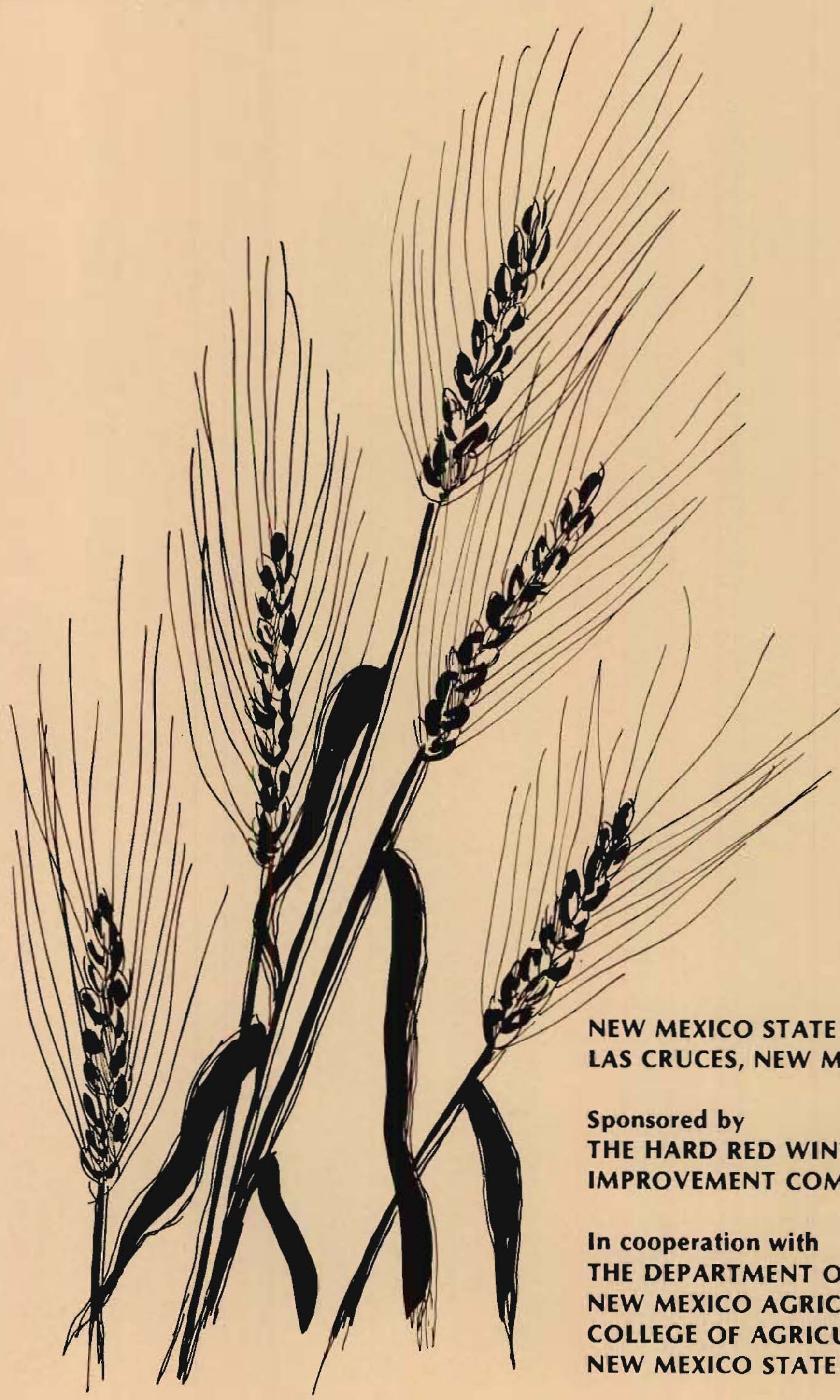
PROCEEDINGS

SIXTEENTH HARD RED WINTER WHEAT WORKERS CONFERENCE

FEBRUARY 8-10, 1983



NEW MEXICO STATE UNIVERSITY
LAS CRUCES, NEW MEXICO

Sponsored by
THE HARD RED WINTER WHEAT IMPROVEMENT COMMITTEE

In cooperation with
THE DEPARTMENT OF CROPS AND SOILS
NEW MEXICO AGRICULTURAL EXPERIMENT STATION
COLLEGE OF AGRICULTURE
NEW MEXICO STATE UNIVERSITY

UNITED STATES DEPARTMENT OF AGRICULTURE

Agricultural Research Service

and

State Agricultural Experiment Stations

in the

Hard Red Winter Wheat Region

PROCEEDINGS

OF THE

SIXTEENTH HARD RED WINTER WHEAT WORKERS CONFERENCE

New Mexico State University
Las Cruces, New Mexico
February 8-10, 1983

Report not for publication[1]

Agronomy Department
Nebraska Agricultural Experiment Station
University of Nebraska
Lincoln, Nebraska
April, 1983

[1]This is a conference report and includes information furnished by State Agricultural Experiment Stations, USDA-ARS, and researchers in the private sector. The report is not intended for publication and should not be referred to in literature citations nor quoted in publicity or advertising. Permission to use statements herein should be requested from individuals and agencies involved.

FOREWORD

The Hard Red Winter Wheat Workers Conference held in Las Cruces, New Mexico, February 8-10, 1983, was the sixteenth in a series that started in 1929 with the organization of the cooperative state-federal regional program of hard red winter wheat investigations. The last conference was in Fort Collins, Colorado in 1980. Wheat workers from 14 states and three foreign countries attended. The 86 participants represented State Agricultural Experiment Stations, the Agricultural Research Service (USDA), Seed Companies, Chemical Companies, CIMMYT and ICARDA.

The program, which focused on problems of wheat improvement and production, was organized into 6 sessions and a one-half day business meeting. Thanks are extended to Lavoy Croy and members of his program committee and to members of the New Mexico organizing committee headed by Ralph Finkner for the excellent program and local arrangements. A special word of appreciation also goes to E. G. Heyne, Chairman of the regional committee, under whose sponsorship the conference was held and M. A. Niehaus, Head of the Department of Crops and Soils, New Mexico State University.

The Proceedings contains abstracts of most presentations made in the several sessions. The lively and excellent discussions following presentations were not recorded.

-- V. A. Johnson
Secretary, HRWW Improvement Committee
and
Coordinator, HRWW Regional Program

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Lavoy I. Croy
Stillwater, Oklahoma
Rob Bruns
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Francis J. Gough
Stillwater, Oklahoma
Jimmy H. Hatchett
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CONFERENCE PROGRAM

February 8

Conference Opening ---------------------- E. G. Heyne, Chairman
Hard Red Winter Wheat
Improvement Committee

Welcome -------------------------------- G. W. Thomas, President
New Mexico State University

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Breeding for Disease Resistance

Discussion Leader ---------------------- F. J. Gough
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"The Land of Enchantment" --------------- K. J. Lessman, Director
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------------------------------------ M. H. Niehaus, Head
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New Mexico State University

February 10

Business Session ------------------------- E. G. Heyne, Chairman
Hard Red Winter Wheat
Improvement Committee

THE EFFECT OF BAYLETON ON THE YIELD OF WHEAT

J. H. Gardenhire

The effect of Bayleton on the yield of wheat was determined at two locations in Texas in 1982. The cultivar Tam W-101 was used in both locations. Plots were sprayed at vegetative (January), stem elongation (March), and flag leaf (April) in all combinations using 3 ounces material (50%) per acre. Powdery mildew was reduced by each of the sprayings. Plots sprayed twice (March-April) were free of powdery mildew. Plots receiving an application during each of the months of January, March and April or March and April averaged significantly higher yields than unsprayed plots.

Date	Dallas	McGregor	Average
J-M-A	36.7	44.9	40.8
J-M	29.3	40.7	36.7
J	25.9	31.0	28.4
J- A	32.6	41.3	36.9
M-A	36.6	43.3	39.9
M	29.4	36.2	32.8
A	34.9	33.1	34.0
Check	26.6	27.1	26.8
LSD .05	2.2	6.3	

LOSSES CAUSED BY PYRENOPHORA TAN SPOT IN 13 WHEAT CULTIVARS AT STILLWATER, OKLAHOMA IN 1982

F. J. Gough, R. A. Johnston, and T. F. Peeper

Thirteen hard red winter wheat cultivars were sown (75 lbs/A) in undisturbed and fallen wheat stubble on November 19, 1981, at Stillwater, Oklahoma. The cultivars were randomized in three blocks of plots with each plot consisting of 10 18.3-m (60-ft) rows spaced 25.4 cm (10 in) apart. From samples collected on February 22, 1982, and oven dried for 10 days at 30°C, the straw on and above the soil surface across all plots was estimated to be 3,681 ± 655 kg/ha (3,284 ± 584 lbs/A).

Infection of plants by ascospores of *Pyrenophora tritici-repentis* on the straw began about mid-March and continued through the growing season. On April 29 and again on May 10, 4.9 m (16 ft) of one end of each plot was sprayed with chlorothalonil (Bravo 500, 40.4% a.i.) at the rate of 1.3 L of a.i./ha (18.4 fl oz/A) using an 8-ft boom with six 1/4 PT Teejet nozzles. On April 29, 5% and 10% of the flag leaves of cultivars Newton and Osage, respectively, were judged to be fully developed; those of other cultivars were 95% to 100% developed. Tan spot lesions were present on all leaves on April 29. The number of tan spot lesions per cm^2 of flag leaf area was estimated on May 3 and May 20 from the sprayed subplots and on May 20 from the unsprayed ones (Table 1).

A 1.5-m (5-ft) row sample was harvested from both the third and fourth rows from the eastern edge of each sprayed and unsprayed portion of each plot on July 6. The harvested plants were threshed with a small head thresher, except for five heads from primary tillers, selected randomly at harvest, from each harvested sample. These heads were individually hand threshed and the seed counted and weighed. Values representing 1000 kernel weights were calculated from the hand threshed samples.

Responses of the cultivars to tan spot infection, in terms of yield, indicated that those with the highest yield potential sustained the greatest loss from the disease (Table 2). This relationship did not appear to exist relative to kernel weight. Differences in yield and kernel weight between sprayed and unsprayed plants were attributed almost entirely to the suppression of tan spot in the flag and penultimate leaves of the sprayed plants. Septoria leaf blotch, leaf rust, and powdery mildew occurred only in trace amounts in these canopy leaves.

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Use of trade names does not imply endorsement of the named products or similar ones not mentioned.

Table 1. Numbers of tan spot lesions per cm^2 of flag leaf area of fungicide sprayed and unsprayed plants of 13 wheat cultivars.

Cultivars and Statistics	Lesions/cm^2			
	Sprayed[a]		Unsprayed	Difference
	May 3[b]	May 20[c]	May 20[c]	May 20
Centurk	0.35	0.37	0.98	0.61
Rocky	0.27	0.37	0.82	0.45
Payne	0.20	0.21	0.72	0.51
TAM W-101	0.14	0.18	0.63	0.45
Wings	0.33	0.45	0.85	0.40
Vona	0.14	0.19	0.75	0.56
TAM W-105	0.17	0.32	0.61	0.29
Triumph 64	0.18	0.28	0.76	0.48
Newton	0.22	0.14	0.54	0.40
Scout 66	0.13	0.15	0.56	0.41
Osage	0.11	0.23	0.29	0.06
DeKalb-573A	0.29	0.28	0.87	0.59
Texred	0.57	0.65	1.48	0.83
Means	0.23	0.29	0.76	0.47

Cultivars (E_a)
CV = 63.9%
$LSD_{0.05}$ = 0.16 (unsprayed)

Treatments (E_b)
CV = 65.4%
$LSD_{0.05}$ = 0.16

[a]Sprayed with chlorothalonil on April 29 and May 10 at the rate of 1.3 L/ha (18.4 fl. oz/A).

[b]Based on 10 flag leaves collected randomly from the sprayed subplots of each main plot (cultivar).

[c]Based on 5 flag leaves collected randomly from each sprayed and unsprayed subplot of each main plot (cultivar).

Table 2. Yields and kernel weights of 13 wheat cultivars, naturally infected with Pyrenophora tritici-repentis, with and without fungicide protection of the upper canopy leaves.

Cultivars and Statistics	Yield (bu/A)				1000 kernel weight (g)		
	Sprayed[a]	Unsprayed	Bu	%	Sprayed	Unsprayed	% Diff.
Wings	46.4	34.4	12.0	25.9	24.0	23.3	2.9
Vona	47.2	33.1	14.1	29.9	24.9	19.3	22.5
TAM W-101	39.4	32.0	7.4	18.8	23.0	21.1	8.3
DeKalb 573A	38.9	30.8	8.1	20.8	24.5	23.9	2.4
Rocky	37.8	29.3	8.5	22.5	17.9	16.7	6.7
Payne	36.0	29.2	6.8	18.9	19.1	17.5	9.1
Texred	32.1	29.1	3.0	9.3	22.7	16.3	28.2
Newton	35.9	28.6	7.3	20.3	21.5	17.8	17.2
Triumph 64	31.4	26.3	5.1	16.2	31.8	30.5	4.1
TAM 105	29.9	25.2	4.7	15.7	19.5	19.5	0.0
Centurk 78	24.8	23.2	1.6	6.5	14.4	13.3	7.6
Osage	28.0	23.0	5.0	17.9	25.5	21.1	17.3
Scout 66	27.0	21.1	5.9	21.8	27.5	25.9	5.8
Means	35.0	28.1	6.9	19.7	22.8	20.5	10.1

CV - cultivars; yield (E_a) = 21.5%, kernel wt. (E_a) = 23.9%

- treatments; yield (E_b) = 10.6%, kernel wt. (E_b) = 14.4%

$LSD_{0.05}$ - cultivars; yield (E_a) = 8.0 bu, kernel wt. (E_a) = 2.4

- treatments; yield (E_b) = 1.5 bu, kernel wt. (E_b) = 1.5

[a]Sprayed with chlorothalonil on April 29 and May 10 at the rate of 1.3 L/ha (18.4 fl. oz/A).

TWO QUANTITATIVE METHODS OF MEASURING DISEASE REACTION OF WHEAT SEEDLINGS INOCULATED WITH FUSARIUM SPECIES

J. P. Hill and C. A. Armitage*

Root and foot rots of cereals are commonly found throughout the major wheat growing areas of the world (1). Cochliobolus sativus (Ito and Kurib.) Drechsl. ex Dastur may induce the disease, either alone or in a complex with one or more Fusarium species (2, 6, 8, 10). Fusarium roseum Link emend. Snyd. & Hans. 'Culmorum', F. roseum 'Graminearum' and F. roseum 'acuminatum' are the Fusaria most commonly associated with the disease (3, 4, 9). Environmental stress (moisture, nutritional, insects, etc.) enhances the disease and increases yield loss (1, 4, 5).

Resistance has generally not been an effective means of disease control because major genes effective against any of the causal agents have not been identified (1). There have been reports of general resistance (horizontal resistance sensu Vanderplank) but this resistance is difficult to identify and manipulate (7, 11). A simple, quantitative disease assessment method is needed to identify, select, and breed for increased resistance to the foot and root rot pathogens.

Two quantitative disease assessment methods sensitive enough to detect cultivar differences in disease expression when seedlings are inoculated with Fusarium species have been developed. A 5 mm diameter water agar disc containing a known number of Fusarium macroconidia is used as inoculum. The leaf inoculation method consists of growing seedlings under moisture stress. Leaves of 3-wk-old seedlings are pierced with a sterile dissecting needle and the inoculum is secured by cellophane tape over the wounds. One week later the lesions are measured. This method demonstrated that Calvin sustained larger lesions than Scout when inoculated with either F. roseum 'Culmorum' or F. roseum 'Acuminatum'. Vic sustained smaller lesions than Scout under identical conditions.

The root inoculation method consists of placing the inoculum on seeds germinating under the rag doll method. The inoculated seedlings were rewrapped, kept moist, and stored at room temperature. One week later the upper root portions were removed, surface sterilized, and placed on Potato Dextrose Agar. Fusarium colonies grew from the infected tissue and the infection percentage was recorded. Inoculation with 5, 10, or 25 spores per disc demonstrated that Scout and Calvin had similar infection percentages while that of Vic was significantly lower. The infection percentage generally increased as the number of spores per disc increased.

The relative cultivar reactions were similar under both inoculation methods. Vic sustained smaller lesions and a lower infection

*Authors not in attendance at the conference. They are from the Department of Botany and Plant Pathology, Colorado State University at Fort Collins.

percentage than Calvin and Scout. Vic and Calvin have been reported as field resistant and susceptible, respectively, to foot and root rot in North Dakota (Quick, J., personal comm.). General resistance is usually governed by a series of minor genes and cultivar resistance differences may be small. These inoculation methods seem to be sensitive enough to detect these cultivar resistance differences. Further studies are needed to determine if the differences detected in the laboratory are correlated with amount of disease and yield in field plots. If this correlation exists, these inoculation methods would facilitate identification of small resistance differences and allow breeders to select for increased resistance.

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BREEDING FOR RESISTANCE TO CEPHALOSPORIUM STRIPE

D. E. Mathre and J. M. Martin

To screen for Cephalosporium stripe reaction, we produce inoculum by culturing the fungus on autoclaved oat kernels and then add these to the seed furrow at the time of planting using 15-20 g of inoculum per 3.3 m row. See Crop Science 15:591 for details of this procedure.

In regard to variation in virulence of the pathogen, we have found that most isolates are highly virulent. All 15 isolates from 15 different counties in Kansas were highly virulent, as were most from Montana and other areas where this disease occurs. Only occasionally will an isolate of low to moderate virulence be found.

From the standpoint of host susceptibility or resistance, most bread wheats are highly susceptible but a few have some tolerance and/or moderate resistance. When we screened the parents of most of the cultivars recently grown in the Great Plains, we found many to be highly susceptible including Triumph, Tenmarq, Nebred, Pawnee, Orfed, Ponca, Brevor, Burt, and Parker.

From screening of over 1,000 lines in the USDA Small Grains Collection, plus regional nurseries and breeders' lines, we have identified the following materials to be "less susceptible" or somewhat resistant: PI 278212, PI 094424, CI 07638, and CI 11222. In addition, the cultivars Manning (CI 17846) and Lenore (CI 17726, a SWW type) exhibit good yielding ability under heavy disease pressure. MT 7579 and Winridge (CI 17902) also exhibit some resistance.

Several problems have arisen as we have attempted to transfer Cephalosporium resistance.

1) Resistance seems to be associated with late maturity and tall, weak straw.

2) Resistance is inherited as a quantitative trait.

3) There is a strong environmental component that affects disease severity such that we see a large variation in severity between years.

We feel that breeders can make the best and most rapid progress by selecting for high yield under disease pressure.

One source of near immunity is Agrotriticum derived from Agropyron elongatum crossed with Triticum aestivum.

PRESENT STATUS OF WHEAT STEM RUST

D. V. McVey

The United States has been divided in 8 ecological wheat production areas. However, for our purposes only three areas will be considered. These are Zone 1N, Zone 3, and Zone 7. During the past four years, there has been no change in the wheat stem rust race population. In fact, there has been very little stem rust present. No collections were made in Zone 1N in 1980 and 1982, and no collections made in Zone 7 in 1980 and 1981. The races identified (1979-1982) and the percentage of each race are given in Table 1. The two race groups most frequently identified continue to be 15 and 151.

The _Sr_ genes used for race identification and the percent virulence formed for each gene in the three zones are given in Table 2. The genes _Sr_ 6, 9a or 9b provide protection against race 15; _Sr_ Tt-1, Tmp provide protection against race 151 (QSH); _Sr_ 6, 9e, 11, Tt-1, and Tmp provide protection against race 151 (QFB).

A list of _Sr_ genes which offer protection are given in Table 3. Within the group offering a very high level of resistance to which no virulence has been found in North America are _Sr_ 31, 27, and the Texas wheat 'Amigo'. Among those offering an intermediate level of protection for which no virulence has been found in North America are _Sr_ 24, 26, 29, and 30. However, combinations of _Sr_ 6, 17, Tt-1, Tmp are very effective.

The seedling reactions to stem rust of the 1983 entries of the Northern and Southern Hard Red Winter Wheat Performance Nurseries are given in Tables 4 and 5 respectively. I believe the most important parts are the reactions to races 151 and 15B-2. If an entry has an infection type (IT) zero with QSHS and RSHS, the entry undoubtedly has _Sr_ 36 (Tt-1). If an IT; or IT;1 occurs with QFBS, TNMH and TNMK, _Sr_ 6 is probably present. If an IT 0; or IT; occurs with RTQQ and TNMH then _Sr_ 17 is probably present. When a comma separates two IT, the entry is segregating.

Table 1. Percent isolates of races of wheat stem rust identified.

	Races of wheat stem rust											
	15			151		11	32	113	29	17		56
	TNM	TLM	TDM	QFB	QSH	RCR	RJC	RKQ	HJC	HNL	HDL	MBC
Zone 1N												
1979		22		11		33					33	
1981	11			82							7	
1980 & 82	No collections											
Zone 3												
1979	44	12	7	7	14		2	12				2
1980				75								25
1981			63	14	12					2	8	
1982	83								17			
Zone 7												
1979	50					20		20				10
1980 & 81	No collections											
1982	100											

Source: Races of *Puccinia graminis* f. sp. *tritici* in the U. S. by A. P. Roelfs, D. L. Long, and D. H. Casper, published in Plant Disease in the years 1980, 1981, 1982, 1983.

Table 2. Virulence of *Puccinia graminis* f. sp. *tritici* on single-gene differentials.

	Percent of isolates virulent on Sr genes														
	5	6	7b	8	9a	9b	9d	9e	10	11	15	16	17	Tt-1	Tmp
Zone 1N															
1979	67	0	89	44	44	33	100	22	56	22	78	100	44	89	22
1981	73	0	18	100	82	7	100	11	11	11	89	100	82	18	11
Zone 3															
1979	100	22	79	86	19	26	98	63	81	70	37	100	32	74	65
1980	100	0	25	75	75	0	75	0	25	0	100	100	100	0	25
1981	90	12	73	100	14	12	100	63	76	76	37	100	71	73	63
1982	83	17	100	100	0	0	100	83	100	83	17	100	100	83	83
Zone 7															
1979	100	20	100	70	40	40	90	50	80	50	50	100	80	90	60
1982	100	0	100	100	0	0	100	100	100	100	100	100	100	100	100

Source: Races of Puccinia graminis f. sp. tritici in the U. S. by A. P. Roelfs, D. L. Long and D. H. Casper, published in Plant Disease in the years 1980, 1981, 1982, 1983.

Table 3. Sources of resistance for protection from _Puccinia graminis_ f. sp. _tritici_.

Effectiveness	
High	Intermediate
6	8
9e	9a
17	9b
27 (WRT238-5)	9e
31	10
36 (Tt-1)	11
'Amigo'	24
	26
	29
	30
	Tmp.

Table 4. Seedling reaction of the 1983 Northern Regional Hard Red Winter Wheat Performance Nursery to <u>Puccinia</u> <u>graminis</u> f. sp. <u>tritici</u>.

Cultivar or Sel. No.	Reaction to Isolates							
	72-00-1370C	72-44-703C	71-21-584B	72-18-630B	72-00-53A	75-32-1622A	72-4-1A	74-21-1409A
	151		11-32-113				15B-2	
	QFBS	QSBS	RHRS	RSHS	RTQQ	RTQS	TNMH	TNMK
1. Kharkof	S,2	S	S	S	S	S	S	S
2. Warrior	S	S	S	S	S,23CN	S	S	S
3. Roughrider	0	0	S	0	S	S	S	S
4. NE77465	0	S	0;	2	0	S	0	0;
5. NE78414	0	S	1	;1	$;1^-$	23CN	0;	0;
6. NE78696	0;	2^-	2	S	0;	2	0;	0;
7. NK78W296	0	0	S	0	S	S	S	S
8. NK78W283	S	S	S	S	$;1^-$	S	$;1^-$	S
9. NE7802	0	S	S	-	0;,S	S	0;	0;
10. NE76706	0;	S	S	S	;	S,2CN	;	0;
11. NE77682	-	S	-	S	;,S	-	-	S
12. SD74221	0	0,S	2^-	S	S	S	0;,S	S,0;
13. SD74209	0	0,S	2^-	2	0;	S	0	0;,S
14. SD76705	0	0	0	0	0	S	0;	0;
15. SD75284	2	2	0	S	0;	S	;1	S
16. SD76598	0;	2	$;1^-$	$2^=$	0;	;1	0;	0;
17. SD76694	0	0	0;	2	0;	;1	0	0;
18. SD79613	0	S	0;	S	0;	S	0;	0;
19. SD79112	0	S	2	S	0,S	S,;1	0;	0;
20. CO745775-4	2^-,0;,S	2,S	;1	2^-,S	0;	2^-,S	$;1^-$N	S,R
21. SD79560	S	S,2^-	S,$2^=$	2,S	S,;	S,2	S,;	S,2
22. SD791041	0;,2^-	0	0	0	0;	2^-,1	2^-,0;	2
23. SD791058	0;	S,2	S,2	S,2	S,;	S	;	0;
24. ND7687	0	S	S	S	S	S	0;	0;
25. WI166	S	S	S	S	S	S	S	S
26. MT7811	0	$2^=$C	0	$2^=$	0	-	0	0
27. MT7840	1N	S	S	;1	$;1^-$N	1N	;1N	S
28. MT7877	S	S	S	S	S	S	S	S
29. MT8003	S	S	S	S	S	S	S	S

Table 5. Seedling reaction of the 1983 Southern Regional Hard Red Winter Wheat Performance Nursery to *Puccinia graminis* f. sp. *tritici*.

		Reaction to isolates							
		72-00-1370C	72-44-703C	71-21-584B	72-18-630B	72-00-53A	75-32-1622A	72-4-1A	74-21-1409A
Cultivar		151		11-32-113				15B-2	
or Sel. No.		QFBS	QSHS	RHRS	RSHS	RTQQ	RTQS	TNMH	TNMK
1.	Kharkof	S,2^{-}	S	S	S	S	S	S	S
2.	Scout 66	S	S	S	S	;1^{-}	S	;1	S
3.	Sage	2	2	2^{-}	2	;	2^{-}	;	2
4.	TX78V3630	0;	2	S	S	$2^{=}$	23	0;	0
5.	TX78V2408	$2^{=}$	2	2^{-}	S	$2^{=}$	23	2,S	2,S
6.	TX71A562-6-28	0	2	2^{-}	2	0	2^{-}	0	-
7.	TXGH2875	$2^{=}$	2^{-}	2^{-}	1	1	1	1	2^{-}
8.	KS79H69	0	0	$2^{=}$	0;	;1	1	$2^{=}$	-
9.	NK77W4093	0	2^{-}	2^{-}	2^{-}	2^{-}	2^{-}	;	0;
10.	NK77W505	2^{-}	2	2^{-}	2^{-}	;	2^{-}	;	$2^{=}$
11.	NK77W4593	0;	$2^{=}$	0;	$2^{=}$	0;	;1	0;	0;
12.	NE77682	0;	2	2	2	0	2	0	0;
13.	NE78668	$2^{=}$	$2^{=}$	$2^{=}$	$2^{=}$	1	1	$2^{=}$	$2^{=}$
14.	NE80413	0;	$2^{=}$	0;	$2^{=}$	0;	1	0;	0;
15.	NE78696	0	2^{-}	$2^{=}$	2	;	$2^{=}$	0;	0;
16.	NA80137	0,S	S	2^{-}	2,S	0;,S	2,S	0;	0,2
17.	NA80310	0	2^{-}	$2^{=}$	$2^{=}$	2^{-}	2^{-}	0;	0;
18.	NS80300	0;	2^{-}	;1	2^{-}	2^{-}	2^{-}	0;	0;
19.	W7442B	S	S	S	S	S	S	S	S
20.	W7452B	2	2^{-}	S	S	S	S	S	S
21.	TX69A569-1-69	2	S	S	S	S	S	S	S
22.	TX80A5609	2^{-}	2^{-}	2	S	2	S	S	S
23.	TX80A6025	0	2^{-}	2,S	1	;,S	1,S	0;	0;
24.	TX80GH2679	$2^{=}$	$2^{=}$	2^{-}	2^{-}	2^{-}	$2^{=}$	$2^{=}$	2^{-}
25.	TX80GH3009	0	2^{-}	$2^{=}$	;1-C	0;	1	0	0;
26.	OK754615E	S	S	S	S	S	S	S	S
27.	OK79257	$2^{=}$	2^{-}	0;,$2^{=}$	1	1,S	;1,S	1,S	S,1
28.	OK79256	1,S	$2^{=}$,S	$2^{=}$,S	1,S	S,1	S,;1	S,1^{-}	S,1
29.	OK80019	$2^{=}$	$2^{=}$	$2^{=}$	$2^{=}$	1	1	$2^{=}$	$2^{=}$
30.	OK80268	$2^{=}$	$2^{=}$	$2^{=}$	$2^{=}$	1	1	$2^{=}$	$2^{=}$
31.	CO796326	1,S	S	$2^{=}$,S	$2^{=}$,S	;	S	;1-	S
32	CO796386	S	S	S	S	S	S	S	S
33.	RH790610	;,$2^{=}$	S,2	1	S	2	23	0;,S	S
34.	IL76-3845	2	2	$2^{=}$	S	;1^{-}N	S	;1^{-}N	S
35.	IL77-4259	$2^{=}$	$2^{=}$	$2^{=}$	$2^{=}$	$2^{=}$	1	$2^{=}$	$2^{=}$

SOIL BORNE MOSAIC VIRUS IN THE SOUTHERN PLAINS

O. G. Merkle

Soil borne mosaic virus of wheat (SBMV), although not as devastating as other pests, e.g. greenbugs, stem rust, and wheat streak mosaic virus, nevertheless reduces wheat yields when it occurs. Losses from the virus have averaged 3.1% over the past 7 years in Kansas.

Apparently no physiologic specialization exists in either _Polymyxa graminis_, the vector, or the virus. Genetic resistance appears to be from a single major gene with some modifiers. The narrow genetic base for resistance makes vulnerability very high, although to date resistance has been quite stable. It is imperative that a search be made for other sources of resistance.

Field reactions of numerous wheat genotypes to SBMV have been evaluated in both the hard red winter wheat region and the soft red winter wheat region. The rosetting symptom that is observed in susceptible genotypes in the soft wheat region is not observed in the hard red winter wheat area.

Currently Tam W-101 wheat is planted on soil fertility plots ranging in pH for 4.5 to 6.8 near Muskogee and Enid, Oklahoma. SBMV has been observed in both areas. These plots will be evaluated for SBMV to determine whether soil pH influences the expresion of symptoms. No results can be reported because this is the first year of the experiment.

Little is known of the effect of the virus on symptomless resistant varieties, the infection process, the conditions necessary for infection, or whether the present resistance is to the virus, the vector, or both. All of these should be fruitful areas of research which will increase our knowledge of host and pathogen.

PROGRESS IN BREEDING WHEAT FOR RESISTANCE TO WHEAT STREAK MOSAIC VIRUS

E. E. Sebesta

Use of wheat x Agropyron elongatum derivatives as a source of resistance to wheat streak mosaic involves screening and agronomic evaluation of material derived chiefly from the hybridization of wheat with parental material produced by irradiation procedures. My work indicates that a number of populations tracing to C.I. 15321 and C.I. 15322 appear promising. In addition, a number of selections resulting from an X-rayed pollen grain appear to be useful. Cytogenetic studies of this material are planned for the future.

In 1976, research was undertaken independently to utilize rye as a source of resistance to wheat streak mosaic virus, and in collaboration with Dr. Hatchett (Entomologist, USDA-ARS, Manhattan, KS) as a source of resistance to Hessian fly.

Initially, two varieties of rye, 'Balbo' and 'Gator' were used as potential sources of resistance. Crosses were made with Seuwon 92 wheat, and the chromosomes of the primary hybrids doubled with colchicine. Plants grown from seed produced on doubled sectors were completely sterile. Heads of sterile plants were fertilized with pollen from various wheats and from Gaucho triticale. Subsequently, these seed stocks were tested for resistance to both pests.

In regard to virus resistance, a homozygous population has been established. This material is indistinguishable from wheat. Cytological studies show that it has 21 pairs of chromosomes and at present is considered to be an alien substitution line with only one pair of rye chromosomes governing resistance. Resistant plants of this line were crossed with several varieties of wheat. The F_1 plants from each cross were tested for resistance to the virus in the fall of 1982. All plants were susceptible and eventually died. This is similar to the behavior of F_1 plants derived from crosses of wheat with C.I. 15321 and C.I. 15322 developed from Agropyron elongatum as the source of resistance. Tests of F_2 progenies should give evidence as to the basis of resistance from rye.

Since the evidence available indicates only one pair of rye chromosomes controls resistance to the virus, X-ray procedures, as were used successfully to transfer leaf rust resistance (Teewon) and greenbug resistance (Amigo), are planned to effect transfer of the gene(s) for resistance to wheat. Research indicates that resistance to Hessian fly and to wheat streak mosaic virus are on different rye chromosomes.

THE WHEAT DISEASE SITUATION IN NEBRASKA DURING 1982

J. E. Watkins
presented by
J. W. Schmidt

In 1982 many wheat growers in central and eastern Nebraska were impacted by disease losses. The major disease problems were wheat scab, Cephalosporium stripe, leaf rust, and Septoria leaf blotch. Spring and summer weather was unusually wet and cool for must of the state and was the predominant contributor to the rapid and serious disease development. For example, at Mead, NE, 19 days of measureable rain was recorded between May 10-31. Similar weather conditions were present during June and through much of July.

Wheat Scab

The wet cloudy conditions and a lack of wind kept much of the eastern and south central Nebraska wheat crop continuously wet during the flowering period. This resulted in the most devastating wheat scab epidemic in Nebraska crop history. Scab had not caused detectable damage to the Nebraska wheat crop since 1951 although observed in trace amounts during the interim years. Much of the 1982 wheat crop in eastern and south central Nebraska, involving approximately one million acres, was affected in varying degrees. It was estimated that winter wheat production in Nebraska was reduced approximately 8 percent.

Differential reaction to scab was noted in some fields and in some varieties in the Nebraska varietal tests. Most differences were attributed to time of flowering with later maturing varieties or later planted fields being less affected by scab. This was viewed as an escape from infection rather than varietal resistance to infection. Yields and test weights of wheat from scab affected areas were generally lower and germination tests on combine samples of scabby wheat usually ranged between 45-60 percent. Conditioning and treating the seed with carbonix brought germination up to better than 90 percent. Most growers in the scab affected area planted carboxin treated seed or purchased seed wheat from outside the scab affected area for this planting season. The amount of seed wheat treated in eastern and south central Nebraska rose from less than 5 percent in previous years to 70-80 percent in 1982.

Cephalosporium Stripe

In 1982 certain wheat fields throughout Nebraska were severely damaged by Cephalosporium stripe. Yields in these fields were reduced 30-40 percent or more. In many other fields the disease was present to a lesser degree. This disease received little notice by most crop observers because of the wheat scab epidemic. However, we are more concerned about the potential development and destructiveness of Cephalosporium stripe than wheat scab or any other wheat disease in the state.

Cephalosporium stripe was first found in a single field in southeastern Nebraska in 1981 and we were surprised that it was so widely distributed in 1982 although we suspected that it had occurred in western Nebraska in 1980 and 1981. Explanations for its sudden widespread appearance in 1982 could be related to the extended growing period in the fall of 1981 resulting in extensive root development and the moderate wet conditions in the spring of 1982 favoring symptom expression.

Our main concern over this disease is that we have no good management techniques to recommend other than a 3-year rotation with a row crop or oats. This is feasible for eastern and south central Nebraska but not for the wheat-fallow system of western and panhandle Nebraska where alternate crop choices are limited. Another concern is what affect will this disease have on the reduced tillage wheat-fallow system being promoted for much of the Great Plains.

Wheat Leaf Rust - Septoria Leaf Blotch - Tan Spot

The same weather conditions that brought on the wheat scab epidemic also brought about an influx of foliar diseases. Leaf rust and Septoria leaf blotch were predominant in eastern and south central Nebraska with tan spot more evident in the west. Wheat became infected with Septoria in the fall of 1981. These leaves apparently served as sources of inoculum because Septoria symptoms began to show up early in 1982. Septoria continued to move upward on the plant and with the presence of severe leaf rust caused considerable blighting of the flag and flag-1 leaves. Spraying was recommended and those fields treated with mancozeb, even when sprayed only once, showed must less injury to the flag leaf than nonsprayed fields. The data in Table 1 showing results of a foliar fungicide trial at Clay Center, NE, nicely illustrates the effectiveness of chemicals in disease control and higher yields and 1000-kernel weights.

Table 1. Chemical control of wheat leaf rust, Septoria leaf blotch, and tan spot in 1982, Clay Center, NE.

Treatment and rate (ai)/acre	Number of applications*	Disease Index** % leaf rust	Disease Index** Leaf spot***	Yield bu/A	1000-kernel wt. (g)
Control		100.0a****	8.70abc	27.2c	28.6c
Dithane M-45 80WP 1.6 lb	1	66.0b	8.90a	32.1c	33.6ab
Bayleton 2EC 4 fl oz	1	58.0b	8.75ab	33.7bc	32.8abc
RH-5781F 1.5EC + Tween 20 0.4 lb	2	40.0c	8.35cd	40.7ab	34.0ab
Bayleton 50WP 2 oz	1	37.0cd	8.70abc	40.2ab	33.2abc
Dithane M-45 80WP 1.6 lb	2	36.0cd	8.70abc	31.3c	34.0ab
RH-5781F 1.5EC + Tween 20 0.2 lb	2	36.0cd	8.55abcd	34.1bc	32.8abc
CGA-64250 3.6EC 2.6 fl oz	1	27.0cde	8.40bcd	41.9a	31.2bc
M-8225F 1.6 lb	2	18.0def	8.75ab	33.7bc	33.2abc
RH-5781F 1.5EC + Dithane M-45 80W 0.4 lb + 1.6 lb	2	9.0ef	8.30d	42.8a	35.6ab
RH-5781F 1.5EC + Dithane M-45 80W 0.2 lb + 1.6 lb	2	4.2f	8.35cd	39.5ab	36.8a
Experimental Mean		39.2	8.6	36.1	33.25

* Application dates were June 1 and June 7 which corresponded to growth state 10.1 (mid-late boot) and 10.5 (flowering) on the Feekes Large Scale of wheat plant development.

** % leaf rust is the severity on the flag leaf. The scale appraising leaf spot intensity is that developed by Saari and Prescott (0 to 9).

*** Septoria leaf blotch (*Septoria tritici*) was the predominant leaf spot.

**** Numbers in a column with a letter in common are not significantly different (DMRT P = 0.05).

THE EFFECT OF THE GREENBUG GENE (BIOTYPE C) ON THE YIELD OF WHEAT

J. H. Gardenhire

The effect of the greenbug gene (biotype C) on the yield of wheat was determined at three locations in Texas in 1982. Homozygous resistant, segregating and homozygous susceptible F_5 populations originating from common $BC1F_1$ plants heterozygous for the Amigo gene were evaluated at Dallas, Chillicothe, and Bushland. At Dallas the homozygous resistant and segregating populations yielded 29.5 and 29.0 compared to 26.3 bushels per acre for the susceptible lines. The average yield increase was 11.2% for populations possessing the greenbug gene. The resistant lines were also resistant to powdery mildew. At Chillicothe, where no powdery mildew was present, populations possessing the greenbug gene produced 8.3% higher yields than the homozygous recessive populations. In an irrigated trial at Bushland, where diseases were of no importance, all populations averaged 89 bushels per acre. At Dallas where leaf rust occurred early, no differences for leaf rust reaction were observed for the populations possessing the Amigo resistance.

REDUCED INCIDENCE OF WHEAT STREAK MOSAIC IN WHEAT CURL MITE RESISTANT WHEAT

T. J. Martin

Wheat curl mite (WCM) resistance derived from Salmon reduced the incidence of wheat streak mosaic (WSM) in naturally infested field plots, by 61, 57, and 60% in 1979, 1982, and 1982, respectively. When a single WCM was transferred manually to each plant of WCM resistant and susceptible seedlings in the greenhouse, the incidence of WSM in WCM susceptible lines was 39% as compared to 10% for the WCM resistant lines.

KS80H4200 (PI475772), a WCM resistant F_5 plant selection from the cross Salmon/Sage/3/Larned/Eagle//Sage, was released as germplasm by the Kansas Agricultural Experiment Station in cooperation with USDA-ARS in the fall of 1982.

KS80H4200 is susceptible to WSMV when inoculated mechanically. Reduced incidence of WSM only occurs when the virus is transmitted by its natural vector, the WCM.

GREENBUG BIOTYPE DISTRIBUTION IN THE TEXAS ROLLING PLAINS

J. M. Moffatt and W. D. Worrall

Changes in greenbug biotype create one of the most challenging problems in breeding for resistance to this pest. In 1968 the predominant biotype inthe Great Plains was biotype C (Harvey and Hackerott, 1969). In 1979, however, a new biotype (biotype E) was collected near Bushland, Texas. Subsequent tests revealed that biotype C resistant Amigo wheat and sorghum with biotype C resistance derived from tunis grass were susceptible biotype E (Porter et al. 1982). Puterka et al. (1982) made greenbug collections from wheat fields in 23 counties of the Texas Rolling Plains (TRP) in 1981 to determine the prevalence and distribution of biotype E. Biotype E greenbugs were found in 17 counties. Fourteen counties contained both biotypes in the same fields. Biotype C remained, however, the predominant biotype, accounting for 75% of the greenbugs collected.

It is important from a breeding standpoint to have current information regarding the dynamics of the greenbug population as a whole. To that end this study was initiated as a follow-up to Puterka et al. to monitor any subsequent shifts in the biotype C to E ratio in the TRP.

During the week of February 15-19, 1982, greenbugs were collected from wheat fields in 7 counties of the TRP. The sampled counties represent a north-south and east-west grid through the region. Ten separate wheat fields in each county were sampled with 3 samples being taken from each field (30 samples/county, with approximately 10 greenbugs/sample). The greenbugs were collected with aspirators and transferred into zip-lock bags along with fresh wheat plant material. The greenbugs remained in these bags while they were transported to the greenhouse. Colonies were established using the same method described by Puterka et al. (1982). Once colonies were established they were evaluated for biotype.

Two wheat varieties, 'TAM W-101' and 'Amigo' were used to differentiate the two biotypes. TAM W-101 is susceptible to both biotype C and E. Amigo is resistant to biotype C but susceptible to biotype E. Two seeds of each variety were planted in caged plastic pots 19.1 cm in diameter (one pot/colony) and 10 cm pot stakes were used to label the position of the TAM W-101 seed. When these seedlings reached the 1-2 leaf stage they were infested with 10 greenbugs per plant. Readings were taken when the first susceptible plant showed chlorotic tissue. All pots were monitored for 5-7 days after being read. If any question arose concerning the identification of the biotype, the colony was screened again.

The results of this survey showed highly significant increases of biotype E in Archer and Dickens counties. No biotype E greenbugs were collected in these counties in 1981, however, biotype E comprised 46 and 78 percent of the greenbug population in Archer and Dickens counties, respectively, in the 1982 survey. There was a highly significant increase of biotype E for the TRP, in total, from 25 percent in 1981 to 48 percent in 1982.

Although biotype E is currently well distributed throughout the region, the relative predominance of biotype E in the western portion of the region and biotype C in the east in 1981, indicates that the new biotype probably entered from the southern High Plains of Texas. This supposition is further supported by the large acreage of grain sorghum grown in this area from which fall migration may occur.

GREENBUG RESISTANT WHEATS

K. B. Porter, G. L. Peterson, W. D. Worrall,
J. H. Gardenhire, and M. M. Morad

Resistance to biotype C greenbug has been transferred from 'Amigo' to a number of experimental lines and cultivars. The most extensive evaluation of agronomic performance has been made of BC_3 lines of TAM W-101, TAM 105, and TX71A562-6, Sdy sib/Tmp (62A4615)//Ctk to Amigo. A total of 18 of these backcross lines homozygous for the Amigo gene, were evaluated in replicated performance trials at Bushland (both irrigated and dryland), Chillicothe and Dallas. In general, backcross lines were similar in performance to their respective recurrent parent. Backcross lines exhibited good resistance to powdery mildew at Dallas and were also found to be quite resistant to races of stem rust for which they were evaluated by Dr. D. V. McVey at the Cereal Rust Laboratory, ARS, USDA, University of Minnesota, St. Paul, MN. The Amigo gene appears to provide resistance to stem rust, as well as resistance to powdery mildew. Average yield of the backcross lines were not significantly different from that of the recurrent parent except at Dallas where TAM 105 produced a substantially lower yield, 17 bu/A, than the average yield, 27 bu/A, of 7 backcross lines. The backcross lines appeared to be less sensitive to daylength which became more evident at Dallas. At Dallas, backcross lines headed 4, 2, and 15 days earlier than their recurrent parent, TX71A562-6, TAM W-101 or TAM 105. Mildew resistance could have contributed to the difference between the average yield of TAM 105 backcross lines and the recurrent parent TAM 105. The fact that TAM 105 headed 15 days later than the average heading date of the BC_3 lines probably resulted in TAM 105 incurring more damage from both powdery mildew and leaf rust and consequently it produced a lower yield and lower test weight at Dallas. These lines, although resistant to biotype C, are susceptible to biotype E.

Protein, flour yield, and loaf volume of 8 backcross lines of TX71A562-6 did not differ significantly from those of the recurrent parent. Most backcross lines required shorter mixing times than TX71A562-6 but all were considered to have good quality. Backcross lines of TAM W-101 and TAM 105 did not differ significantly in protein, or in milling and baking performance from their recurrent parents. All produced medium loaf volume and required medium to long mixing time.

Breeding for resistance to biotype E was initiated in 1980, shortly after the replacement of biotype C by biotype E in the High Plains of Texas. At the present time (winter of 1982-1983) the greenbug biotype in the High Plains of Texas appears to be predominately, if not exclusively, biotype E. Backcross lines to Amigo described above have been backcrossed to the biotype E resistant germplasm line 'Largo', an amphiploid of 'Langdon' durum/_T. tauschii_, developed by Dr. Leonard Joppa, USDA, ARS, North Dakota State University. Biotype E resistant selections have been made from BC_3 F_2 populations and the fourth backcrosses (5th dose) are being made at this time. The biotype E resistance of Largo has been easily transferred. In most cases the derived lines will have both the Amigo and _tauschii_ genes for resistance. Initial field evaluation of the biotype E resistant lines is anticipated in the fall of 1983.

CHINCH BUG RESISTANCE IN WHEAT

J. Stuart and G. Wilde

The purpose of this study was to evaluate wheats for chinch bug resistance.

Wheats involved in plant resistance evaluations included several public wheat varieties, wheats rated as lightly or uninjured by chinch bugs in a wheat nursery in 1935 (Jones, 1937), synthetic hexaploid wheats derived from crosses between tetraploid _triticum_ species and a diverse group of diploid _T_. _tauschii_, synthetic hexaploid wheat parental lines, and wheat germplasm involving _Agropyron_.

Female chinch bug reproduction and longevity experiments indicated that there was little difference in chinch bug reproduction and longevity between most entries evaluated. Chinch bugs were also able to develop at the same rate and attain the same size on most wheats involved in a nymphal development experiment. First instar nymph mortality was not attributable to host plant resistance in a nymph mortality experiment, however, some adult feeding preference to wheats was indicated by adult chinch bug numbers counted in field plots and an experiment performed in the laboratory. In addition, some differences in chinch bug reproduction on wheats were also indicated by numbers of eggs and nymphs counted in samples taken from field plots. Mundszentpusstai No. 403, Alstroum (spelt), Purkof, Newton, TAM W-101, CI 15321, and germplasm involving _Agropyron_ were the wheats most consistently indicating chinch bug antibiosis in most experiments.

THE CURRENT STATUS OF BIOTYPE E GREENBUG

J. A. Webster, K. J. Starks, and R. L. Burton

Brief History

Early in 1980, Porter et al. (1982) found in laboratory tests that seedlings of the greenbug resistant 'Amigo' wheat germplasm release (Sebesta and Wood, 1978) and Amigo derivatives were susceptible to progeny of greenbugs collected from the Bushland, Texas, area in November 1979. They concluded that the predominate biotype in greenbug collections made in this area was other than biotypes A, B, or C, justifying a new biotype, designated as "E".

Current Distribution and Biology

Porter et al. (1982) reported that biotype E was found 75 miles north of Bushland in May 1980, while in 1981, Puterka et al. (1982) found that biotype C was the predominate (75%) biotype in the Texas Rolling Plains (north central). In a 1980 Texas-Oklahoma survey, K. J. Starks and R. L. Burton found pure cultures of biotype E in the panhandle of those states. The percentage of biotype C increased eastwardly with 100% biotype C in the central and southeast portions. The results of a 1982 Oklahoma survey were similar. Biotype E was identified in Kansas and Nebraska by T. L. Harvey from sorghum collections made in 1980 by K. O. Bell and P. T. Nordquist, respectively. By 1981, biotype E was found in 23 of 24 counties in Nebraska (Kindler et al., in press). Based on samples taken mainly from sorghum in Kansas in 1982, biotype E was the most predominate biotype; about 20% of the samples were biotype C (T. L. Harvey, personal communciation). Morphologically, biotype E is similar to biotype C. Daniels and Chedester (1981) reported that laboratory colonies of biotype E began reproduction earlier under higher temperatures than biotype C. Webster and Starks (in press) and Salto (1981) found the the oviposition rate of biotype E was slightly higher than biotype C on selected barley lines.

Problems Working With Biotype E

It appears to us that cultures of biotype E have a tendency to go into the egg laying stage more readily than biotype C, however, the egg laying phase of both biotypes can disrupt greenhouse plant resistance tests in Texas and Oklahoma during February and March (Starks and Burton, 1977). Greenhouse cultures of biotype E that killed Amigo during the winter of 1981-82 in Stillwater greenhouse tests failed to kill Amigo during the spring and summer of 1982. The culture was substituted with another biotype E culture that kills Amigo. The problem with the original culture has not been resolved.

Plant Resistance in *Triticum* to Biotype E

The Amigo gene is useful in areas where biotype E is not present, however, whether the new biotype will become the predominate biotype in all of the greenbug geographical areas is unknown. Current approaches of Oklahoma State University and ARS researchers in developing resistance in wheat to biotype E include: 1) developing wheat-rye hybrids using selections of 'Insave' rye as the resistant parent, 2) incorporating *Triticum tauschii* into adapted wheats, and 3) evaluating new materials from wheat collections for resistance to biotype E. Selected triticale lines are being retested to confirm resistance to biotype E. *Triticum* species need to be evaluated for greenbug resistance.

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REGIONAL PERFORMANCE RESPONSE OF SEVERAL COMMONLY GROWN CULTIVARS

R. Bruns

The great plains states where hard red winter wheat is grown is highly variable. Environmental variability is high not only within this large region, but climatic patterns change significantly from year to year. Most researchers familiar with these variable conditions feel that regional adaptation is a valuable trait that can provide some degree of consistency in production.

Several past studies have attempted to identify regional adaptation through the use of mean performance and linear regression coefficients. We felt that it may be worthwile to look at additional current yield information. The data base for these comparisons is all of the replicated yield trials available to us since 1979. This represents over 550 trials and is a considerably larger data base than has been available from past studies.

	Yield bu/A	No. Loc.	Reg. Coef.	r^2	1979 Yield	No. Loc.	1980 Yield	No. Loc.	1981 Yield	No. Loc.	1982 Yield	No. Loc.
Triumph	39.4	151	.81	.86	53.5	8	41.4	39	36.7	46	38.4	58
Trial X	43.9				61.2		45.9		40.5		42.9	
Scout 66	42.0	339	.86	.89	49.1	47	43.4	100	40.6	120	37.6	72
Trial X	44.6				50.7		46.3		42.5		42.0	
Newton	43.9	282	1.02	.88	51.8	20	46.4	64	41.2	82	43.1	116
Trial X	43.4				52.3		44.9		40.0		43.4	
Rocky	46.1	340	1.01	.92	51.7	68	47.8	94	43.7	101	42.3	77
Trial X	44.7				48.6		47.0		42.4		41.6	
Vona	45.7	301	1.15	.93	48.6	26	47.8	75	44.4	93	44.6	107
Trial X	43.2				48.1		44.6		41.6		42.6	
Wings	48.5	326	1.09	.92	49.7	21	49.9	88	44.7	100	50.4	117
Trial X	46.3				48.0		47.3		43.6		47.6	
Hawk	48.5	266	1.12	.94	----	--	56.7	35	50.4	85	45.4	146
Trial X	45.5				----		52.2		45.3		44.1	
TAM 105	47.1	321	1.07	.90	38.0	17	49.7	77	46.2	108	47.5	119
Trial X	43.5				38.7		45.4		41.5		44.8	

When reviewing this data together with the scatter graphs and plotting the linear regression lines, several interesting observations may be made.

1. There is relatively little difference among these varieties in average regional performance at low yield levels.

2. There are large differences among these varieties in average regional performance at high yield levels.

3. Tall varieties do not have a marked yield advantage over short varieties in the lower yield ranges.

Computed performance using linear regression coefficients * (LRC)

	$\overline{X}$ = 25 bu/A	$\overline{X}$ = 50 bu/A	$\overline{X}$ = 80 bu/A
Triumph	24.1	44.3	68.6
Scout 66	25.3	46.6	72.1
Newton	25.1	50.6	81.2
Rocky	26.2	51.5	81.8
Vona	24.3	53.1	88.4
Wings	25.1	52.6	85.6
Hawk	25.7	53.5	86.8
TAM 105	27.3	54.1	86.2

*note: trial mean components may vary for each variety--data use should be limited to general observations.

4. Many varietal responses across yield ranges appear to be nonlinear. This raises some serious questions concerning the use of linear regression evaluations to predict varietal response accurately. This is of concern especially when working at or beyond the limits of the data base. Our experience suggests that by the time enough data is generated to give a significant linear regression, we are better off using actual data than putting it into a linear regression prediction form.

An example of nonlinear varietal response--TAM 105

		Actual Response (bu/A)	Lin. Reg. Coef.	Predicted Response (bu/A)		
Trial $\overline{X}$ 10-45 (bu/A)	TAM 105	34.7	.99	12.6	47.3	81.9?
(180 loc.)	Trial X	32.3		10	45	80
All Trials	TAM 105	47.1	1.07	11.3	48.7	86.2
(321 loc.)	Trial X	43.5		10	45	80

5. Varietal responses in sub-regions or particular environments can be drastically different than over-all regional averages.

		Bu/A	
Kansas on continuous cropping	Newton	49.2	LCR = .78
(34 loc.)	Trial X	45.0	r^2 = .59
All trials in region	Newton	43.9	LCR = 1.02
(282 loc.)	Trial X	43.4	r^2 = .88

6. Varietal responses to seasonal differences can be highly significant. The results of the 1982 season show this very well.

		Bu/A		
Pre 1982 (120 loc.)	Hawk	52.3	LCR = 1.09	r^2 = .94
	Trial X	47.3		
1982 (146 loc.)	Hawk	45.4	LCR = 1.13	r^2 = .94
	Trial X	44.1		

HYBRID ADAPTATION

John Erickson

Regression analysis is a useful tool for characterizing germplasm. Regressing an entry mean on its trial mean over a number of trials gives a measure of the response to changing environments. An r^2 value also may be computed as a measure of stability for the entry over changing environments.

Some advantages of using regression analysis are as follows: 1) entries in a nursery don't have to be constant as long as they are representative of the germplasm being evaluated; 2) comparisons can be made among entries grown: a) in different trials, b) in unequal numbers of trials, c) in different locations, d) in different years.

Some restrictions apply to the valid use of regression analysis as follows: 1) an adequate number of entries per trial; 2) entries representative of the germplasm; 3) appropriate test locations, some high and some low mean sites to stabilize the regression line; 4) data from two or more years; 5) usually at least 20 data points.

Table 1 gives a regression analysis of several varieties and hybrids grown in Montana for several years. The older varieties are much less responsive than Centurk or Nugaines. The hybrids generally were comparable to the newer varieties in response to changing environments. Calculated individual entry means at various theoretical site means showed the hybrids to be superior to the older varieties, but comparable to Centurk and Nugaines for yield.

Table 2 is a listing of data from the southern Great Plains area. The top half of the table shows two hybrids with their parents on either side and comparable data for two check varieties. B397 is a full dwarf parent with a high by·x value. The two R-line parents have comparable by·x values to the varietal checks. The hybrids are very responsive to changing environments. At a 20 bu/A yield the hybrids are inferior to the check varieties, at 40 bu/A the hybrids are 4% better than the checks. The hybrids show about a 13% advantage at 60 bu/A, a 17% advantage at 80 bu/A, and a 20% advantage at 100 bu/A. The strong response to increasingly favorable conditions would indicate an adaptation of these hybrids to irrigated or highly productive dryland.

The lower half of Table 2 shows the same two R-lines and their hybrids with a low responding female parent, B281. In comparisons with the same checks, the hybrids show an 8% advantage at 20 bu/A, a 4% increase at 40 bu/A, 3% at 60 bu/A and about 2% at 80 or 100 bu/A. The hybrids have their best relative advantage under low yield conditions.

The above data illustrate at least two points. First that it is possible to develop hybrids with a range of response levels. Second that the response of the hybrids is related to the response of their parents.

Table 1. Regression Analysis (Montana)

Entry	n	by·x	r^2	$\bar{y}$ @ $\bar{x}$ of: 25	50	75	100
Cheyenne	85	0.721	0.797	29.3	47.3	65.3	83.4
Winalta	85	0.787	0.852	28.1	47.8	67.5	87.1
Centurk	92	1.029	0.904	24.3	50.0	75.8	101.5
Froid	57	0.611	0.769	25.1	40.4	55.6	70.9
Nugaines	72	1.060	0.861	27.3	53.8	80.3	106.8
DK505	35	1.016	0.922	27.4	52.8	78.2	103.6
NH67	73	0.941	0.893	26.6	50.2	73.7	97.2
DK522	82	0.950	0.895	29.3	53.0	76.8	100.5
NH401	61	0.963	0.880	26.3	50.3	74.4	98.5
NH77	20	1.104	0.846	27.9	55.5	83.1	110.7
Variety x	78.2	0.842	0.837	26.8	47.9	68.9	89.9
Hybrid x	54.2	0.995	0.887	27.5	52.4	77.2	102.1

Table 2. Hybrid-Parent Regression Analysis

Entry	n	by·x	r^2	$\bar{y}$ @ $\bar{x}$ of: 20	40	60	80	100
R362a	25	1.008	0.935	17.2	37.4	57.6	77.7	97.9
H166	25	1.421	0.893	10.8	39.2	67.6	96.0	124.5
B397	25	1.284	0.854	2.7	28.4	54.0	79.7	105.4
H165	25	1.204	0.891	18.6	42.7	66.8	90.9	114.9
R362b	25	0.928	0.785	21.6	40.1	58.7	77.3	95.8
Vona	25	0.994	0.897	21.5	41.4	61.3	81.2	101.0
Tam 101	25	1.022	0.738	17.0	37.4	57.8	78.3	98.7
R362a	30	1.108	0.910	13.9	36.0	58.2	80.4	102.5
H107	30	1.029	0.910	21.8	42.4	62.9	83.5	104.1
B281	30	0.883	0.808	20.6	38.3	55.9	73.6	91.2
H104	30	1.049	0.945	20.1	41.1	62.1	83.1	104.0
R362b	30	1.008	0.826	17.9	38.1	58.3	78.4	98.6
Vona	30	1.080	0.885	18.1	39.7	61.2	82.8	104.4
Tam 101	30	0.980	0.759	20.8	40.4	60.0	79.6	99.2

VALUE OF INDIVIDUAL TEST LOCATIONS AS ESTIMATED FROM REGIONAL YIELD DATA

L. Robertson

Conducting yield trials is perhaps the single most expensive task in the development of new cultivars. We all recognize the advantages of choosing test sites that give what we believe is valid information for a particular geographic area.

This paper develops data to measure the value or predictability of individual test locations that identify or rank yield performance over a large geographic area. If locations can be identified with a high degree of predictability or reliability, more lines can be discarded and fewer lines carried to the next generation with little chance that good lines have been discarded. The converse situation would be to eliminate a location(s) that consistently gave poor predictive results. Potential savings arise from eliminating locations with little value or from carrying fewer lines.

Materials and Methods

The method chosen for this study is to compare each cultivar's overall nursery mean yield as the dependent variable with the cultivar's individual location yield as the independent variable using regression analysis. The data set used are the two regional yield nurseries grown throughout the hard winter wheat region for the years 1977-1981.

The following three assumptions are necessary for the evaluation of this study:

1. Each location has equal importance in determining varietal potential.

2. Differences among locations are due to environment and not to particular management techniques.

3. Environmental conditions affecting a location are uniform across cultivars but cultivar response differs to environment.

Results and Discussion

Linear correlation values of individual locations are given in Table 1 for the Southern Regional Performance Nursery (SRPN). Linear correlation values are a measure of closeness of ranking of individual locations with the overall nursery mean. It is suggested that locations with high correlation values are more valuable test sites for yield than locations with low correlation values. The data show a wide variation of correlation values, with the dryland nursery at Clovis having the lowest correlation (predictive) value and Bushland irrigated having the highest value.

Some locations were extremely variable over the 5 years studied, i.e., North Platte -.06 to .68, whereas other locations were very stable in their predictive value, i.e., Bushland irrigated .62 to .89 and Lahoma .42 to .59.

Locations with high correlation values identified more of the highest yielding cultivars than did locations with low correlations (Table 2). The 5 locations with the lowest correlations identified an average of 3.68 of the top 10 yielding cultivars while the highest correlating sites identified an average of 6 of the top 10 yielding cultivars. Table 3 shows the same locations with yields converted to a percent of the nursery mean yield.

These results indicate that, in general, higher yielding sites are better predictors of nursery mean yields than are lower yielding sites. There were, however, some notable exceptions to the above generalization, indicating that factors other than yield per se are important.

Table 4 indicates the same pattern of correlation values, generally increasing as yield increases. Non-conforming data again confirm that factors other than yield per se contribute to the differences among locations.

Northern Regional Performance Nursery data are given in Table 5. Clovis irrigated had the highest correlation values for this nursery and Williston had the lowest correlation. Trends in this nursery appear to be similar to those discussed for the SRPN.

Clovis and Bushland grew both dryland and irrigated nurseries with the dryland always having a smaller correlation than the irrigated nursery.

Conclusions

Conclusions suggested from this study are as follows:

1. Differences do exist among locations as to their "predictive" value in relation to an area average.

2. Differences do exist among locations as to their ability to identify highest yielding cultivars based on regional average.

3. On a state basis, Nebraska locations appeared to have the best predictive value (highest r values).

4. Irrigated locations as a group have higher predictive values than dryland sites.

5. Low yielding sites have little, if any, predictive value.

6. High yielding sites have best predictive values.

7. Locations with low predictive values are of little use in selection nurseries or preliminary yield nurseries where yield is primary selection criteria.

8. Locations with low predictive value may require extra testing to support release and/or marketing decisions for these areas.

9. Selection at locations with low predictive value may enhance identification of lines with narrow rather than broad adaptation.

Table 1. Linear Correlation Values, Variety Location Yield with Overall Variety Nursery Mean.

	1981	1980	1979	1978	1977	$\bar{x}$
Lind, WA	.32	.24	.06	.52	.08	.24
Aberdeen, ID irr.	.45	.56	.22	-.02	--	.30 (4)
Tetonia, ID	.57	--	--	.63	.49	.56 (3)
Columbia, MO	.61	.67	.42	.64	.27	.52
Ames, IA	.49	.44	-.06	--	--	.29 (3)
Urbana, IL	.14	.47	.29	.40	.41	.34
Brookings, SD	.32	.45	--	--	--	.39 (2)
Highmore	.42	--	--	--	--	.42 (1)
Presho	.22	.21	.00	.22	--	.16 (4)
Mead, NE	.77	.71	--	--	.63	.70 (3)
Clay Center	.81	.76	.47	.64	--	.67 (4)
North Platte	.55	.44	-.06	.68	.50	.42 (4)
Sidney	.54	--	.71	.57	.64	.62 (4)
Alliance	.27	.17	.77	.54	.50	.45
Hutchinson, KS	.27	.28	.37	.73	.37	.40
Hays	.64	.70	.30	.31	.57	.50
Garden City	.26	.27	--	.39	.16	.27 (4)
Colby	.52	.75	.71	.75	.60	.67
Ft. Collins, CO	.17	.72	.67	.53	.37	.49
Springfield	.33	.46	.60	.07	.43	.38
Akron	.49	.48	.46	.21	--	.41 (4)
Julesburg	--	--	.65	.49	--	.57 (2)
Burlington	--	--	.26	--	.41	.34 (2)
Stillwater, OK	.24	.66	.69	.63	.69	.58
Altus	.43	.62	--	.69	.40	.54 (4)
Lahoma	.42	.46	.56	.58	.59	.52
Goodwell irr.	.72	.49	.63	.88	.60	.66
Dallas, TX	.49	.61	.35	.53	.49	.49
Chillicothe-Vernon	.47	.48	.36	.67	.59	.51
Bushland irr.	.79	.89	.75	.86	.62	.78
Bushland dryl.	.36	.71	.52	--	.57	.54 (4)
Clovis, NM irr.	.74	.51	.85	.37	.58	.61
Clovis dryl.	.22	.24	-.06	.29	.07	.15
Farmington	.38	.47	.89	--	.56	.58 (4)

Table 2. Top 10 Cultivars Identified by Various Locations, SRPN.

	1981	1980	1979	1978	1977	$\bar{x}$
	Low Predictive Sites					
Lind, WA	4	4	3	5	5	4.2
Ames, IA	5	4	3	-	-	4.0
Presho, SD	3	2	4	5	-	3.5
Garden City, KS	3	4	-	4	3	3.5
Clovis, NM dryl.	3	2	3	4	4	3.2
	High Predictive Sites					
Mead, NE	6	6	-	-	6	6.0
Clay Center, NE	7	6	8	5	-	6.5
Colby, KS	5	6	8	8	4	6.2
Goodwell, OK	6	5	5	7	5	5.6
Bushland, TX irr.	7	7	6	6	3	5.8

Table 3. Location Predictive Value as a Function of Location Mean Yield Converted to Percent of Nursery Mean Yield, SRPN.

	1981	1980	1979	1978	1977
	Low Predictive Sites				
Lind	58	56	24	77	35
Ames	164	134	52	--	--
Presho	59	48	32	51	--
Garden City	50	77	--	72	49
Clovis, dryl.	79	46	30	23	46
	High Predictive Sites				
Mead	146	126	--	--	97
Clay Center	140	145	54	64	--
Colby	71	139	122	110	74
Goodwell	161	115	152	178	117
Bushland, irr.	177	157	170	209	127
Nursery Mean KG/HA	3209	3490	3670	2916	3425

Table 4. Correlations of Cultivar Location Yield With Nursery Mean Yield, SRPN.

1981	1980	1979	1978	1977
5 lowest yielding sites				
.71	.46	.06	.22	.08
.27	.24	-.06	.21	.07
.24	.21	.00	.07	.16
.21	.46	.26	.63	.57
.46	.24	-.06	.64	.60
5 sites averaging closest to nursery mean				
.61	.47	.56	.57	.41
.49	.45	.71	.53	.59
.43	.66	.52	.73	.63
.45	.62	.36	.75	.49
.47	.61	.29	.40	.57
5 highest yielding sites				
.74	.44	.85	-.02	.64
.72	.75	.63	.54	.62
.49	.76	.75	.88	.37
.79	.89	.89	.53	.41
.17	.72	.67	.86	.56

Table 5. Linear Correlation Values, Variety Location Yield With Overall Variety Nursery Mean, NRPN.

	1981	1980	1979	1978	1977	$\bar{x}$
Lind, WA	.18	.55	-.04	.75	.39	.37
Aberdeen, ID irr.	.34	.70	--	--	--	.52 (2)
Tetonia, ID	.39	--	.16	.46	.72	.43 (4)
Moccasin, MT	.65	--	.44	--	.51	.53 (3)
Sidney	.72	--	--	.14	--	.43 (2)
Conrad	.79	--	--	--	--	.79 (1)
Hettinger, ND	--	--	--	--	.21	.21 (1)
Casselton	.43	.13	--	--	--	.28 (2)
Williston	.03	.21	--	--	-.05	.06 (3)
Brookings, SD	.21	.61	--	--	.28	.37 (3)
Highmore	.65	.05	-.11	.70	--	.32 (4)
Presho	.27	.48	.57	.52	--	.46 (4)
Mead, NE	.69	.52	.19	.19	.54	.43
North Platte	.53	.61	.26	.65	.62	.53
Sidney	.52	--	.71	.52	.82	.64 (4)
Alliance	.39	.56	.53	.65	.81	.59
Waseca, MN	.44	.30	.60	.76	--	.53 (4)
St. Paul, MN	--	.61	.51	.35	.37	.46 (4)
Lethbridge, Alta.	.77	.45	-.16	.41	.74	.44
Clovis, NM irr.	.68	.83	.57	.50	.80	.76
Clovis, NM dryl.	.41	-.10	.16	.04	.48	.20
Archer, WY	.55	.18	.40	.58	--	.43 (4)
Sheridan, WY	.68	.67	.39	.30	--	.51 (4)

YIELD COMPONENT STABILITY

E. L. Smith and F. P. Cammack

Ten winter wheat genotypes representing a range of expression for yield and the components of yield were grown for two years at each of four field locations and one greenhouse location. Grain yield, tiller number, kernel weight, and kernels per spike were measured on each genotype.

Significant genotype by environment interactions were noted for all traits with the exception of year by location by genotype interaction for tiller number. Regression analysis indicated that above average yields were associated with below average stability (i.e. β values greater than 1.0) for yield. Above average yields were associated with above average stability for kernels per spike, near average stability for tiller numbers and below average stability for kernel weight (Table 1).

F23-71, a germplasm line from Romania, was included in the study because of high values for number of kernels per spike. It exhibited a high degree of instability (β = 1.81) for that trait in this study. Lovrin 6, characterized by large kernels, was highly stable for that trait (β = 0.55).

The greenhouse location was used to examine the performance of yield components under nonstress conditions. The relationship between field and greenhouse results for yield and yield components is shown in Table 2. There were no negative correlations among components from greenhouse data but kernels per spike was negatively correlated with kernel weight from the field data.

In conclusion, it appears that the simultaneous interpretation of yield component means and stability parameters is, at best, complicated. The optimum expression of each yield component needed to maximize yield could not be determined in this study. However, the highest yielding genotypes had near-average stability for the three components, indicating that stability may be more important than absolute expression of components.

Table 1. Yield and yield components, means and regression coefficients (2 years, 4 locations).

	Yield (kg/ha)		Tiller no.		K/S		KWT	
	$\bar{x}$	$\bar{b}$	$\bar{x}$	$\bar{b}$	$\bar{x}$	$\bar{b}$	$\bar{x}$	$\bar{b}$
TAM W-101	3917	1.22	58	1.07	28	0.62	39.0	1.12
Burgas 2	3629	1.28	39	0.75	39	0.64	36.2	1.16
Partizanka	3513	1.23	47	1.00	36	0.96	33.7	1.37
NR391-76	3498	0.01	37	0.68	45	0.95	37.5	1.30
Newton	3343	1.18	52	1.10	42	0.62ns	27.7	1.06
Vona	3286	0.97	58	1.49	42	1.22	28.0	0.93
Triumph 64	3257	0.52ns	56	1.32	29	1.05	36.3	0.56
Scout 66	3109	0.75	58	1.24	30	1.10	33.7	0.84
F23-71	2824	1.08	33	0.62	50	1.81	33.9	1.11
Lovrin 6	2720	0.76	37	0.73	29	1.03	50.4	0.55ns
Mean	3310	--	47	--	37	--	35.7	--
Standard dev.	293	--	6.0	--	3.0	--	1.6	--

Table 2. Phenotypic correlation coefficients among yield and yield components, field and greenhouse data.

	Tiller No.	K/S	KWT
Yield	a) 0.627**	-0.100	0.321**
	b) 0.841**	0.590**	0.271**
Tiller No.		0.021	-0.100
		0.315**	0.089*
K/S			-0.408**
			-0.036

a = field data (df = 227), b = greenhouse data (df = 587)

SD 84811 - A NEW CHEMICAL HYBRIDIZING AGENT (CHA)

J. P. Foster

In the mid-'70's, a project was established at Shell's Sittingbourne Research Center to find materials which would render wheat male sterile. Following mechanistic lines of reasoning, several chemicals emerged, each of which had distinct advantages and disadvantages -- the latter being mainly phytotoxicity of various forms.

Through ongoing synthesis, second generation compounds have proven much superior in these respects and have allowed us to focus on hybrid wheat *per se* as opposed to looking for the "right" kind of activity.

We are very encouraged with the results to date and we feel SD 84811 has good potential for the commercial production of hybrid wheat but much more work needs to be done. In terms of compound performance, the dose and timing windows are adequate for practical use, and the resulting hybrid seed is of good quality. Aside from transient yellowing among a few varieties, no phytotoxicity has been observed.

This year tests have been expanded to include a broader spectrum of groups in both the public and private sectors.

USE OF ALIEN GENETIC INFORMATION FOR WHEAT IMPROVEMENT

K. L. Goertzen and B. L. Goertzen

Hard red winter wheat has been improved by the addition of genetic information from *Aegilops ovata*, *Agropyron elongatum*, and *Secale cereale*.

Some of the more important improvements are:

1. Wheat streak mosaic virus resistance.
2. Cephalosporium stripe resistance.
3. Leaf and stem rust resistance.
4. Field tolerance to greenbugs.
5. High protein.
6. Heat tolerant wheat.

BREEDING FOR DROUGHT RESISTANCE IN WHEAT

N. T. Nguyen, R. C. Johnson, and O. G. Merkle

The largest acreage of dryland hard red winter wheat in the United States is in the central and southern Great Plains. Wheat is frequently subject to drought stress of sufficient intensity and duration to adversely affect production. Genetic improvement of drought resistance would bring productivity closer to the existing genetic potential, and would contribute significantly to yield stability of winter wheat in the region. In the past, because of the lack of reliable selection criteria and screening techniques, wheat breeding for drought resistance has been indirect, based mostly on empirical yield testing. Selection for early maturity has been emphasized as a drought escape mechanism. However, drought resistance mechanisms will be especially useful in minimizing yield losses when drought occurs during critical reproductive periods. Very little research has been reported on wheat in the Great Plains in relation to physiological mechanisms of drought resistance and their genetic control. Few potential traits associated with drought resistance have been studied in sufficient detail to be useful in wheat improvement programs in the Great Plains. Our specific objectives in this project are to: 1) characterize physiological mechanisms related to specific types of drought resistance (avoidance and tolerance) in winter wheat, 2) determine the amount of genetic variation for drought resistance traits of potential use, and 3) determine the inheritance of those traits and their relationship to plant productivity (biological yield, grain yield and yield components). Our long range goal is to identify selection criteria for drought resistance and to develop suitable screening techniques that will be useful for breeding more drought resistant wheat cultivars. A breeding-physiology team approach has been undertaken to achieve this goal.

GERMPLASM ENHANCEMENT ACTIVITIES AT KANSAS STATE UNIVERSITY

R. G. Sears and B. S. Gill

I. Germplasm Enhancement

Kansas State University, under the direction of Dr. Bikram S. Gill, is maintaining one of the largest collections of wild germplasm and genetic stocks in the U. S. outside of the USDA germplasm system (Table 1). During the past three years this collection has been extensively studied for disease resistance as well as its taxonomic, biologic, and cytogenetic characteristics. At present a large number of accessions have been identified with resistance to important diseases and insects in the Great Plains (Table 2). This germplasm source represents potentially important new genes in breeding for genetic resistance. In cooperation with both state and USDA scientists, Dr. Gill is coordinating an effort to 1) transfer new genes for resistance to plant diseases and insects into hexaploid wheat, and 2) develop appropriate genetic stocks in adapted winter wheat backgrounds. Specific objectives of this research are as follows:

1. To develop genetic stocks in Wichita containing genes '*ph*', *kr1*, *kr2*, and *Rht3*, in both winter and spring backgrounds.

2. To develop bridging reconstituted genomic stocks AABB and AABBDDDD from crosses of Wichita with tetraploid species and goatgrass.

3. To transfer disease and insect resistant genes from *Triticum dicoccoides* (AABB), *T. araraticum* (AAGG), and *T. tauschii* (DD), by the use of bridging stocks.

4. To carry out cytogenetic analysis and chromosome mapping of transferred genes for proper documentation of disease resistant genes.

5. To characterize germplasm and resulting hybrids for heat, drought, and salt tolerance.

6. To carry out field trials for yield, and other agronomic traits of the disease and insect resistant germplasm and make selections for germplasm releases.

II. Tissue Culture

Research is focused on the use of tissue culture in interspecific or intergeneric crosses involving wheat. Chromosome rearrangement (translocations and inversions) and aneuploidy are not uncommon occurrences in tissue cultures. We are using tissue cultures of wheat-rye hybrids to investigate the feasibility of tissue culture as a tool to generate chromosome exchange in a wide crossing program. Presently we have documented that the selection ND7532 carries either dominance or partial dominance for superior tissue culture response. This allows poor performing wheats or their relatives to be crossed with ND7534 and their F_1 progeny grown as tissue cultures with relative ease. Because wheat and rye chromosomes can be distinguished from one another using Giemsa C-banding, wheat x rye R_0 and R_1 somaclones can be examined for frequency and types of chromosomal interchange. Presently we are trying to document the feasibility of this approach as well as describe some of the genetic consequences of passing wheat or wheat-rye hybrids through a tissue culture system.

Using tissue culture in a wide crossing program has several potential advantages apart from the potential of chromosomal exchange. First, many wide hybrids require embryo culture to recover the F_1 hybrid. Tissue culture of these immature embryos (scutellum tissue) allows for the possibility of clonally propagating these rare F_1 hybrids. Regenerating a number of plants is useful either in further studies or backcross or chromosome doubling procedures. Secondly, rare hybrids can be maintained potentially indefinitely through immature spikelet tissue culture and subsequent plant regeneration. Thirdly, the manipulation of cell populations, rather than plants, undoubtedly will prove useful for studying and utilizing somaclones from intergeneric or interspecific crosses.

Table 1. Inventory of K-State wild wheats and other germplasm collection.

T. boeoticum	640
T. urartu	203
T. dicoccoides	239
T. araraticum	262
T. tauschii	128
Aegilops spp. (20)	334
Genetic stocks	352
Misc.	257
Total	2,415

Table 2. Disease and insect resistance evaluation of wild wheats and goatgrass (total accessions 1,472). The transfer and genetic analysis of resistant genes is in progress.

Disease or insect	# Tested accessions	# Resistant accessions
Greenbug	179	19
Hessian fly D biotype	433	138
GP biotype	54	28
Wheat curl mite	755	0
Tan spot	64	4
Wheat streak mosaic virus	385	12
Leaf rust culture 6 PRTUS	1201	427

CHEMICAL HYBRIDIZING AGENTS IN WHEAT BREEDING

K. D. Wilhelmi

CHEMICAL HYBRIDIZING AGENTS - (C.H.A.'s)

Nearly 13 years ago Schmidt et al. (1970) stated, "if a male gametocide could be developed, it would have many advantages over the cytoplasmic male sterility restoration system." Today several chemical companies including Rohm and Haas have active research programs to synthesize, to identify, and to evaluate the efficacy of new C.H.A.'s, and a number of use patents have been issued.

Rohm and Haas has been interested in C.H.A.'s for more than 20 years and was a leader in this field in the early days of research with cotton. One of our newest programs is the development of hybrid wheat by utilizing chemicals to alter normal pollen production in the female parent (C.H.A.'s have also been called pollen suppressants). The chemical we use, HYBREX^{TM}, today has evolved over more than 10 years of costly research, and is a third or fourth generation compound. However, we are still fine tuning the use of the chemical since only about 4-5 years of actual field experience in producing hybrids by chemical means have passed. We have an extensive agricultural chemical research effort to backstop and provide the plant breeders with technical support in utilizing the chemical the most effective way in the overall hybrid seed program.

Requirements for Chemical Hybridizing Agents

1. Complete or nearly complete male sterility.
2. Little or no plant phytotoxicity or injury to female flower parts.
3. Systemic in activity to effectively sterilize all tillers.
4. The "window" for application time should allow for inclement weather and large acreages to be sprayed.
5. Interactions of genotype x environment x chemical and combinations thereof must be small.
6. Environmentally safe and non-toxic to humans, animals, etc.
7. Cost efficient.
8. Reasonably easy to apply.

Application of Chemical Hybridizing Agents

As with most agricultural chemicals, the time of application to the plants is critical if successful end results are expected. The female parent is treated with the C.H.A. at a growth stage somewhat before anthesis and even meiosis. The application window varies with environmental conditions, but appears to be acceptable.

Schmidt, J. W., V. A. Johnson, and P. J. Mattern. 1970 (April 29-May 13). In Proceedings of the Third FAO/Rockefeller Foundation Wheat Center. Ankara, Turkey. pp. 158-165.

Genotypes of wheat vary in optimal dosage required to obtain the desired level of male sterility of the female parent. We predetermine the effective dosage (ED) rate to apply to each female parent put into crossing blocks from genotype/dosage studies. These studies are conducted at various sites in the HRWW area to get a sample of environmental influences on chemical activity. Recommended application rates sometimes need fine tuning at application time if extreme environmental conditions prevail for a period prior to spraying time. As a rule of thumb, fields or crossing blocks exhibiting extreme variability in stand or growth stage at application time generally should be abandoned, or let go into commercial production as the chemical may not be completely effective. This allows the hybrid seed producer to harvest the envisioned hybrid seed for production with his other crop since it was not chemically treated.

Seed producers are trained by Rohm and Haas field agronomists on how to most effectively produce hybrid seed. Growers are advised by area on choice of hybrid to produce, calibration and modification of spraying equipment, proper determination of growth stage to apply the C.H.A., calculations of percent hybrid obtained in his production field, and many other aspects of hybrid seed production.

HYBRID PERFORMANCE

Significant expression of heterosis in hybrid wheat grain yields has been difficult to find in the HRWW area. There are three possible explanations for this phenomenon:

1. the low yield level of inbred lines in the hybrid;
2. too few hybrids evaluated to resolve heterosis problem;
3. low specific combining ability effects.

In the first two years of yield testing, Rohm and Haas HRWW hybrids had difficulty competing with the commonly used check varieties. Seldom if ever did one of our hybrids rank number one across a series of experiments, or even in the top five yield groups. This situation has improved greatly with more yield testing and screening of parents for hybrids. Today, our second generation hybrids are no longer embarrassing to enter in public or private tests, and in some areas we have identified hybrid combinations that are very respectable. Rohm and Haas is hopeful that future hybrids emanating from proven parent inbred lines that have undergone further cycles of selection will be even more advantageous for yield than present day hybrids.

The question of yield advantage of F_1 wheat hybrids has been discussed and argued by wheat breeders and geneticists for more than 20 years. Yet, today I know of no single wheat hybrid that wins every yield trial in which it is entered; furthermore, this situation could very likely hold true for the next 20 years. As we project into the future, realizing our present knowledge of genetics and the wheat plant, it will take a tremendous breakthrough in genetic engineering to develop wheat types (hybrid or line) that will routinely yield 50% better than the best available check variety. Indications are that hybrid performance tends to be more stable over environment than are varieties grown in similar experiments.

Our hybrid yield testing program is based on comparisons with a set of five standard varieties, which are carefully selected to represent the competition of both private and public releases. We do not estimate the percentage of heterosis for every hybrid tested. This is simply because of two reasons:

1. The cost of testing hybrids and all their parents would be prohibitive.

2. Most of these studies are more academically oriented and have little utility in the seed business, but their importance in genetic studies should not be overlooked.

HYBRID WHEAT BREEDING AND UTILITY OF C.H.A.'s

Rohm and Haas has initiated a breeding program for the development of pure lines to serve as parents in new hybrid combinations. This program was necessary since we could easily exhaust the supply of public cultivars readily available to everyone as parental stock. Moreover, and probably a more important factor, not all cultivars have the appropriate floral and pollen characteristics to serve as parents in viable hybrid combinations.

The main thrust in our line/hybrid breeding program is the development of parents for hybrids, and of course, the testing of experimental hybrids. Particular emphases are placed on yield, resistance to insects and diseases, agronomic acceptance, milling and baking qualities, winterhardiness, and other factors. Another factor which is very important to us and which conventional breeders are not concerned with is the floral characteristics of the wheat plant, i.e., anther extrusion, flower opening.

Chemical hybridizing agents are useful to the breeder and offer several distinct advantages unavailable to normal wheat breeding programs. Most of these are simply because there is abundant F_1 seed available for rapid screening of numerous populations. We are using C.H.A.'s in our program for the following items:

1. Early testing of the combining ability of prospective new parent lines. This is done by diallel or other special mating designs of Griffing (1956).

Griffing, B. 1956. Concept of general and specific combining ability in relation to diallel crossing systems. Australian Journal of Biol. Science 9:463-493.

2. Breeding Value -- a relative measure of general combining ability (g.c.a.) for each parent tested either as male, female, or both. These values are based on hybrid vigor estimates from numerous testing sites and are a non-classical measure of g.c.a. when sufficient observations are present.

3. Early elimination of non-promising hybrid combinations from the breeding program. No need to keep low yielding populations in the program.

4. Random mating population breeding - genes for various traits can theoretically be accumulated by forced random hybridization by nature.

5. Development of a tester program for rapid identification of superios lines without making all possible hybrid combinations.

6. Eliminates the need for hand emasculation in the greenhouse, or in the field.

7. Hybrids can be "tailor made" for any production area. This is expecially true for the simpler, dominantly inherited traits.

Our total wheat breeding effort is new and still in the embryonic stage as compared with most breeding programs of the Great Plains. We realized some time ago, however, that hybrid breeding and conventional breeding are simultaneously both competitive and complementary. Presently-grown popular conventional varieties have been derived largely from the breeder's intuition and ability to make the proper crosses for selection of new varieties, which include Newton, TAM 105, Brule, Wings, and others. We hope our knowledge using the techniques above will help us speed up the system of identifying superior lines.

We are now just beginning to experience and appreciate the importance of combining ability and genetic diversity in our hybrid breeding program. As Dr. Karl Lucken stated in 1981, "hybrid wheats eventually will not be simply hybrids between conventional lines or cultivars." We feel it is necessary to have a supporting breeding program to provide a continual supply of elite parents for new hybrids in the future.

ADVANTAGES OF PRODUCING HYBRID WHEAT CHEMICALLY

The purpose of this portion of the presentation is not to defend the chemical approach to hybrid wheat, but merely to point out that hybrids produced chemically may be accomplished in some ways

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Lucken, Karl. 1981. Breeding and production of hybrid wheats. In Agronomy Abstracts, p. 66.

that are simpler than the traditional cyto-sterile/restorer system. The reasons for this are the following:

1. Any conventional cultivar may potentially and quickly be used as a female or male parent in producing hybrids. This ultimately depends on its floral characteristics.

2. Breeding of parent lines is simplified -- no concern with male sterility or restorer genes.

3. Parental increase needs for A, B, and R lines is eliminated although seed stock of parent lines will need to be maintained for the C.H.A. system also.

4. Parental increases can be made much faster and easier.

5. Combining ability estimates of a potential parent line are more useful and reflect the true breeding potential of that line which may be lost when converted to a male sterile for the CMS system.

6. Hybrids in production can be modified quickly.

Every new idea or system introduced normally has disadvantages associated with it, and using the C.H.A. technology to produce hybrids is no exception. Our biggest disadvantages are the expense for the chemical and its application, which are reoccurring. This is not a factor in the CMS system. The question of which system would be the most profitable in the long run is a matter of conjecture, but we believe that the C.H.A. endeavor will prove worthwhile. We know that HYBREX™ offers many breeding advantages. With adequate time, resources, and sound scientific planning, we expect to eventually be successful in making available wheat hybrids which are highly profitable to the farmer.

THE SOFT-HARD WINTER WHEAT CLASSIFICATION PROBLEM

Robert K. Bequette

The Problem

Several years ago I received a phone call from a very disturbed grain elevator operator in South Texas. He had purchased and shipped a large quantity of Chaparral, a Hard Red Spring (HRS) Wheat variety marketed in South Texas by DeKalb. Several car loads of this grain had been graded SRW wheat at the Gulf. At that time, SRW wheat was selling for about 50¢/bushel less than HRW wheat. The elevator and its farmer-customers were faced with a significant financial loss and they blamed DeKalb for this problem.

Prior to its release, Chaparral had been adequately tested by the DeKalb laboratory, the Crop Quality Council, and several mills in Texas. Also, I had provided grain samples to the Federal Grain Inspection Service (FGIS) for identification purposes. Consequently, a few phone calls with appropriate explanations solved the problem and everyone was satisfied that DeKalb was not the villain. Unfortunately Hard/Soft classification problems are seldom solved as easily as the Chaparral example cited above.

Low protein or weathered Hard Red Winter (HRW) wheat shipped from Illinois, Missouri, southeast Kansas, northeast Oklahoma, and central Texas is often graded Soft Red Winter (SRW) wheat instead of HRW. When this happens, elevator operators and farmers normally suffer price discounts of $0.25 to $1.00 per bushel. Domestic millers who purchase SRW and receive erroneously classified HRW or SRW which contains a significant percentage of HRW cannot make acceptable pastry flour from the grain.

When grown in western Missouri or in Texas, SRW wheat is often graded HRW or mixed wheat since environmental factors sometimes favor a high percentage of vitreous kernels. In this case, producers or elevators may make an unexpected profit. However, most importers of U. S. hard wheat expect a premium product which can be blended with mediocre local wheats to make an acceptable bread flour. These importers are not happy when our hard wheat does not perform as expected. Canadian and Australian hard wheat is not adulterated with soft wheat.

Mixing of the two wheat classes (HRW and SRW) normally occurs at the farm or country elevator. This happens especially during the rush of wheat harvest. Since licensed grain inspectors, wheat breeders, and cereal chemists often have difficulty differentiating between hard and soft wheats, it is not surprising that farmers and country elevator operators may unknowingly bin them together. Moreover, intentional mixing of the wheat classes by some greedy grain merchants does occur whenever there is a significant price differential between HRW and SRW wheats.

This problem is not unique to varieties developed by private seed companies, or to semi-dwarf varieties. It is a perennial problem which has been around since the U. S. Grain Standards for Wheat were adopted in 1918 (3).

The extent of the unintentional wheat class mixing problem varies with their yield potential. When SRW varieties out-yield HRW varieties, then SRW moves into the eastern edge of the HRW wheat production region. When superior HRW wheat varieties are released they tend to move into the traditional SRW wheat area.

In the past few years the wheat class mixing problem has taken on a new twist. Some of the newer hard wheat mills in the eastern U. S. have encouraged production of both HRW and HRS wheats in areas which traditionally have produced soft winter wheat. This gives those mills a price advantage for their flour due to reduced freight rates on wheat, but it creates problems for soft wheat mills in the region.

Terminology -- Is Part of the Problem

As presently used, the terms "hard" and "soft" may have several meanings when applied to wheat. This terminology problem creates considerable confusion and misunderstanding when people from various segments of the industry try to communicate. The term "hard" can have any of the following meanings when applied to wheat:

1. Physical properties (actual hardness) of the endosperm which determine friability and consequently:

    a. Power required to grind and reduce the kernel and its fractions.

    b. Siftability and flowability of the fractions produced during milling.

    c. Final size distribution of the flour particles.

    d. Starch damage content of the flour.

2. Has a high percentage of vitreous (not chalky or yellowberry) kernels.

3. Has high protein content.

4. Has good bread baking properties.

5. Has strong flour properties as measured by physical dough tests such as the mixograph and farinograph, or by tests such as Zeleny sedimentation and MacMichael acid viscosity.

6. In some parts of Europe "hard" means *Triticum durum* while "soft" means *Triticum aestivum* (both hard and soft endosperm varieties).

Usages 2, 3, and 4 probably were developed by early day millers when they observed that vitreous kernels appeared hard and glassy when cut in cross section and usually had good bread baking properties. In contrast, kernels which appear soft and starchy when cut are characterized as being 'yellowberry' or 'chalky' and generally have poorer bread baking properties.

We know today that the superior bread baking properties of the vitreous kernels are due to their generally higher protein content. The U. S. Grain Standards for Wheat employs % vitreous kernels as a rough estimate of protein content (3). Unfortunately the Standards employ the wording 'Dark Hard and Vitreous' (DHV). The unfortunate coupling of the words 'hard' and 'vitreous' has led many farmers, grain merchants, and even some wheat breeders to erroneously believe that vitreous kernels always have hard endosperm while chalky or starchy kernels always have soft endosperm, which is not true.

U. S. Grain Standards

The U. S. Grain Standards for wheat are based on visible kernel characteristics which are supposed to place them into various classes. This allows the wheat to be stored separately by class and used in products for which they are best suited (3, 4).

When attempting to grade a problem wheat shipment, grain inspectors licensed by the Federal Grain Inspection Service (FGIS) attempt to identify the varietal components by studying the external features of the kernels (1, 2). This is a very tedious and costly process. In addition, I personally have serious doubts regarding the ability of most inspectors to accurately identify the varietal components of commercial grain.

Methods of Differentiating Between Hard and Soft Wheats

Contrary to the belief of many wheat breeders, it is often impossible to tell hard from soft wheat by visual inspection, cutting, biting, or chewing or other simple methods. Results of these procedures generally reflect differences in protein and moisture content, or sometimes kernel shape, but not true differences in kernel hardness. Visual identification of wheat for hardness classification can often be misleading because of the following reasons:

1. low protein, non-vitreous, or weathered hard wheat often looks like soft wheat, and

2. soft wheat with a high percentage of vitreous kernels can easily be mistaken for hard wheat. This is true for both red and white wheats.

Hard and soft wheats may accurately be distinguished by several laboratory tests. They include:

1. The Brabender Micro Hardness Tester which measures the time required to grind a small sample with a burr mill (5).

2. Values read from the Near Infra Red Reflectance instruments used to determine protein and moisture content (7).

3. The Particle Size Index grind-sift procedure developed in the early 1930's by Cutler and Worzella at Purdue University (4, 5, 6, 7, 8).

4. The Pearling test has been used successfully by wheat breeders but kernel shape influences test results (8).

Results of all grain hardness tests are significantly influenced by moisture content of the grain. I doubt if any available hardness test can provide a quantitative assessment of Hard-Soft wheat mixtures.

The Federal Grain Inspection Service does not, as yet, employ any hardness test for routine grading and classification of commercial wheat.

Milling Properties by Endosperm Hardness

The most consistent differences between hard and soft wheats are their milling properties.

Hard wheats are usually conditioned to 15-16% moisture content for 18-24 hours prior to milling. This toughens the bran and softens the endosperm. Toughening the bran is the main objective when conditioning soft wheat. Soft wheats are usually conditioned for a much shorter time and to a much lower moisture content than hard wheats. Increased softening of soft wheat endosperm reduces sifting rate and consequently, production rate of the mill.

Some of the important differences in milling properties of hard and soft wheat and differences in flour mill design required to accommodate hard and soft wheat are outlined in the table below.

Milling Products	Hard Wheat	Soft Wheat
Particle shape	Mostly sharp, angular, fractured through cells and starch granules.	Many free starch granules, some free protein particles.
Particle size	Many large, few small	Many small, few large.
Flour starch damage	6-9%	3-5%
Flour feel	gritty, granular (fine sand)	smooth, silky (graphite)

Milling Products	Hard Wheat	Soft Wheat
Flow properties	good	poor, tend to "bridge" in hoppers
Sifting properties	good	poor
Mill Design, Operation		
Grinding Rolls	1.00	0.70
Sifters	1.00	1.30
Minimum Spout Angle	45-60°	as close to vertical as possible
Power to operate	1.00	0.95

A mill designed for hard wheat can usually accommodate only 10-20% soft wheat in the mill mix. Greater amounts of soft wheat will reduce production rate significantly and may cause mill choke-ups.

Use of Hard and Soft Wheat Flours

Hard wheat flour is generally considered superior to soft wheat flour for yeast leavened baked products (6, 8). This is primarily because wheat breeders have selected hard wheats for the factors important in bread baking. These factors include high protein content, high flour water absorption, medium to medium long mixing requirement, good mixing tolerance, large loaf volume and fine, lacy internal loaf structure.

Hard wheat flours are not acceptable for most chemically leavened baked products because of high starch damage and water absorption. For most chemically leavened baking uses, soft wheat flours with low water absorption produce the lightest, tenderest products (6, 8). U. S. soft wheat breeders select for soft endosperm, extremely low water absorption and low protein content. I have seen soft wheats which were fully equal to comparably grown hard wheats for all factors important in bread baking. Flours from such wheats would not be acceptable to U. S. cookie bakers because of their high water absorption capacity.

Genetics of Wheat Hardness

The physical hardness or friability of wheat endosperm is a highly heritable trait (3, 4, 8). There is no genetic demarcation between hard and soft wheat. A continuous spectrum from the hardest durums to the softest soft wheats is possible.

Environment prior to harvest can have a significant influence on external and internal kernel appearance and causes minor variations in actual endosperm friability. However, GENETICALLY TRUE HARD WHEATS DO NOT BECOME SOFT AND SOFT WHEATS DO NOT BECOME HARD DUE TO ENVIRONMENTAL CONDITIONS.

Conclusions

I have attempted to explain and clarify some of the difficulties and ramifications of the soft-hard wheat classification problem.

1. It is difficult, if not impossible, to quickly and accurately distinguish between hard and soft varieties having the same kernel color and external kernel features.

2. Accidental or intentional mixing of hard and soft wheat creates mechanical and economic problems for millers and reduces suitability of the flour for its intended baked product.

3. Your efforts have created a product which has a good image in domestic and foreign markets. This image is tarnished when SRW wheat is blended with HRW wheat, or when shipments of SRW are classified HRW wheat.

4. Terminology used to describe kernel appearance, milling and flour properties is confusing and may lead to serious misunderstandings. I hope you take this into consideration when conversing with someone from the grain, milling, or baking industries. As questions until you are sure you know what they are saying.

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USE OF ALIEN GENETIC INFORMATION IN RELATION TO BREAD QUALITY

K. L. Goertzen, B. L. Goertzen, K. A. Siffring

First crosses with wheat using alien genetic material was to find restoration of cytoplasmic sterility to produce hybrid wheat. A wealth of worthwhile characteristics was found.

The transparencies presented showed mixographs of wheat containing alien genetic information that had good tolerance or resistance to wheat streak mosaic.

The mixographs demonstrate a range of quality characteristics from poor functional properties of the protein to excellent functional properties of the protein.

The protein levels were all higher than the Newton and Scout 66 wheat checks.

The mixographs demonstrate that good bread quality has been obtained by applying adequate selection pressure in crosses between wheat and some *Agropyrons*, *Secale* or *Aegilops*.

ELEVATED PROTEIN: IS IT AN ATTAINABLE BREEDING OBJECTIVE IN HARD RED WINTER WHEAT?

V. A. Johnson

The ARS-Nebraska wheat research team has conducted research on wheat protein since 1954. This and other research has identified constraints to as well as opportunities for genetic manipulation of grain protein. Major among these are the following:

Grain yield and grain protein content are likely to be negatively correlated in most, but not all, production environments.

The correlation is seldom of sufficient magnitude to permit very much of the protein variation to be explained by differences in yield; r^2 values usually are less than 0.5.

Environment exerts strong influence on grain protein level in ways other than through yield. These include temperature, soil moisture availability, soil N-availability, defoliation from disease or insect attack, length of grain maturation period, etc. These effects are not well understood.

Protein level in wheat is under genetic control. Measurements of genetic effects are difficult because of large environmental influences.

Genes with relatively large effect on grain protein have been identified in the Atlas wheats and Nap Hal. *Aegilops* is believed to have contributed a major gene(s) to Plainsman V and related hard winter wheats developed by Seed Research Associates in Kansas.

There is strong evidence of the existence of numerous genes with small effects on protein in *Triticum aestivum* L. For example, selection for high protein in CIMMYT early generation spring wheat hybrid populations by L. Klepper was effective in raising protein levels significantly above that of Super X.

Lysine variation in common wheat is limited (0.3 to 0.4% of protein) and scarcely exceeds the resolution capability of amino acid analyzers. Selection for lysine has been de-emphasized in the ARS-Nebraska program.

Nitrate reductase is involved in elevated protein in common wheat. Elevated N-reductase has been demonstrated in Atlas 66, Nap Hal, Lancota, and other lines derived from Atlas-derived lines. Our data suggest that elevated N-reductase is necessary for but does not assure elevated grain protein content because of the effect of other enzymes involved in protein synthesis.

High protein lines initially selected in the ARS-Nebraska program were non-productive, tall, small seeded, and agronomically unacceptable. Data from replicated irrigated trials at Yuma, Arizona in 1982 (Tables 1 and 2) indicate that high protein lines with more acceptable agronomic traits can be selected.

Bio-energetic constraints may contribute to negative correlations of yield and protein because increased inputs of carbon assimilates and nitrogen are necessary to achieve protein elevation (Bhatia and Rabson). There is disagreement among breeders as to whether this would apply in less favorable production environments in which the true genetic potential of varieties for yield would not be expressed.

A non-destructive solvent flotation technique for separation of wheat seed on the basis of protein content, developed by A. Garzon Trula, Madrid, Spain, may offer an effective rapid method for protein selection in bulk hybrid populations (Table 3). The technique is based on differential density and H_2O absorption capacities of protein and starch in the wheat seed. Protein with a density of 1.2, compared with 1.7 for starch, absorbs approximately five times more H_2O than starch. Seed soaked for seven to ten days in H_2O at a temperature of 0 to 1°C does not germinate and can be separated in solvent solutions with 1.25 density. Seed must be sieved to remove small shrivelled kernels before soaking.

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Table 1. Promising high protein winter wheat lines in replicated irrigated trials, Yuma, Arizona, 1982.

Entry	Maturity	Plant height	100-seed weight (g)	Grain yield (q/ha)	Grain protein (%)
33	ME	M.sh.	3.5	64.6	13.3
28	E	Med.	4.3	52.8	16.3
24	E	Sh.	3.8	50.4	16.2
35	E	M.sh.	3.9	48.6	15.6
25	E	Sh.	4.0	45.4	16.1
27	E	M.sh.	3.8	41.2	18.2
TAM 105	ML	M.sh.	3.1	37.0	13.0
$LSD_{0.05}$	--	--	0.5	9.9	2.0

Table 2. Promising high protein spring wheat lines in replicated irrigated trials, Yuma, Arizona, 1982.

Entry	Maturity	Plant height	100-seed weight (g)	Grain yield (q/ha)	Grain protein (%)
15	L	MT	3.8	62.1	15.6
5	Med	M.sh.	2.8	61.6	16.2
17	ME	Med.	5.0	58.2	15.8
7	ML	Med.	3.2	56.7	16.8
33	E	Sh.	4.6	51.4	16.9
31	ME	M.sh.	4.4	51.2	16.4
42	E	M.sh.	3.7	51.1	16.7
35	E	Sh.	3.1	49.0	17.8
Super X	E	Sh.	4.3	52.6	13.2
$LSD_{0.05}$	-	-	0.4	10.9	1.5

Table 3. Separation of high protein from low protein seed in bulk hybrids by solvent flotation.[a]

Population	Protein content (%) High protein fraction	Protein content (%) Low protein fraction
Experimental Hybrid		
1	19.0	16.1
2	18.1	16.3
3	17.2	15.2
4	18.6	13.8
5	17.4	14.3
6	18.1	15.0
Lancota (check)	14.3	12.5

[a] Based on method of Mr. A. Garzon Trula, Ministry of Agriculture, Madrid, Spain.

PROBLEM OF WHEAT SCAB IN HARD RED WINTER WHEAT, 1982

P. J. Mattern

Scab is not a new disease. Trace amounts are found every year, but environmental conditions were ideal during 1982 for its development in parts of Missouri, Kansas, Iowa, and Nebraska.

The disease is seen on a regular basis in countries with high rainfall and high humidity during flowering and pollination. The winter wheat fungus disease is caused primarily by Fusarium graminearum and until recent years there was no knowledge that mycotoxins could be associated with the disease.

It was the unusual combination of an extended period of above normal rainfall coupled with below normal temperatures that brought on the disease problem. These conditions coincided with the flowering and pollination period which are the susceptible growth stages for a scab infection.

Approximately one-third of the wheat acreage and one-quarter of the Nebraska crop production was infected with scab during 1982.

It was readily apparent that the disease was reducing yield and quality, but what about the possibility of mycotoxins developing in the grain and/or straw? Mycotoxins are toxic fungal metabolites which may be produced during an infection of food (in this case grain) and subsequently affect the health of animals and/or humans when consumed.

Wheat scab infection, caused by certain genera of Fusarium, is capable of producing toxins in cereal grain. The most commonly produced toxins are:

1. Zearalenone (F-2 toxin, Giberella toxin). This toxin is estrogenic in nature and similar to zearalanol (Ralgro), a commonly used growth promotant in cattle.

2. Vomitoxin (Deoxynivalenol, DON, refusal factor). This material in sufficient amounts can produce vomiting in swine, or a higher level partial or complete feed refusal.

In early October, 1982 the USDA reported on its survey of scab-damaged wheat. Analysis of 160 samples taken from eastern Kansas and Nebraska showed that less than 3.5 percent of the hard red winter wheat crop was affected by scab and that no sample from the survey area which grades U. S. Number 1 or 2 exceeded the "concern level" for vomitoxin in wheat established by the Food and Drug Administration. The following major points are summarized:

U. S. Wheat Grades Number 1 and Number 2 averaged 0.77 ppm, ranging from 0.0-1.64 ppm for samples analyzed.

Eighty-one percent of the samples which graded U. S. Number 3 averaged less than 2 ppm.

Total damage and total defects were the two grading factors which gave the highest correlation with ppm of vomitoxin.

Concern levels of vomitoxin suggested by the FDA are:

-- Finished wheat products for human consumption, 1 ppm.

-- Wheat for milling, 2 ppm.

-- Animal feeds, 4 ppm in wheat which should make up less than 10% of swine and pet rations and less than 50% of the diet for cattle and chickens.

Following are some of the vomitoxin data from the 1982 Nebraska crop:

Vomitoxin* Data (ppm) from Milled Fractions Obtained with a Buhler Laboratory Mill

Sample	Flour	Shorts	Bran
A	NDA	2.0	12.0
B	"	2.0	6.4
C	"	4.0	NDA
D	"	4.0	16.0
E	1.0	4.0	9.0

*NDA of other mycotoxins:
Aflatoxin, B_1, B_2, G_1, or G_2
T-2 toxin
Diacetoxyscirpanol (DAS)
Zearalenone

Vomitoxin Data (ppm) from Buhler Laboratory Milled Samples with Extremely High Levels of Scab Infection

Sample	Wheat	Flour	Shorts	Bran
82-2692	4.0	2.1	12.0	7.0
82-2693	2.2	1.6	9.5	4.0
82-2694	12.0	8.2	21.0	60.0

DEVELOPMENT OF HARD WHITE WINTER WHEATS IN KANSAS

G. M. Paulsen

Kansas State University began a program of developing hard white winter wheats several years ago when it was noted that they offered some advantages over the hard red winter wheats grown in the state. The advantages that have been advanced -- but not always demonstrated -- for white wheats include the following:

1. White wheats have higher flour extraction rates than red wheats when the two classes are milled to similar color standards.

2. High extraction rates increase the flour protein content because more of the endosperm adjacent to the aleurone, which contains a higher proportion of protein, is recovered.

3. White wheats make more appealing whole-wheat baked products than red wheats. Many foreign customers use only whole-wheat products; they have historically preferred white wheat cultivars and white whole-wheat flours.

4. Color specifications for milling standards of wheat flour are used by several countries. Flours from white wheats typically have better color scores than flours from red wheats even at normal extraction rates but especially at high extraction rates.

5. White bran is usually more valuable than red bran. It is frequently considered a co-product, not a by-product, of the milling process because of its use in breakfast foods, snack foods, and other cereal products.

6. Studies show that white wheat disappearance from U. S. markets is characterized by consistently large export demand and generally small carryover, whereas hard red winter wheat disappearance is characterized by unstable export demand and the largest carryover of any class (Heid, W. G. 1980. U. S. Wheat Industry. Agr. Econ. Rept. 432, USDA, Washington, DC.)

7. Hard white wheats might be marketable at a premium price because of their apparent advantages. Even if they did not command a premium, however, white wheats might be more competitive on the world market and might move at times when hard red winter wheat is not moving.

The only apparent agronomic disadvantage of hard white wheats is their susceptibility to preharvest sprouting. High, wide diurnal temperatures during grain development followed by wet, humid conditions after maturation induce more sprouting in white wheats than in red wheats. Little preharvest sprouting beyond acceptable limits has been observed in our studies, however. We have seen the problem mainly in the eastern part of the state when harvest was delayed by wet weather. Preharvest sprouting is not expected to be a problem in most of Kansas. Moreover, we have identified germplasm having good resistance to preharvest sprouting, which we are incorporating into adapted experimental lines by breeding.

Most of our experimental white wheat lines have come from crosses between red wheat parents, some with high grain protein content. Yield, adaptation, grain physical qualities, and other traits unrelated to color have not differed between red and white wheat experimental lines. Most present red wheat cultivars apparently have one or two genes for red of the three genes that control seedcoat color; thus, there is little reason to expect that other traits would be affected.

Wheat production in the Great Plains greatly expanded with the introduction of 'Turkey Red; from Russia in 1874. 'Turkey Red' was so highly adapted that present cultivars still have it in their pedigrees and the tradition of the red seedcoat color has been retained to this day. Our studies indicate, however, that hard white winter wheat is as agronomically feasible as hard red winter wheat, that both classes are equally suitable for breadmaking, and that the apparent advantages of hard white winter wheat merit consideration.

VARIATION IN THE MINERAL ELEMENT COMPOSITION OF WHEAT FLOUR AND BRAN

C. J. Peterson

The importance of mineral elements in the diet is well recognized by nutritionists. Wheat can provide significant amounts of minerals in the diet as a whole grain product. After milling, flour products possess a fraction of the mineral concentrations found in whole grain. Concern over mineral deficiencies has lead to the inclusion of Mg, Ca, Fe, and Zn in proposed U.S. flour fortification standards. In order for fortification procedures to be effective, it is important to account for natural variation in flour mineral concentrations. Recently, flour and bran samples from varieties in the 12th International Winter Wheat Performance Nursery (IWWPN) grown in 1980 were examined to evaluate the natural variation in mineral concentrations and the relationship between minerals and protein content.

Energy dispersive X-ray fluorescence spectrometry was used for flour and bran mineral analyses. It is a rapid, nondestructive, multi-element technique and sample preparation is relatively simple. Mineral values and levels of precision obtained by X-ray fluorescence were comparable to those reported using other analysis techniques.

Analysis of the 12th IWWPN from six locations showed that highly significant variation in flour mineral concentrations was associated with production sites. The varieties included in the IWWPN are genetically diverse and possess a wide range in protein levels. Variation in flour mineral concentrations among genotypes was shown to be highly significant and relatively stable over environments. The ranges in mineral concentrations among varieties were as wide or wider than variation produced by location effects. The interaction of genotype and environment also was found to be a highly significant source of variation. Natural variation in Fe, Zn, and Mg concentrations was large relative to proposed fortification standards.

Correlations in mineral concentrations in flour with flour protein content (Table 1) showed that a significant portion of the variation in mineral concentrations is related to variation in protein levels. Phenotypic correlations with protein were all highly significant and, with the exception of K, positive. Genotypic correlations of Mg, P, S, Fe, Cu, and Zn with protein were high, ranging from 0.88 to 0.96. These high positive genotypic correlations with protein suggest an added nutritional advantage of high protein cultivars. Correlations of mineral concentrations with protein in bran were highly variable. Several minerals are likely associated with phytate and fiber in the bran.

Table 1. Correlation coefficients of mineral elements with protein in wheat flour and bran samples from the 12th IWWPN grown in 1980.

	Mg	P	S	Cl	K	Ca	Mn	Fe	Cu	Zn
					Flour					
Phenotypic	.35**	.37**	.92**	.32**	-.42**	.55**	.52**	.59**	.31**	.73**
Genotypic	.89	.88	.96	-.35	-.17	.21	.64	.94	.88	.95
					Bran					
Phenotypic	.22**	.03	.88**	.15*	-.32**	.76**	.52**	.69**	.12	.48**
Genotypic	.13	.48	.62	-.18	.36	-.25	.31	.46	.74	.55

PLANT ARCHITECTURE APPROACH TO WHEAT IMPROVEMENT

H. T. Nguyen, E. L. Smith, L. I. Croy, and R. C. Johnson

Genetic modifications of the plant architecture (yield components, canopy architecture, and root characteristics) and physiological systems (photosynthesis, partitioning of photosynthetic assimilates, leaf area duration, and rate and duraction of the grain filling period) are necessary to further improve genetic yield potential of hard red winter wheat in the Great Plains. Using the plant architecture approach, the breeder can place greater emphasis on yield potential by breeding for the optimum expression of physiological characteristics and morphological yield components.

We have collected several wheat genotypes differing in plant architecture from various breeding programs around the world to supplement the USDA collection. Some large spike and large-seeded lines from Europe were identified, crossed and backcrossed to locally adapted winter wheat cultivars. Four wheat germplasm lines with increased kernel weight were recently released as a result of this architecture breeding program.

Further research is needed to study yield component compensation and determine optimum expression of yield components under the semiarid, dryland conditions of the Great Plains. More breeding-physiology team efforts are required to characterize canope architecture and root systems. Rate and duration of the grain filling, harvest index, biological yield, and tillering are other traits that must be studied in relation to grain yield. As we attempt to modify the sink capacity to attain higher yield levels, attention should also be given to the source capacity, which is related to photosynthesis and leaf area duration during grain-filling.

The long range goal of this project is to develop adapted wheat germplasm possessing different architectural and physiological characteristics which will be useful for the development of hard red winter wheat cultivars with high yield potential and highly adapted to the environmental conditions of Southern Great Plains, and for the purpose of increasing the genetic base of the crop.

HIGH TEMPERATURE RESISTANCE DURING GRAIN DEVELOPMENT AS A BREEDING CRITERION FOR WHEAT

G. M. Paulsen

Wheat breeders have long recognized, directly or indirectly, the adverse effects of high temperature stress on grain development of wheat. They have done so by advancing the maturity of wheat so that it escapes stress during late stages; this is limited, however, by the danger of late spring freeze injury and by low yields of extremely early cultivars. Additional resistance of wheat must come from increasing the physiological tolerance of wheat to high temperatures.

Considerable evidence shows that high temperatures are of major importance in winter wheat production in the hard red winter wheat region. Wheat, being a cool-season C-3 species, is physiologically unadapted to high temperatures. Experimental data and yield models show that the optimum temperature during grain development is about 25 C, whereas field temperatures of 35 C or higher are not uncommon at that time. Even irrigation fails to increase wheat yields to high levels achieved in some other parts of the world except during certain years when temperatures are lower than normal. Finally, we have the anomaly of record wheat production during most years when spring freezes occur, an indication that the conditions associated with freeze injury are extraordinarily favorable for uninjured wheat.

The physiological effects of high temperatures on wheat are many. Grain filling rate is accelerated by moderately high temperatures, but is slowed more by still higher temperatures. Grain filling duration, on the other hand, is shortened by all temperatures above the optimum. In leaves, protease enzymes, whose main substrate is the major photosynthetic enzyme, ribulose-1,5-bisphosphate carboxylase, increase in activity, speeding senescence and decreasing the rate and leaf area for photosynthesis. Other important enzymes, such as nitrate reductase, decrease in activity during high temperature stress. Australian researchers believe, however, that the primary effect of high temperature stress is on the spike, not the leaves. They suggest that high temperatures act directly on the spike to cause cessation of grain growth. The result in either case is low yields.

Genetic variation in tolerance to high temperature stress occurs in common wheat, but the magnitude appears to be small and it may be more quantitative than qualitative. Alien germplasm appears to have more variation and may be useful for improving this trait in wheat. Breeding for high temperature tolerance is also complicated by the lack of clearcut selection procedures. The uncertainty over whether the primary effect of high temperature stress is on leaves or spikes, for instance, may have to be resolved before significant progress can be made by breeding.

A METHOD OF ASSESSING HEAT TOLERANCE IN WINTER WHEAT

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

High temperature stress, particularly during anthesis and grain filling, may represent a severe constraint on grain yields throughout the Great Plains area. We are attempting to determine if the membrane stability test for grain sorghum developed by Dr. Sullivan at the University of Nebraska may be adapted for use in winter wheat. This technique is described very thoroughly by Blum and Ebercon (1981). The procedure was used on seven winter wheat cultivars grown in the field in the 1982 season (Table 1). Sampling was done at the stage of anthesis for each cultivar.

Nugaines exhibited the greatest amount of heat injury, while TAM 105 showed the least amount of heat injury. Since TAM 105 was developed under Texas conditions and Nugaines was developed under conditions of the Pacific Northwest, these are results that one might expect because high temperature tolerance is probably more important under Texas conditions than in the area of the Pacific Northwest. Therefore, the preliminary results are quite encouraging. However, it remains to be seen whether this trait is important to grain yields under high temperature stress. Much work is needed to determine the inheritance of this trait, the effect of plant age on the trait, and the correlation of the trait with grain yield.

Reference

Blum, A., and A. Ebercon. 1981. Cell membrane stability as a measure of drought and heat tolerance in wheat. Crop Sci. 21:43-47.

Table 1. Heat injury of seven winter wheat cultivars as determined by the electrical conductivity test at anthesis in the 1982 growing season.

Cultivar	Heat injury*
	%
TAM 105	30.5
Wichita	46.1
Vona	56.7
Baca	62.4
Trapper	65.3
Centurk 78	66.9
Nugaines	75.7
$\overline{X}$	57.7
L.S.D. (0.05%)	15.6

* Heat injury was induced by incubating leaf discs in test tubes in water bath for one hour at 44° C.

REGIONAL BUSINESS MEETING

Hard Red Winter Wheat Improvement Committee
February 10, 1983
Las Cruces, New Mexico

Minutes

The meeting was called to order by Chairman Heyne at 8:00 a.m. Committee members in attendance were:

M. K. Brakke, ARS, NE
*R. Bruns, NAPB, CO
L. I. Croy, OK
A. L. Diehl, Northrup-King, NE
J. R. Erickson, Hybritech, KS
R. E. Finkner, NM
J. H. Gardenhire, TX
E. C. Gilmore, TX
F. J. Gough, ARS, OK
E. G. Heyne, KS
J. P. Hill, CO
V. A. Johnson, ARS, NE
T. J. Martin, KS
P. J. Mattern, NE
O. G. Merkle, ARS, OK
G. M. Paulsen, KS
K. B. Porter, TX
J. S. Quick, CO
B. J. Roberts, Cargill, CO
A. L. Scharen, ARS, MT
J. W. Schmidt, NE
R. G. Sears, KS
E. E. Sebesta, ARS, OK
E. L. Sharp, MT
E. L. Smith, OK
K. D. Wilhelmi, Rohm & Haas, NE
W. D. Worrall, TX

* Represented by J. L. Reeder

Committee members not present:

R. E. Atkins, IA
L. E. Browder, ARS, KS
K. F. Finney, ARS, KS
J. H. Hatchett, ARS, KS
C. Hayward, Pioneer, KS
W. J. Hoover, KS
B. J. Kolp, WY
J. Michels, TX
M. R. Morris, NE
R. A. Olson, NE
V. R. Stewart, MT
G. A. Taylor, MT
R. W. Toler, TX
B. B. Tucker, OK
N. A. Tuleen, TX

Regional Nurseries

V. A. Johnson reported that the Winter Wheat Regional Hybrid Nursery was discontinued after the 1982 season for lack of entries from commercial companies engaged in development of hard red winter wheat hybrids.

Breeders from private companies in the region are more interested in having limited numbers of their hybrids tested in the Southern Regional Performance Nursery (SRPN) or the Northern Regional

Performance Nursery (NRPN). Reasons offered include more test sites and direct comparison of performance with the best new experimental varieties in the region.

Following discussion, a motion to accept privately developed hybrids and experimental lines for evaluation in the SRPN and NRPN was approved.

A motion to establish a limit of 45 entries in each of the two regional evaluation nurseries (SRPN and NRPN) was approved.

It was agreed that cooperating states and companies would not be limited to a specified maximum number of entries in the SRPN and NRPN; rather, they are instructed to prioritize candidate entries to provide guidance to the regional coordinator in the event that the total number of candidate varieties exceeds the 45-entry limit. This is the procedure currently followed. In the public sector, the state, rather than individual Experiment Stations within the state, is the recognized unit for candidate entries for the SRPN and NRPN. In the private sector, each company is a unit.

Check Varieties (Regional Nurseries)

SRPN -- A motion to retain Kharkof (long-time check) and Scout 66, remove Sage, and add TAM 105 as check varieties was approved.

NRPN -- Retention of Kharkof (long-time check) and Warrior and removal of Roughrider as check varieties was approved. Coordinator was instructed to extend the testing period of semi-dwarf entries beyond the normal 2 years to accelerate identification of a good semi-dwarf for use as a nursery check variety.

UWHN (Southern Materials Section) -- Motion to retain Warrior and Scout 66 and substitute Vona for Tascosa as check varieties was approved.

UWHN (Northern Materials Section) -- Retention of Warrior, substitution of Centurk 78 for Winoka, and substitution of Norstar for Froid was approved.

Soilborne Mosaic Nursery -- Currently used checks Pawnee, Bison, and Concho will be retained as check varieties.

Size of Uniform Winterhardiness Nurseries (UWHN)

There was agreement that the maximum number of entries in the Northern Materials Section and Southern Materials Section should not exceed 300 in each section.

Regional Nursery Test Sites

SRPN and NRPN -- The regional coordinator in the past has accepted new sites proposed by public sector cooperators if there is sufficient justification for them. It was suggested that this procedure continue to be followed. Current sites appear to be adequate. USDA policy does not permit distribution of nursery seed to privately controlled sites by the coordinator. Such arrangements must be between individual state breeders and commercial seed companies.

Uniform Winterhardiness Nursery -- The planting and winter survival evaluation of several hundred lines of wheat each year by cooperators in the northern plains is a large and time-consuming task. It is a very important activity for southern breeders who use the nursery for winterhardiness information on their materials that otherwise would be difficult for them to acquire. Because it is largely a service to southern breeders provided by northern cooperators, retention of an adequate number of good test sites has become increasingly difficult.

In 1983 the sites are as follows:

Southern Materials Section	Northern Materials Section
Mead, NE	Brookings, SD
Brookings, SD	Casselton, ND
Casselton, ND	Williston, ND
St. Paul, MN	St. Paul, MN
Lethbridge, Alberta	Winnipeg, Manitoba
	Lethbridge, Alberta

An additional site in South Dakota and a site in Montana would be desirable. The coordinator was instructed to contact cooperators in these states to determine if the additional test sites can be arranged for 1984 and subsequent years.

Willingness to grow the UWHN and participate in the winterhardiness evaluation was expressed by a commercial seed company breeder who pointed out that the nursery would be abandoned and destroyed after survival evaluation in early spring. The coordinator was instructed to contact ARS legal counsel to ascertain whether this would change the ARS policy prohibiting the placing of regional nurseries coordinated by ARS scientists on privately controlled land.

Seed Requirements for Regional Nurseries

Currently: 15 lb/new entry in SRPN.
11 lb/new entry in NRPN.
100 g/entry for Northern Section and Southern Section of UWHN.
60 g/entry for SBMN.

The amount of seed/entry for the SBMN will be increased to 80 grams to accommodate the four test sites now utilized (Urbana, IL; Manhattan and Hesston, KS; and Lincoln, NE).

Seed Treatment of Regional Nursery Entries

A motion to require seed of entries to be untreated was approved.

Regional Reports

The need for information about growing conditions and other factors pertinent to performance from each site was discussed. Most cooperators find this information useful and suggested that it be retained in the regional reports. This will be done. There also was a consensus for retention of the Coefficient of Variation in site yield data analyses.

Large-scale Milling and Baking Tests

Tom Roberts reported on action taken by the Wheat Quality Council to require varieties submitted for collaborative tests to have a minimum of 11.5% protein in the wheat (14% moisture basis) to be considered acceptable for evaluation.

Germplasm Enhancement

Interest among regional cooperators in undertaking a regional recurrent selection program in hard red winter wheat was sought by the coordinator. Chemical pollen suppressants now make possible enforced genetic recombination in wheat and establishment of recurrent selection approaches to germplasm enhancement.

A motion that the new regional chairman appoint a committee to investigate the possibilities for such a program with the regional coordinator was approved.

Assignment of PI Numbers

Currently PI numbers are not routinely assigned to entries in the SRPN and NRPN as was formerly done. PI numbers are assigned only at the request of breeders. Failure to request PI numbers results in the loss of potentially valuable germplasm.

A motion that the regional coordinator contact breeders to request permission to assign PI numbers at the time of removal of their entries from the regional nurseries was approved.

Hard Red Winter Wheat Improvement Committee

Guidelines for ARS, state, and private sector representation on the committee, size of the committee, and disciplines represented were discussed. Chairman Heyne discussed the history of the regional committee and pointed out that it had operated successfully over the years with few guidelines. A motion that the regional committee continue to function as it has in the past with minimum rules and guidelines was approved.

Chairman Heyne was requested to prepare a statement of the history and procedures followed by the committee for inclusion in the Conference Proceedings. The statement prepared by Chairman Heyne follows:

The HWW Workers Regional Committee - 1931 to 1983

E. G. Heyne

There has been an active coordinated wheat program in the winter wheat area of the Great Plains since 1931. Dr. K. S. Quisenberry assumed the leadership of the cooperative nursery testing programs at that time. Since then there has been a USDA representative acting as a coordinator of this program and has served as the secretary of the committee. There have been only three cordinators -- K. S. Quisenberry, L. P. Reitz, and V. A. Johnson.

Workshops have been held on a three- or four-year schedule (16 in 51 years).

The committee has functioned successfully on an informal basis. I have not located any specific guidelines except the minutes of each workshop. Since 1965 the committee has included wheat workers from both the public and private sectors.

Officers. Prior to 1958 a chairman was elected to serve the group from one meeting to the next. The National Wheat Improvement Committee was organized in 1958 and represents the entire U. S. wheat workers. Four members from each region (four) have four members and the total committee is made up of 16 members plus a chairman and secretary. Since 1958 our region has elected a chairman and two representatives to NWIC with the USDA coordinator being the fourth representative. These four people have, on some occasions, operated as an executive committee.

Members. Each organization in the region actively participating in wheat research has selected their own representatives on the committee. These persons have been designated by the directors. The number of individuals representing each organization has not been defined. It is expected that each member be an active wheat research worker and conducting research in a major area (breeding, pathology, entomology, physiology, genetics, quality, soils, agronomy). Each of the members appointed has a vote as the business meeting or through mail ballots.

Meetings. Generally on a three-year basis.

Quorum. None established (majority of those voting).

Committees. The chairman has appointed such committees as requested or needed to carry on the activities of the region.

National Wheat Improvement Committee. J. W. Schmidt, chairman of the National Committee, reviewed its status, membership and activities.

The National Wheat Improvement Committee

John W. Schmidt

The National Wheat Improvement Committee held its Annual Meeting at Purdue University, West Lafayette, Indiana, November 2-3, 1982. Dr. D. H. Smith, Jr., reported that the World Collection of Small Grains has been removed to the National Small Grains Collection. He requested that private and public wheat breeders submit useful advanced lines that did not achieve cultivar status for inclusion in the National Small Grains Collection. The facility housing the National Small Grains Collection has been improved and plans for a new facility have been produced. This new facility will probably be built at Beltsville, Maryland.

The NWIC Germplasm Committee membership is identical with the Wheat Crop Advisory Committee. They have asked for proposals dealing with germplasm enhancement with federal funding when such proposals can be included in the federal budget.

Mr. Jerry Rees, Senior Vice President of the National Association of Wheat Growers (NAWG) and Executive Director of the NAWG Foundation described the Association and Foundation activities. The NAWG Foundation is an educational and charitable nonprofit organization supporting education and research. They hope to have available $3 million by 1992 for such activities. The first formal activity of the Foundation was the support of the National Wheat Research Conference held at Beltsville, MD, October 26-28, 1982. ARS and NWIC cooperated with the Foundation in presenting the Conference.

The Plant Variety Protection (PVP) Wheat Subcommittee reported their activity in trying to revise and update the "Exhibit C" form used in obtaining plant variety protection. They hope to provide a means of updating the check cultivars and to suggest a more standardized approach to data collection. Criteria for determining what constitutes a cultivar were discussed with considerable disagreement expressed with the present PVP definition of cultivar status requirements.

An international workshop on Septoria diseases is scheduled at Bozeman, Montana for August 2-4, 1983. The NWIC will join Montana State University in sponsoring the workshop. Dr. J. F. Schafer, ARS-USDA Cereal Rust Laboratory, reported on the activities of the Cereal Rust Laboratory. He presented an up-date on the leaf rust situation especially in southeastern U. S. where wheat acreage has increased dramatically with the advent of double cropping, especially of wheat and soybeans. This expanded wheat acreage has intensified leaf rust development.

The NWIC passed a resolution calling for support of the regional wheat quality laboratories, the development of improved facilities for storage of the National Small Grains Collection, increased priority for federal and state research addressing the Barley Yellow Dwarf Virus problem, inclusion by ARS of public plant breeding programs in the germplasm enhancement effort, and support of the Nebraska Crop Improvement resolution requesting a strong ARS regional wheat development program. Dr. E. G. Heyne and Dr. A. B. Campbell as editors and Dr. K. B. Porter as treasurer were recognized for their contributions to the Wheat Newsletter.

E. L. Smith, chairman of the Germplasm Subcommittee of the NWIC, reported that a wheat descriptor list has been assembled; Dr. Doug Dewey has been named National Technical Advisor for germplasm enhancement; and that proposals for wheat germplasm enhancement now are being solicited.

Resolutions

The following three resolutions were unanimously adopted:

No. 1. (Adapted from a resolution of the Nebraska Crop Improvement Association, passed at its annual meeting on January 18, 1982.)

WHEREAS, enormous variation in wheat production environments over locations and years necessitates an organized system of regional evaluation and coordination of wheat research activities across state boundaries and across scientific disciplines to assure continued improvement in the productivity and quality of U. S. wheat; and

WHEREAS, comprehensive regional evaluation can identify superior wheat genotypes and delimit their areas of adaptation in significantly less time than would be required if evaluation were confined to the state of origin; and

WHEREAS, the cooperative regional wheat programs promote dissemination and use of improved germplasm via regional evaluation nurseries, impartial objective quality laboratories, communication of vital research information and performance data in regional reports, and research planning at periodic regional wheat workers conferences; and

WHEREAS, the USDA in the past has provided leadership of the four U. S. cooperative wheat research programs by assigning official coordination responsibilities to ARS wheat scientists; and

WHEREAS, the regional program coordinators were designated wheat technical advisors under USDA-SEA-AR but, with return of ARS in the last reorganization, the wheat technical advisors' positions were abolished; and

WHEREAS, ARS scientists who continue to coordinate the cooperative regional wheat research programs do so without official assignment; and

WHEREAS, the Hard Red Winter Wheat Improvement Committee believes the Agricultural Research Service is uniquely suited to provide leadership for the cooperative regional wheat research programs in the United States, and that such leadership cannot reasonably be provided by any state or the private sector; and

WHEREAS, the Hard Red Winter Wheat Improvement Committee perceives that only through strong ARS leadership of the regional programs can the continuity necessary for maximum U. S. progress in wheat improvement be assured;

BE IT THEREFORE RESOLVED that the Hard Red Winter Wheat Improvement Committee unanimously urges the Agricultural Research Service to reassess its role in this important coordination activity, and

BE IT FURTHER RESOLVED that the Hard Red Winter Wheat Improvement Committee requests the ARS to officially assign responsibility for coordination of the cooperative regional wheat programs to designated ARS scientists and, thereby, maintain its leadership of this vital activity.

No. 2. (Passed unanimously by the Hard Red Winter Wheat Improvement Committee, February 10, 1983, Las Cruces, New Mexico.)

(Directed to: ARS Administration and Agricultural Experiment Station Directors. With regard to: The recent restructuring and reorientation of National Program Staff responsibilities in the Agricultural Research Service, USDA.)

WHEREAS, the former National Program Staff Scientist for Small Grains position provided a critical coordination and planning role for wheat improvement in the U. S.; and

WHEREAS, the above position provided vital leadership role for ARS wheat scientists; and

WHEREAS, the above position provided a focal point for contact by the production, processing, marketing, consuming and exporting sectors of the U. S. wheat industry; and

WHEREAS, the above position provided a vital spokesman for the U. S. in international wheat research information exchange; and

WHEREAS, the Hard Red Winter Wheat Committee does not think that one NPS scientist can effectively provide planning and coordination for all cereal crops;

BE IT THEREFORE RESOLVED that the Hard Red Winter Wheat Improvement Committee urges the Agricultural Research Service to reassess its National Program Staff positions and provide a National Program Staff Scientist for Small Grains coordination and planning.

No. 3. WHEREAS, the Sixteenth Hard Red Winter Wheat Workers Conference has been an informative and enjoyable conference and has been conducted in an efficient manner;

BE IT THEREFORE RESOLVED that the Hard Red Winter Wheat Workers express their appreciation to Dr. Koert Lessman, Associate Dean and Director, New Mexico Agricultural Experiment Station, and to Dr. Merle Niehaus, Head, Department of Crops and Soils, New Mexico State University, for use of their facilities and for serving as hosts and participants in this conference; to Dr. Ralph Finkner for making local arrangements; and to Dr. Lavoy Croy and the program committee for developing an interesting and informative program for this conference.

BE IT FURTHER RESOLVED, that the Hard Red Winter Wheat Workers commend Dr. Elmer Heyne and express their appreciation to him for his effective leadership during the past three years.

BE IT FURTHER RESOLVED, that the Hard Red Winter Wheat Workers express appreciation to the New Mexico Seedsmen's Association and to the New Mexico Crop Improvement Association for their financial support of the conference.

Submitted by Resolutions Committee:
J. S. Quick (chairman)
A. L. Diehl
William Boccus

Election

E. L. Smith was elected Chairman of the Hard Red Winter Wheat Improvement Committee. V. A. Johnson will continue as Secretary and Bill Roberts and Joe Martin were elected Representatives to the National Wheat Improvement Committee. They, together with the Chairman and Secretary, will represent the Hard Red Winter Wheat Region on the National Committee.

Submitted by Nominating Committee:
O. G. Merkle (chairman)
Gary Paulsen
W. D. Worrall

Site of Next Regional Conference

An invitation from Gary Paulsen to hold the 1986 Regional Conference at Kansas State University was accepted.

V. A. Johnson
Secretary

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