAM107) with a intermediate coleoptile (longer than TAM107). It is susceptible to leaf rust, and soilborne and wheat streak mosaic viruses, and Hessian fly. It is moderately resistant to stem rust (contains genes Sr6 and is heterogeneous for the Amigo gene). NE88427 has good test weight characteristics (similar to Siouxland, and superior to Redland and Arapahoe) and winterhardiness. Straw strength is adequate (superior to Vista). The recommended growing region for NE88427 needs further refinement, however it appears to do well in most parts of Nebraska in the absence of leaf rust. The end-use quality of NE88427 is adequate, most similar to Scout 66 for protein and ash content, gluten strength as determined by the mixograph, and loaf characteristics.

The following lines are under small scale increase with earliest possible release in 1995: NE88584 (Centura/Dawn//Colt sib) which is a tall wheat for western Nebraska, NE90476 (Bennett/Brule 83 Composite), and NE90524 (Brule seln/4/Bez 1/3/Ctk//Arthur//Ctk 78).

With the release of new varieties Alliance, Vista, Rawhide, Arapahoe, and co-release of Ike and TAM 200, many of the most advanced current breeding lines are not expected to be released.

2. Nebraska Variety Testing

Thirty-nine entries were included in some or all of the locations in the Fall Sown Small Grain Variety Tests in 1993. Due to various inclement weather conditions, 13 dryland and no irrigated or ecofallow nurseries were harvested for yield data. The top ten lines for dryland production were:

Entry	Av. Yield bu/a	Entry	Av. Yield bu/a
NE89522	58.8	Arapahoe	55.1
Alliance	57.3	TAM107	55.1
NE88427	55.9	Karl 92	54.6
Redland	55.8	NE89526	54.3
Vista	55.6	TAM200	54.2

In 1992 the top ten lines for dryland production were:

Entry	Av. Yield bu/a	Entry	Av. Yield bu/a
NE88595	49.25	Arapahoe	43.15
NE88427	48.18	NE87612	42.75
Vista	47.55	TAM107	42.63
Redland	45.97	NE83404	42.44
N87V106	44.24	Yuma	42.31

Turkey had the lowest yield in 1993 (36.4 bu/a) and in 1992. Hybrids continue to do well in these tests, but may not be economical for many growers. Not all lines were tested in all locations, hence other high yielding lines may be overlooked when using state averages.

3. Irrigated Wheat Trials

The irrigated wheat nursery at Sidney was lost to hail. This trial is planted at Sidney in cooperation with Dr. D. Baltensperger. The Sidney irrigated trial attempts to simulate the majority of irrigated wheat planting conditions: planted late as would be the case after a summer crop harvest. The results from 1992 and 1991 are:

1992 Results at Sidney		1991 Results at Sidney	
NE88427	42 bu/a	Vista	62 bu/a
Vista	39	Arapahoe	61
TAM200	38	2163	59
Arapahoe	37	KS87H6	59
Agripro Sierra	37	NE83407	58
Hybrid F2#2	36	Newcale	57
Redland	36	Tomahawk	57

Efforts continue to identify lines that may have potential under irrigation, but not necessarily under dryland conditions.

4. Nebraska Intrastate Nursery

The Nebraska Intrastate Nursery (NIN) was seeded at eight locations (Mead is a single replicate for winterhardiness notes and Beatrice is a single replication for observation) and five locations were harvested. The nurseries at Mead and Beatrice (due to too much rain at harvest) and Sidney (due to hail) were abandoned. Lincoln and Clay Center also suffered from excessive rainfall at harvest, but were harvested. McCook, North Platte, and Hemingford were excellent. The main diseases at Lincoln were leaf rust, barley yellow dwarf, and stem

rust. Clay Center and McCook also had severe leaf rust. Part of the nursery at North Platte was affected by take-all due it being on newly farmed ground. None of the other sites had significant disease losses.

The NIN data follow:

	Yield (bu/a)						Rank
VARIETY	Linc.	ClayC.	N.Plat.	McCook	Hemm.	Average	
ARAPAHOE	28.05	29.56	56.11	45.55	66.60	45.174	26
REDLAND	32.12	27.12	59.87	52.38	65.44	47.386	14
RAWHIDE	30.37	16.75	48.83	47.82	64.19	41.592	54
NE87522	32.10	29.04	52.30	46.58	63.81	44.766	32
NE87612	25.89	12.55	56.13	37.93	74.27	41.354	55
VISTA	33.05	24.16	56.39	48.25	74.28	47.226	16
NE88427	27.20	27.40	55.46	47.31	62.89	44.052	36
NE88526	31.70	25.48	57.25	47.91	70.09	46.486	18
NE88584[1]	37.46	30.00	53.54	49.92	73.25	48.834	6
NE88588	29.85	31.27	54.60	52.30	63.88	46.380	19
Alliance	34.73	27.42	59.56	45.02	79.90	49.326	3
NE89526	25.11	29.56	49.24	54.92	54.64	42.694	48
NE89657	28.71	27.04	56.54	37.63	65.86	43.156	44
NEWCALE	31.78	18.19	57.67	43.55	70.94	44.426	34
CODY	17.20	24.14	44.71	46.33	67.96	40.068	58
CENTURA	22.86	23.46	58.96	53.41	70.97	45.932	23
NE90411[1]	28.57	25.39	56.64	52.59	62.97	45.232	25
NE90476	31.68	34.64	50.86	54.78	71.41	48.674	7
NE90479[1]	33.64	33.46	57.79	55.67	66.52	49.416	2
NE90509	24.92	25.66	54.17	51.31	69.66	45.144	27
NE90524[1]	34.70	28.10	54.33	57.69	67.11	48.386	9
NE90574	31.93	24.14	60.43	55.55	72.57	48.924	5
NE90616[1]	29.75	26.26	46.95	44.02	68.88	43.172	43
NE90625[1]	33.17	24.38	60.94	52.13	64.81	47.086	17
N87V106[1]	26.97	26.29	54.13	58.06	58.57	44.804	31
NE89522	14.89	23.67	58.61	48.62	71.92	43.542	39
SCOUT66	33.42	15.64	47.58	47.05	69.12	42.562	50
COLT	33.11	22.49	51.08	37.61	66.61	42.180	51
KARL	27.33	22.12	47.48	49.94	59.56	41.286	56
NE89671	34.84	23.80	66.17	46.88	77.65	49.868	1
NE90626	26.68	30.66	56.89	47.86	69.05	46.228	20
NE91515	32.07	20.75	54.72	47.99	65.56	44.218	35
NE91525	30.23	18.85	49.96	48.76	75.39	44.638	33
NE91527	31.63	26.17	59.03	46.63	73.59	47.410	13
NE91542	33.40	31.71	57.30	52.39	64.86	47.932	11
NE91555	29.43	14.35	54.20	51.85	75.35	45.036	29
NE91562[1]	26.21	22.92	55.77	44.75	67.76	43.482	40
NE91564	23.28	14.45	50.61	43.11	67.58	39.806	60
NE91569	26.44	17.72	52.94	48.88	68.53	42.902	46
TAM200	30.88	8.82	52.19	51.81	66.15	41.970	53
GAGE	23.60	22.70	51.29	42.44	60.29	40.064	59
CHEYENNE	33.09	11.33	48.38	37.47	62.47	38.548	62
NE91571	30.80	26.36	46.83	30.72	59.73	38.888	61
NE91608[1]	26.74	29.77	58.25	51.00	64.53	46.058	22
NE91629	28.07	16.38	58.94	41.70	68.49	42.716	47
NE91631[1]	34.66	27.58	57.08	39.32	68.41	45.410	24

NE91633	36.26	19.44	58.01	39.22	61.84	42.954	45
NE91635[1]	34.73	27.85	53.16	45.04	57.26	43.608	38
NE91647	30.30	26.43	49.94	48.76	55.22	42.130	52
NE91648[1]	25.62	28.64	61.25	54.89	72.91	48.662	8
NE91651[1]	24.55	29.26	60.03	63.35	67.43	48.924	4
NE91691	25.59	23.01	56.64	56.52	68.81	46.114	21
BUCKSKIN	26.03	15.62	44.11	40.82	64.09	38.134	63
ROUGHRIDER	28.51	26.75	44.01	29.52	57.60	37.278	64
SIOUXLAND	21.89	26.54	54.23	42.13	68.43	42.644	49
NE91467	29.96	23.55	47.38	46.72	69.43	43.408	42
NE91509	28.95	24.44	55.05	45.39	71.09	44.984	30
NE91518	23.29	25.86	59.14	47.26	70.11	45.132	28
VBF0168	30.92	24.86	58.42	49.15	75.07	47.684	12
HBC208	27.29	21.32	56.57	50.86	80.21	47.250	15
HBF0263	24.54	36.62	55.86	52.64	70.44	48.020	10
HBF0337	22.27	27.90	45.75	46.68	60.10	40.540	57
VBF0589	18.48	24.69	51.13	60.36	63.98	43.728	37
TAM107	25.39	22.36	55.94	44.39	69.06	43.428	41
GRAND MEAN	28.73	24.29	54.30	47.80	67.46		
CV	19.18	12.87	6.87	9.97	4.80		
LSD	9.19	5.21	6.22	8.05	5.40		
MSE	41.32	13.31	18.95	15.46	14.28		
SED	4.55	2.58	3.08	3.93	2.67		
ALPHA	5.00	5.00	5.00	5.00	5.00		
R-SQUARED	0.30	0.72	0.69	0.82	0.73		

[1] Advanced to USDA Regional Nurseries for further testing.

In general, the experimental lines performed very well compared to the released varieties in the nursery. Vista, Redland, and Alliance were the best released varieties. Though some millers and bakers think that insufficient attention is paid to quality when compared to yield, it should be noted that NE89671 was dropped from further consideration despite its being the highest yielding line in the nursery due to poor quality. In 1992, NE89671 was the second highest yielding line in the NIN. It should be noted that every trial was analyzed using nearest neighbor procedures to remove field trends. Despite using these statistical techniques, CVs (a measure of test precision) for Lincoln and Clay Center were still very high. This is the third year of having only partially useful data which makes selection very difficult. Twenty-five of the above experimental lines were continued in the NIN for further testing. This is a normal retention rate compared to previous years. All lines were thoroughly analyzed for milling and baking quality including an optimized bake test prior to retention. The Nebraska Wheat Quality Lab milled and baked 40 advanced experimental lines and check varieties from the NIN. Four experimental lines (NE88584, Alliance (formerly NE88595), NE89657, and NE90625) had very good loaf volumes from 940cc to 1,000cc. Each of these lines scored very good for internal and external bread properties. However, two lines were scored as having less than favorable bread making potential. NE88526 had a low loaf volume (880cc) and gummy crumb properties. Sticky dough handling characteristics out of the mixer and poor crumb texture properties were noted for NE89671. The Nebraska Wheat Quality Lab identified five (5) experimental lines from the 1992 Nebraska Triplicate Nursery (all were advanced to the 1993 NIN) as having notable promise. NE91509, NE91527, NE91562, NE91631, and NE91691 had loaf volumes in excess of 900cc. The external appearance and internal characteristics of these experimental lines were scored good to very good.

In 1992, the top ten lines for yield were:

1992 NIN Yield Summary Data:

	Yield (bu/a)						Without McCook		
Variety	LincNA	N.P.	McCNA	HemNA	AVG	RANK	AVG	RANK	KEEP*
N87V106[1]	62.57	73.23	39.44	41.89	54.283	1	59.230	1	1
Newcale	44.78	64.60	30.69	61.45	50.380	2	56.943	6	1
NE89671	50.50	56.25	33.30	60.78	50.208	3	55.843	7	2
NE90524[1]	49.63	65.90	26.17	55.31	49.253	4	56.947	5	1
NE90411	57.64	59.95	27.19	49.71	48.623	5	55.767	8	1
NE90518	60.48	54.30	23.25	56.42	48.613	6	57.067	4	4
NE89523	46.94	67.25	17.95	62.25	48.598	7	58.813	2	3
NE90625[1]	51.64	58.83	27.38	54.94	48.198	8	55.137	12	1
NE90626	54.09	56.38	26.18	55.61	48.065	9	55.360	11	4
NE89522[1]	45.97	57.30	24.04	62.13	47.360	10	55.133	13	2

[1] Advanced to USDA Regional Nurseries for further testing.

5. Nebraska Triplicate Nursery

All of the concerns about the NIN data are also true for the Nebraska Triplicate Nursery (NTN). Interestingly, as opposed to last year when Redland topped the trial, Redland ranked 10th, Arapahoe ranked 14th, and the remaining checks ranked lower yet. The yield data are:

	Yield (bu/a)						Rank
VARIETY	Linc.	ClayC.	N.Plat.	McCook	Hemm.	Average	
NE92412	28.38	14.48	56.24	67.07	60.90	45.414	28
NE92434	24.92	23.82	57.07	56.36	48.75	42.184	51
NE92444	26.83	25.39	48.61	47.04	47.71	39.116	57
NE92455	30.93	24.24	64.10	67.35	64.10	50.144	5
NE92456	26.16	25.94	57.15	57.31	67.45	46.802	18
NE92458	33.49	23.63	58.59	62.23	61.11	47.810	15
NE92459	31.25	17.82	56.20	59.10	64.55	45.784	24
NE92461	32.06	21.95	50.74	58.89	58.39	44.406	36
NE92462	32.72	24.68	61.38	63.16	66.99	49.786	7
ABILENE	18.63	13.27	55.99	58.68	61.24	41.562	54
NE92464	30.92	15.21	48.59	61.12	75.17	46.202	22
NE92466	26.83	25.24	60.36	52.91	66.66	46.400	21
NE92471	32.81	18.47	62.99	51.52	68.24	46.806	17
NE92476	19.86	20.67	58.69	49.22	66.29	42.946	45
NE92477	28.52	31.87	55.42	58.12	69.80	48.746	12
NE92484	24.03	13.93	52.54	49.76	56.51	39.354	56
NE92509	30.19	16.71	65.44	48.71	67.73	45.756	25
NE92513	27.23	27.39	66.98	57.40	63.12	48.424	13
NE92522	26.56	27.55	60.57	61.54	72.19	49.682	8
ARAPAHOE	28.58	27.85	59.44	58.65	66.23	48.150	14
NE92529	20.83	7.94	63.31	59.46	63.64	43.036	44
NE92531	18.59	8.08	54.88	52.93	59.89	38.874	58
NE92532	33.81	28.05	59.05	49.38	42.77	42.612	49
NE92538	33.85	23.95	59.19	69.58	67.54	50.822	3
NE92539	19.05	25.78	54.04	58.72	62.26	43.970	40
NE92542	26.95	26.88	51.78	45.69	63.18	42.896	47
NE92556	18.66	22.67	39.58	49.80	50.87	36.316	61

NE92557	18.22	29.80	59.88	51.69	66.50	45.218	32
NE92558	26.56	23.18	53.73	53.81	64.37	44.330	38
REDLAND	28.12	22.83	60.69	62.06	72.66	49.272	10
NE92566	33.47	14.82	45.81	57.66	70.10	44.372	37
NE92578	28.24	29.18	66.31	52.02	72.06	49.562	9
NE92587	21.02	21.28	46.79	59.53	69.18	43.560	41
NE92601	28.95	13.81	55.42	44.54	40.47	36.638	60
NE92603	31.81	33.86	55.71	54.02	58.65	46.810	16
NE92605	29.37	24.24	66.31	60.45	72.86	50.646	4
NE92608	24.66	17.50	56.33	58.07	69.88	45.288	30
NE92614	29.07	23.58	63.13	65.24	69.00	50.004	6
NE92616	24.82	19.68	56.92	43.98	68.32	42.744	48
SIOUXLAND	13.74	23.60	65.14	48.46	66.76	43.540	42
NE92618	25.23	22.61	59.45	68.73	69.39	49.082	11
NE92625	29.02	21.90	51.89	60.56	65.36	45.746	26
NE92628	31.31	25.77	70.94	69.30	71.99	53.862	1
NE92634	12.57	29.03	51.27	52.03	63.18	41.616	53
NE92637	30.51	25.01	53.38	51.63	65.50	45.206	33
NE92638	27.52	13.54	57.67	52.52	69.51	44.152	39
NE92639	17.90	20.34	53.23	51.76	49.86	38.618	59
NE92644	29.00	26.18	57.47	58.71	61.65	46.602	19
NE92646	20.03	21.87	66.91	56.87	62.73	45.682	27
TAM107	19.95	15.33	56.11	50.66	70.96	42.602	50
NE92651	25.45	24.43	54.63	53.76	64.49	44.552	35
NE92652	20.63	20.00	56.25	53.90	65.45	43.246	43
NE92662	30.27	30.79	61.78	59.65	72.00	50.898	2
NE92668	23.09	22.48	59.93	53.97	55.15	42.924	46
NE92672	25.40	26.75	55.53	55.74	63.50	45.384	29
NE92678	28.78	25.95	51.44	60.08	58.18	44.886	34
NE92699	22.57	5.60	47.68	58.70	65.11	39.932	55
NE92709	31.86	16.04	54.81	59.32	68.83	46.172	23
NE92715	29.70	18.25	61.82	52.96	63.59	45.264	31
TOMAHAWK	31.90	19.92	48.32	67.91	64.94	46.598	20
NE92716	27.42	22.54	48.49	53.14	58.63	42.044	52
GRAND MEAN	26.41	21.89	56.89	56.48	63.84		
CV	13.00	19.29	7.39	7.46	4.87		
LSD	5.75	7.06	7.04	7.12	5.21		
MSE	12.03	18.18	18.04	12.08	9.88		
SED	2.83	3.48	3.47	3.48	2.57		
ALPHA	5.00	5.00	5.00	5.00	5.00		
R-SQUARED	0.66	0.69	0.67	0.80	0.88		

In 1992, the top ten lines were:

	Yield (bu/a)				
VARIETY	Linc.	N.P.NA	HemNA	AVG.	RANK
REDLAND	72.20	72.50	55.57	66.757	1
NE91648	66.43	72.60	61.15	66.727	2
NE91631	64.13	70.33	65.71	66.723	3
NE91564	68.10	72.67	58.07	66.280	4
NE91632	63.53	70.68	62.56	65.590	5
NE91571	65.87	70.94	58.21	65.007	6
NE91405	57.20	79.06	57.01	64.423	7
NE91635	60.33	74.69	55.81	63.610	8
NE91562	63.83	68.40	58.45	63.560	9
NE91525	58.23	75.54	56.11	63.293	10

Twenty-one lines were advanced to the Nebraska Intrastate Nursery which is the slightly below normal for advancement from this nursery. The slightly lower than normal level of advancement was caused by poor data upon which to select elite lines. All lines were thoroughly analyzed for milling and baking quality including an optimized bake test prior to advancement. The Nebraska Wheat Quality Laboratory milled and baked 61 composite wheat samples form the 1992 Duplicate Nursery (advanced to the 1993 NTN). Flour milling indicated generally high flour extractions, greater than 72%, and low flour ash contents, between 0.34 and 0.46%. However, two wheat samples, NE92566 and NE92716, were rated as having poor milling characteristics with low flour extractions and excessive endosperm remaining on the bran. Wheat protein contents of these samples from the Duplicate Nursery ranged from 11.8% to 15.0 (14% moisture basis). Average Mixograph curve characteristics indicated weaker dough mixing properties than samples from previous years.

Two experimental lines, NE92466 and NE92608, were rated as having very good dough handling properties and baking characteristics. NE92566 was rated as having poor baking quality. This line had sticky dough handling properties out of the mixer, a gummy crumb, and very poor to poor bread characteristics.

6. Regional Nurseries

The Southern Regional Performance Nursery (SRPN) was harvested only at North Platte, and Hemingford. Yields were as follows:

	Yield (bu/a)			Rank
Entry	N.Platte	Hemming.	Average	
CI1442	43.95	49.69	46.820	45
CI13996	46.15	68.94	57.545	34
PI495594	57.38	65.64	61.510	26
OK88767-11	52.26	64.06	58.160	31
OK88767-02	51.79	57.73	54.760	39
OK88767-15	53.09	59.06	56.075	36
OK88767-24	54.16	61.49	57.825	33
TX88A6480	53.56	57.31	55.435	37
TX88A6533	66.42	69.40	67.910	5
TX90D9277	56.01	78.49	67.250	8
TX89A7137	58.38	72.31	65.345	16
TX91V4931	53.99	53.60	53.795	40
TX90V8410	61.00	71.28	66.140	11
TX90V7911	48.51	61.75	55.130	38
TX91V5739	39.84	55.87	47.855	44
TX91V3308	45.24	52.10	48.670	43
TX89A7141	56.66	68.08	62.370	22
CO880054	58.75	64.72	61.735	25
CO880169	49.99	72.29	61.140	27
CO880210	48.17	70.28	59.225	29
CO880240	58.49	71.80	65.145	17
KS831374-142	57.81	62.32	60.065	28
KS84063-9-7	44.20	56.74	50.470	41
KS92PO59E	64.77	70.75	67.760	7
KS92P0263-137	53.12	70.63	61.875	24
KS92P0363-134	64.01	72.96	68.485	3
KS92PO425-155	70.08	73.53	71.805	1

KS89H48-1	63.00	66.86	64.930	18
N87V106	53.16	59.56	56.360	35
NE88584	56.61	74.49	65.550	15
NE90479	61.72	64.85	63.285	21
NE90524	55.26	78.38	66.820	9
NE90574	59.74	72.61	66.175	10
XH1455	64.14	67.33	65.735	14
XH1485	58.92	73.01	65.965	12
XH1520	57.86	77.97	67.915	4
XH1529	60.05	75.55	67.800	6
XH1610	58.67	70.23	64.450	20
W87-017-44	49.93	48.62	49.275	42
W189-055	56.68	59.37	58.025	32
T13	60.52	70.98	65.750	13
T4731	64.95	73.55	69.250	2
T70	50.66	73.49	62.075	23
T64	62.90	66.05	64.475	19
TH905	55.00	62.32	58.660	30
GRAND MEAN	55.95	66.40		
CV	8.68	7.78		
LSD	8.16	8.68		

The Northern Regional Performance Nursery (NRPN) also was harvested only at North Platte and Hemingford. Yields were as follows:

	Yield (bu/a)			Rank
Entry	N.Platte	Hemming.	Average	
CI1442	40.64	47.06	43.850	32
CI17439	52.79	47.71	50.250	27
PI511307	52.27	54.15	53.210	23
SD88201	47.76	64.32	56.040	12
SD87143	47.64	63.20	55.420	17
SD89204	49.74	61.51	55.625	16
SD89102	47.36	62.89	55.125	19
SD88231	44.61	65.92	55.265	18
SD89119	57.63	53.98	55.805	15
SD89333	49.08	69.35	59.215	9
ND8930	50.21	56.35	53.280	22
ND8933	52.22	59.69	55.955	13
ND8955	55.44	60.11	57.775	10
ND89142	45.30	51.94	48.620	30
ND8889	53.34	68.55	60.945	6
ND90109	55.09	53.81	54.450	21
NE89522	56.93	75.87	66.400	5
NE89526	43.80	56.43	50.115	28
NE89657	56.66	63.88	60.270	7
Vista	44.95	70.01	57.480	11
NE90625	63.66	76.62	70.140	1
NE88526	46.28	58.02	52.150	24
Alliance	61.64	75.81	68.725	2
NE88588	54.90	65.16	60.030	8
WNH1643	37.71	74.17	55.940	14
WNH1648	35.88	65.24	50.560	26
WNH1650	53.77	81.25	67.510	4

WNH1687	56.42	80.75	68.585	3
WNH1712	46.49	62.61	54.550	20
WI88-083	52.10	52.13	52.115	25
MT8713	29.78	55.14	42.460	33
MT8719	39.72	54.87	47.295	31
ID0426	20.81	45.87	33.340	35
W-198	34.90	62.52	48.710	29
W-2350	28.68	51.78	40.230	34

The data from the Regional Nurseries are interesting because Nebraska lines did well in the NRPN and Kansas lines did well in the SRPN. This result would indicate that moderately early lines were favored this year. In general, the performance of lines in the NIN, NTN, SRPN, and NRPN was similar in all nurseries despite the fewer locations and the unusual climate.

7. Multiple-Location Observation Nursery

Only three of six replications (locations) of this nursery were harvested. In this nursery, seed was harvested from Clay Center, North Platte, and Hemingford. Lincoln, Mead, and Sidney were lost to excessive rain or hail. Of the 325 lines including checks and 40 higher protein lines from Dr. C. J. Peterson's germplasm program that were evaluated, 55 (3 from Dr. Peterson's program) were advanced to the NTN. A number of experimental lines performed better than the average of the six checks. To equate the results across the locations, the data was converted to percent of checks and using this system the highest yielding line was NE93574 (NE86592//KS81121-6/Colt) which had a yield that was 170% greater than the checks. Obviously, the checks performed poorly in many locations and field trends were high. All lines were analyzed for micromilling and microquality prior to advancement.

8. Early Generation Nurseries

a. Single-plot Observation Nursery

Fourteen hundred and ninety-five lines including checks were evaluated in 1992. Of this group over 500 were selected for further testing. Due to delayed harvest and shattering, no lines were discarded on the basis of yield. All the lines were weighed and those lines having sufficient grain for quality testing were sent to the Nebraska Wheat Quality Laboratory. Remarkably, despite the weathered grain, the quality tests appeared to be representative of the true quality and 262 lines were selected for advancement to the mulitlocation test in 1994. An additional, 225 line did not have sufficient grain for quality testing and were planted in a single replication at Mead. These lines may have better performance in a better year or may be more suitable for western Nebraska, hence were not discarded in this unusual year.

b. Headrow Nursery

Over 37,000 headrows were planted at Mead. Included in the 37,000 headrows were headrows selected from segregating bulks shared with us by Kansas State University and donated by Pioneer. The headrows generally survived the winter and were heavily infected with stem rust. This is the first significant stem rust infection in three years and was a great help in selection. Unfortunately, weeds became a problem due to rain-delayed harvest and had to be controlled by a late spraying of herbicides (2,4-D and glyphosate). The herbicide spray and the late rains did not affect fall germination. Fifteen hundred and two lines including checks were selected for further testing. This is a normal level of selection.

a. F_3 bulk hybrids

The F_3 bulk hybrid nursery contained 636 bulks and check plots. The number of F_3 bulks is near the optimal size. Most bulks survived the winter and were satisfactory for selection. Over 38,000 head rows were selected for fall planting. The project goal remains to have sufficiently good segregating F_3 material to select about 40 - 45,000 headrows.

b. F_2 bulk hybrids

The F_2 bulk hybrid nursery contained 589 bulks and check plots. These bulks survived the winter. In order to rush harvest, they were harvested by combine (hence will include some mixed seed). Harvesting four rows gave ample seed for planting the F_3 bulk nursery in 1994 at Mead and at Sidney. All F_3 bulks will be planted at Mead and Sidney to provide better information on how segregating bulks do in the diverse environments and to provide a back-up site for inclement weather.

9. Winter Triticale Nursery

The triticale nurseries this year were a disaster. Sidney trials were hailed out and the Lincoln trials were abandoned due to heavy rain at harvest which prevented harvesting all of the triticale yield trials. Visual selection was used to select early generation lines and head rows for advancement. Advanced lines were hand harvested and the advanced trials will be repeated in entirety in 1994.

The key to improved triticale varieties remains access to improved triticale germplasm and efforts continue to increase germplasm diversity. Triticales with high yield potential are available and may be useful as a feed grain or forage crop. Triticale research replaced our research on feed wheat. Mr. Masrizal, a graduate student, oversees the triticale breeding program.

10. Doubled Haploid and Wheat Tissue Culture Studies

Doubled haploids (completely homozygous lines) can be developed using tissue culture in which plants are regenerated from immature pollen grains (saving a minimum of two years in the breeding program). This year's efforts concentrated on understanding how the system may work in practice. Dr. L. E. Oberthur compared a doubled haploid derived population with a single seed descent population (this would be the conventionally derived reference population for the double haploid population). Though differences were identified between the single seed descent and doubled haploid populations, the differences could be attributed to various forms of gene interaction and not necessarily to tissue culture induced variation (known as gametoclonal variation). In a second experiment, she studied the inheritance of gametoclonal variation and determined it to be heritable. This is the first documentation that gametoclonal variation in wheat is caused by genetic effects. All in all, double haploidy remains a viable system for line development when double haploids can be routinely made.

Improving our ability to make doubled haploids is part of the research of Ms. Vicki Gustafson who is attempting to develop wheat isolated microspore cultures. She has been successful in regenerating over 100 plants from these cultures, but at present the system is highly variable. Future efforts will concentrate on improving the repeatability of the procedures.

As part of the overall tissue culture effort, Ms. Carla Wildhagen, in cooperation with Dr. Amit Mitra, is developing methods for transferring genes from any organism to wheat. Her first major experiment is complete and she is beginning her second experiment.

11. Chromosome Substitution Lines

A series of lines in which single pairs of chromosomes were transferred from Cheyenne, the most important ancestor in the Nebraska Wheat Improvement efforts, to Wichita, an im-

portant wheat from Kansas, and vice versa have been developed by Dr. M. R. Morris. Previous research showed that chromosomes 3A and 6A have major effects on agronomic performance (can reduce or enhance yield by 20%). Current efforts by Dr. Yang Yen are concentrating on developing recombinant chromosome lines which will be used to determine how many genes on the identified chromosomes affect yield. The first field experiment was undertaken in 1993. In cooperation with Agripro Biosciences, hybrids of the chromosome substitution lines have been made to identify chromosomal heterosis. The 1992 trials indicated the hybrids have predominantly additive gene effects. The 1993 trials are questionable due to adverse weather at Lincoln and take-all at North Platte. This work will allow us to better understand and hopefully manipulate genes for agronomic performance.

12. Heat Stress on Grain Filling

Research by Mr. Masrizal continued with Dr. E. Millet, of the Weizmann Institute of Science in Israel, and Dr. M. Clegg, of the University of Nebraska to study the effect of short term heat stress on grain filling in wheat. Our current procedures involve heating the spike for 96 hours with 12 hours of 38 C and 12 hours of 25 C. Ambient conditions are 26 C day and 20 C night in the greenhouse. We have tested eighteen genotypes using this system. There is little genetic variation for stress tolerance, however a significant genotype x treatment interaction was identified indicating there may be small differences among lines for heat tolerance. Our field experiments used a very low-technology method of providing heat stress by placing glass jars over the spikes. In sunlight, temperatures rise in the jars, thus providing a heat stress. The most startling effect was that by heat treating wheat spikes 10 days after anthesis, the seed development can be greatly affecting (almost completely stopped). More subtle changes occur when the heat stress is given to spike 14 and 18 days after anthesis. The seed from the field experiments are being cleaned for quality analyses.

13. Effect of 1B/1R on Agronomic Performance

Previously, Mr. Benjamin Moreno-Sevilla, a graduate student and project leader, had shown that lines containing 1B/1R from the cross Siouxland x Ram were 9% higher yielding than lines with 1B or lines heterogeneous for 1B/1R. Rawhide, a recent release, is heterogeneous for 1B and 1B/1R. 1B/1R and 1B lines were extracted from Rawhide and grown in three environments in Nebraska in 1992 and in 1993. No difference was found for yield between the 1B and 1B/1R lines in 1992 and in 1993 trials. A similar study using NE88427 and NE89522 (advanced lines that are heterogeneous for 1A/1R and 1A) has been initiated to determine if 1A/1R has beneficial effects for yield. Dr. R. A. Graybosch (USDA-ARS) is helping identify which lines contain the rye translocation.

14. Non-red Grain Wheat

In the past, efforts have concentrated exclusively on hard red winter wheat. With the potential Far East market and domestic whole white wheat bread market, efforts will increase for hard white wheat development, mainly in Dr. C. J. Peterson's program. A small effort will continue in developing purple and blue wheats for unique markets. For example blue wheat may have potential for blue wheat flour tortillas similar to blue corn tortillas. Blue wheat can also be used as a marker for natural and induced outcrossing, and potentially as way of determining the level of stress in a field (the blue color forms late in the seed development and stress may end kernel development before the blue color is completed).

15. Wheat Streak Mosaic Virus Research

Ms. Jill Petrisko has initiated research with Dr. Roy French (USDA-ARS) to determine if races exist within the wheat streak mosaic virus. She amplifies DNA complementary to the coat protein RNA using polymerase chain reaction. The complementary DNA is cut with restriction enzymes to determine if there are differences among the DNAs that can be associat-

ed with pathogenicity. In cooperation with Drs. Hein, Baltensperger, and Joe Martin (KSU), she is also developing an improved field assay for tolerance under Nebraska growing conditions. Dr. Martin and his co-workers have developed some germplasm with the first real resistance/tolerance to wheat streak mosaic virus. The gene is rapidly being transferred to Nebraska germplasm.

16. Spring Wheat

The spring wheat trial at Mead is part of the Nebraska State Testing Project. Due to adverse weather at Mead (heavy rains) and Sidney (hail), no formal report was written on spring wheat performance. The trials were also at Concord, and Sidney (dryland and irrigated). In 1992, dryland yields (average yield at Mead was 27 bu/a, at Concord was 45 bu/a, and at Sidney was 38 bu/a) were better than normal, probably due to the cool summer. Irrigated yields were also good (average yield at Sidney was 45 bu/a). Sharp and Prospect were the two best lines (out of nine) averaged over all tests. A white spring wheat, Klassic, had the poorest average yield, but did well under irrigation.

17. Considerations on Nursery Sites

Efforts continue to develop better analytical methods for data analysis. The addition of field trend analyses has already proven itself to be beneficial for analyzing wheat data. The next project is to develop planting designs that better measure spatial variation in unreplicated or partially replicated designs. This research is done in collaboration with Dr. W. Stroup of the Biometry Department. In addition, due to heavy deer grazing at Clay Center and the location being north of the main wheat growing region, the yield trials were moved to Holstein. In future, the southcentral site will probably be moved to a sustainable or organic farm to increase our linkages with these emerging farming groups.

18. Environmental Effects on Plant Height

With the continued interest in taller wheats for western Nebraska, Mr. Necdet Budak, a graduate student, has been studying how to better understand factors determining plant height. As part of this research, all experimental lines are being classified by their response to giberellic acid (an indicator of the main semi-dwarfing genes) and all of the height data are being analyzed to look for lines that are not too tall in eastern Nebraska, but are tall in western Nebraska. He has determined that tall wheats tend to be tall in all locations (e.g. Buckskin) or to be tall in eastern Nebraska (where they are generally too tall) and rapidly become shorter in western Nebraska (where the tall wheats are needed). The latter group is well represented by most modern tall wheat experimental lines. The semi-dwarf wheats can be short in every environment (e.g. Vista) or moderately tall in eastern Nebraska and retain their height in western Nebraska (e.g Arapahoe). It may be possible to select for tall semi-dwarfs that retain their height under stress conditions. Research is continuing to determine which climatic factors affect plant height. In the past, tall wheats in eastern Nebraska may or may not be tall in western Nebraska which has caused problems with line selection and variety recommendations.

IV. GREENHOUSE RESEARCH

The F_1 wheat populations were grown only in the Lincoln Greenhouses to avoid possible losses to winterkilling. Over 610 F_1 populations were grown. This is higher than normal and translates to 692 F_2 plots including checks planted in 1993. An additional 710 wheat crosses were made for breeding purposes including improving the genetic male sterile population (first planted in 1990). Some crosses were made for genetic studies. In the triticale program, over 60 crosses were made.

V. ALLIED RESEARCH

The wheat breeding or variety development project is only one phase of wheat improvement research at the University of Nebraska-Lincoln. The project interacts and depends on research in wheat germplasm development, wheat quality, wheat nutritional improvement, wheat cytogenetics, plant physiology and production practices, and variety testing. Much of the production research is located at the research and extension centers. All components are important in maintaining a competitive and improving wheat industry in Nebraska. The allied research is particularly necessary as grain classification and quality standards change and as growers try to reduce their production costs.

The program also depends on interactions and collaborations with the Wheat Board, Nebraska Wheat Growers Association, regional advisory boards, Foundation Seeds Division, Nebraska Crop Improvement Association, the milling and baking industry, and other interested groups and individuals. The Nebraska Wheat Quality Laboratory cooperates closely with the Wheat Quality Council and baked the large scale cooperator samples. These large scale samples include two lines (NE88427 and Alliance) from the cooperative USDA/University of Nebraska breeding program and are among the most important quality tests for an experimental line or recently released variety. Numerous groups have visited the laboratory and participated in discussions on quality and marketing. Through these interactions, the program is able to remain focused and dedicated to being a premier provider of quality varieties, information, and technologies to help maintain the Nebraska Wheat Industry.

Summary

A below average crop was harvested in 1993 with production estimated at 73.5 million bushels harvested from 2.1 million acres and with a state average of 35 bushels per acre. In eastern Nebraska, heavy rains, and diseases (leaf rust, barley yellow dwarf), and rain at harvest reduced the crop. In western Nebraska the crop was generally very good due to above average rainfall except where wheat streak mosaic virus was present. The extremely variable environmental and disease conditions allowed different wheat varieties to perform well in different areas (2163, Arapahoe, Karl, Redland, Jules, TAM107, and Vista).

Arapahoe continues to be quickly accepted by the growers and became the most widely grown wheat in Nebraska in 1993. Rawhide, released in 1990, is slowly increasing in acreage, but will probably need a dry year before its stress tolerance is valued. Vista, released in 1992, had a good first year.

Alliance (formerly NE88595, Arkan/Colt//Chisholm sib) was released to certified wheat producers in 1993. The name was chosen to honor the 40th anniversary of the founding of the Nebraska Wheat Board; the support of Nebraska Wheat Growers' Association, Nebraska Crop Improvement Association, and the Nebraska Foundation Seed Division; and the interdisciplinary and interstate cooperative research efforts needed to develop this cultivar. Alliance is a white chaff, awned, winterhardy, semidwarf (short coleoptile) wheat with medium maturity. It is similar in plant height to Arapahoe and Redland, taller than Vista, and has moderate straw strength. Alliance has exhibited moderate resistance to stem rust, Hessian fly, and crown rot, and some tolerance to wheat streak mosaic virus. It is susceptible to leaf rust and soilborne mosaic virus. The recommended growing area for Alliance is the dryland wheat production areas of the Panhandle of Nebraska. Using data from the Nebraska Fall Sown Cereal Variety Trials from 1992 and 1993 (22 location-years), Alliance is 8% higher yielding than Arapahoe and TAM107, and 4% higher yielding than Redland and Vista. In the Panhandle (7 location-years), Alliance is 3% higher yielding than Vista, 4% higher yielding than TAM107, 12% higher yielding than Redland, and 14% higher yielding than Arapahoe. Alliance is a genetically lower test weight wheat, superior to Redland and similar to Arapahoe. The milling and baking properties of Alliance were determined using five years of testing by the Nebraska Wheat Quality Laboratory with Arapahoe and Scout 66 as check cultivars. The average wheat and flour protein content of Alliance is lower than Arapahoe and similar to Scout 66. The dough mixing properties were similar to Arapahoe and stronger than Scout 66. While the baking absorption of Alliance was less than Arapahoe and Scout 66, average loaf volumes were greater than the two check cultivars. The external appearance and internal attributes of the baked bread loaf indicated generally acceptable quality characteristics.

In addition, the Nebraska Agriculture Experiment Station has recommended co-release of 'Ike' (formerly KS89H48-1) which was developed primarily by Dr. Joe Martin, Kansas State University at Hays, Kansas. Ike is a high yielding, good test weight, high quality hard red winter wheat with good disease resistance that has performed well in Nebraska, particularly southwestern Nebraska.

Basic research to improve breeding efficiency continued in: 1. wheat tissue culture which will decrease the time required to develop new varieties and genetic engineering to expand the genetic resources available to wheat breeders, 2. recombinant and reciprocal chromosome substitution line analysis which will provide a better genetic understanding of agronomic performance, 3. improving testing sites and data analysis to insure representative and accurate data for selection, 4. a better understanding of plant height to select tall wheats, 5. identifying lines with tolerance to short term heat stress, and the molecular biology of wheat streak mosaic virus and how to select lines with resistance to this pathogen. The winter triticale program will continue and be positioned as a feed grain or forage alternative to winter wheat and barley for growers needing small grain feeds or forage.

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