PROCEEDINGS

FOURTEETH HARD RED WINTER WHEAT WORKERS CONFERENCE

FEBRUARY 8-10, 1977

NEBRASKA CENTER
FOR CONTINUING EDUCATION
UNIVERSITY OF NEBRASKA-LINCOLN
EAST CAMPUS
LINCOLN, NEBRASKA

UNITED STATES DEPARTMENT OF AGRICULTURE

Agricultural Research Service

and

State Agricultural Experiment Stations, Cooperating

in the

Hard Red Winter Wheat Region

PROCEEDINGS

OF THE

FOURTEENTH HARD RED WINTER WHEAT WORKERS CONFERENCE

University of Nebraska
Lincoln, Nebraska
February 8-10, 1977

Report not for publication[1]

Agronomy Department
Nebraska Agricultural Experiment Station
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FOREWORD

Wheat workers from 18 states, Canada and Yugoslavia and from 7 commercial seed companies participated in the Hard Red Winter Wheat Workers Conference held in Lincoln, Nebraska, February 8-10, 1977. This was the fourteenth such conference since the cooperative state-federal regional program of hard winter wheat investigations was organized in 1929. The conference, held at 3-year intervals, is sponsored by the Hard Red Winter Wheat Improvement Committee.

Following the example set by the Thirteenth Regional Conference held in 1974 at College Station, Texas, this was a loosely structured meeting. Seven research areas were identified by the Conference Organizing Committee and a discussion leader (or leaders) was appointed for each area who was entirely responsible for organizing the session. Consequently, the degree of organization and the conduct of the sessions differed but all were relatively loosely structured with a minimal number of short presentations and substantial allowance of time for floor discussion and informal exchange of ideas. Accolades go to Dr. E. G. Heyne and members of his program organizing committee, to the discussion leaders for their contributions to the highly successful conference, and to the local arrangements committee.

A Cereal Rust Nursery Workshop was held on February 7. Eighteen researchers participated. Recommendations of the Workshop are included in this Conference Proceedings. A business meeting of the Hard Red Winter Wheat Improvement Committee occupied the last one-half day of the conference.

Submission of written material for inclusion in this Proceedings was optional. Many participants elected not to do so. Thus, the Proceedings, as printed, is only a partial record of the Conference and does not reflect the full scope of the presentations and intensity of the discussions.

-- V. A. Johnson
Hard Winter Wheat Technical Advisor
and
Secretary, Hard Red Winter Wheat Improvement Committee

CONTENTS

FOURTEENTH HARD RED WINTER WHEAT WORKERS CONFERENCE

CONFERENCE ORGANIZING COMMITTEE

Program

E. G. Heyne (Chairman)
R. K. Bequette
L. H. Edwards
J. R. Erickson
F. J. Gough
J. H. Hatchett
R. A. Olson

Local Arrangements

P. J. Mattern
J. W. Schmidt

PROGRAM

February 8

Morning:

Conference Opening
-- E. L. Smith, Chairman
Hard Red Winter Wheat Improvement Committee

Local Arrangements
-- J. W. Schmidt

Keynote Address and Welcome
-- Martin Massengale
Vice-Chancellor, Institute of Agriculture and Natural Resources
University of Nebraska-Lincoln

Program Procedures
-- E. G. Heyne

Session 1 -- WHEAT QUALITY
R. K. Bequette, Discussion Leader

Afternoon:

Session 2 -- WHEAT PRODUCTION PROBLEMS
L. I. Croy, Discussion Leader

Session 3 -- WINTERHARDINESS
J. R. Erickson, Discussion Leader

February 8

Evening: Conference Dinner
-- Rosalind Morris, Presiding

"Report on Chinese Agriculture"
-- V. A. Johnson
-- R. A. Olson
-- A. P. Roelfs

February 9

Morning: Session 4 -- WHEAT DISEASES
F. J. Gough, Discussion Leader

Session 5 -- WHEAT INSECTS
J. H. Hatchett and K. J. Starks,
Discussion Leaders

Afternoon: Session 6 -- SOIL MANAGEMENT
R. A. Olson, Discussion Leader

Session 7 -- WHEAT BREEDING AND GENETICS
J. R. Welsh and Rosalind Morris,
Discussion Leaders

Evening: Small Group Discussions on Various Sessions

February 10

Morning: Business Session
-- E. L. Smith, Chairman

FUTURE CHALLENGES

M. A. Massengale
Vice Chancellor for Agriculture and Natural Resources
University of Nebraska

It is a pleasure for me to welcome you to Lincoln and the University of Nebraska campus. We are always delighted to have distinguished visitors on the campus of the University of Nebraska. We hope you will take time to become better acquainted with our campus while you are here and return as often as possible.

We are just beginning a new year, with a new U. S. President and new cabinet members and we hope somehow their decisions are such that the American farmer and citizens of the country will both benefit at the same time. This country has quite a tradition and record to uphold.

In the 200 years of its existence -- the United States has become the giant in production of the world's goods. Agricultural productivity has increased along with other production units -- to the point that we are able to produce more than we need to feed our nation. Wheat production has certainly been a part of that growth. We have heard much in recent times about the world food situation -- about our national agriculture policy, or lack of it -- about export and import embargos -- about environment and health concerns in the production of food -- about shortages and surpluses -- and about energy consumption.

The International Wheat Council has projected a record stock of wheat this year -- most of which is already on hand. Or -- as a Kansas journalist wrote last week -- "If farmers never harvest another crop of wheat, enough of the grain is on hand to put bread on the tables of Americans for the next five years." Wheat prices are currently lower than the cost of production. No one is happy about that. Our new Secretary of Agriculture and his team have their work cut out for them. There are problems to face -- and, hopefully, solve. But whatever action is taken -- this year or next year -- we cannot lose sight of another highly important aspect of food production -- preparing for the future. We can be fairly certain that the food needs of the future will require greater agricultural production efficiency than we have seen to date. Demographers tell us there will be from 6.5 to 8 billion people on this earth by the year 2000.

You're here for two days to discuss some of the opportunities and challenges that lie ahead in the development of the world wheat industry. Several problem areas need immediate and continuing attention if we are to meet the opportunities and challenges of the future. Their solution involves multi-disciplinary collaborative research and development activities. Many of the problems are inter-related -- and the solution of one without adequate attention to the others could result in minimal or zero net gains. Improved technology to produce wheat at a lower cost per acre is needed. Research is needed to establish production practices and combinations of crops best suited to each of the wheat areas -- which will best utilize available resources to produce wheat most efficiently and economically. Productive wheat breeding must encompass comprehensive investigation and use of genetic and physiological information. It must have continuity. Achievement of needed productivity levels for the future will depend on a better understanding of plant physiological processes -- and their relationship to genetic potential -- than exists at this time.

Wheat varieties for the future will result from breeding activities already under way. They must possess (1) high yield potential, (2) yield stability, (3) good agronomic characteristics, and (4) the quality needed by the milling and baking industries in the United States and importing countries. The potential for wheat under irrigation should be explored in this region. As food becomes more of a problem in the future, we may need this extra production. Soil fertility levels and fertilization practices needed to maximize wheat productivity and quality in each wheat area must be firmly established. A comprehensive system of wheat disease surveillance and control recommendations is needed. Such information is useful to breeders as well as producers. Management systems to more effectively control weeds, disease and insect pests need to be developed or refined. And -- the wheat industry must have increasing concern for the nutritional value of its product.

The challenges of the future can be met -- but not by one laboratory or one test field or one discipline. It will take a cooperative effort -- the exchange of research information and sharing of germplasm materials -- to get the job done. This regional conference is one example of the kind of cooperative effort needed. I compliment you and commend you highly for getting together as you are in an interdisciplinary grouping to look at major problems facing wheat. I wish you all success for a most productive and profitable conference.

RESUME FOR QUALITY SESSION

R. K. Bequette

Present varieties are evidence that we know how to breed and test for protein content, milling and bread baking quality. But cultural and marketing practices can negate genetic improvements in protein content and bread baking performance. Discussion centered on two topics:

1. Fertilization for maximum yield, protein content and profit.

2. Segregation according to protein content on the farm or at first point of delivery to a commercial grain handling firm.

Dr. David Dibbs, Southern Midwest Director, Potash Institute, Columbia, Missouri, reviewed foliar spraying research conducted with soybeans and corn by John Hanway at Iowa State and with wheat by Karl Finney at Kansas State. On the basis of their results, he speculated that yield and protein content responses in hard red winter wheat might be influenced by:

1. timing of application(s),
2. amount(s) applied,
3. ratio of nitrogen, phosphorus, potassium and sulfur used,
4. basic soil fertility.

Foliar sprays can be applied at advanced stages of plant development. This reduces foliar stimulation and less risk is involved because a better assessment of soil moisture available for plant maturation is possible prior to fertilization.

Additional studies on foliar fertilization of wheat are needed.

Dr. Gary Peterson, soils specialist, discussed Nebraska fertilizer recommendations for wheat. The average recommendation is designed to give maximum yield and 11% protein content in the grain.

Dr. Everett Everson of Michigan presented data showing significant varietal differences in amount of fertilizer required to maximize yields. He discussed the possibilities and problems of breeding and selecting varieties which would produce maximum yields with minimum fertilization.

There has been little economic incentive for individual farmers to produce high protein hard red winter wheat. Montana legislation requires protein testing of all wheat delivered to Public Warehouses and Montana growers receive protein premiums. But circumstances in Montana are unique. Similar legislation could create serious problems in the Southern Great Plains. The relatively high moisture content of Southern Great Plains wheat and the higher temperatures of the region make farm storage hazardous. Consequently, a large proportion of the crop is delivered directly to local elevators in a very short time. The system is geared to handle wheat on a volume basis and high and low protein wheat are often mixed together in the rush.

The situation in the Southern Great Plains is changing. Some growers are receiving protein premiums, but this usually entails farm storage and delivery after the harvest rush.

Sources of information on grower marketing of high protein wheat include:

1. The Wheat Improvement Association
   404 Humboldt
   Manhattan, KS 66502

2. Clive R. Harston
   Marketing High Protein Wheat in the Northern Great Plains
   Montana Agricultural Experiment Station
   Bul. 527 (January 1957)

IMPORTANCE OF WHEAT PROTEIN CONTENT

R. K. Bequette

Wheat protein is important in human nutrition and is in short supply for most of the human race. Therefore, protein content is important from a humanitarian standpoint. Unfortunately, those who most need protein are also short of calories and money. Consequently, they usually take the cheapest wheat available and many of their purchases are financed through various aid or give-away programs. We may have a moral obligation to those less fortunate than ourselves. But there is a limit to our ability to finance philanthropic efforts. However, wheat protein will become more important from a nutritional standpoint as world population increases.

Most domestic and foreign cash customers purchase wheat because of its unique bread baking properties. These properties are related to protein content and protein quality. Present hard red winter varieties have good to excellent protein quality. But regardless of protein quality, it is almost impossible to bake a decent loaf of bread when the flour is milled from wheat having less than 11.0% protein. U. S. bakers demand flours from wheats having 12-13% protein. The same is true in many other developed countries.

Crude bakeries in hot, tropical countries such as the Philippines, the Caribbean, and Africa often demand flours milled from wheats having 14.0-15.5% protein.

Yields of Great Plains Hard Red Winter wheat have increased dramatically during the past decade and average protein content has declined. Better moisture conservation resulting from more timely tillage operations (big tractors) has been an important factor, especially in the drier areas. More farmers are using fertilizer, but many emphasize phosphorus which tends to decrease protein content.

For the past several years, average protein content of Great Plains Hard Red Winter wheat has been too low for bakers' bread flour. If all the Great Plains Hard Red Winter wheat was blended together, protein content would be too low for commercial bread flour.

The newer, high yielding, higher protein varieties may reduce or eliminate further declines in average protein content of Hard Red Winter wheat. But many of the new varieties have stiffer or shorter straw. They can take higher rates of nitrogen without lodging. However, most farmers will fertilize only for yield until there is an economic incentive to fertilize for protein content. Unfortunately, the treatments used to obtain high yields often reduce protein content.

This year many countries had a bumper wheat crop and there is tremendous competition for cash export markets. Canada, Australia, and Argentina are cutting prices.

The Canadian Wheat Board controls all movement of wheat from farm to mill or ship. They guarantee minimum protein content of all export shipments and are experimenting with procedures for paying farmers on the basis of protein content.

The Australian Wheat Board also controls all movement of wheat from farm to market. They guarantee protein content of Prime Hard and Hard grades. They are segregating according to Market Grade and are paying protein premiums to farmers.

Argentina has returned grain marketing to the private sector. But the Grain Board is developing methods of segregating deliveries on a protein basis.

Release of new varieties must be approved by a government or quasi-government agency in Canada, Argentina and Australia. Protein content is a major consideration in all three countries when new varieties are considered for release.

Breeders and farmers often ask why they should worry about protein when growers are not paid on a protein basis. When there is a surplus of wheat, purchasers buy wherever they can obtain the desired qualities. Low protein content can translate into lost markets. Under these circumstances, having a market is a premium for protein content.

MARKETING HIGH PROTEIN WHEAT

K. L. Goertzen

In 1974 9,000 bushels of genetically high protein grain produced from Seed Research Associates wheat varieties were marketed on an identity preserved basis to be used in blending. Since this first marketing of genetically high protein wheat the idea and practice of growing identity preserved high protein wheat has expanded rapidly. The genetically high protein wheat was marketed to demonstrate the feasibility of producing high protein wheat to meet the requirements for blending wheat.

In the fall of 1974 additional plantings were made to produce high protein grain on an identity preserved basis. In addition to wheat produced under contract and marketed on an identity preserved basis many farmers grew some of the Class II wheats to sell for protein premiums.

In the fall of 1975 several thousand acres were planted to genetically high protein wheat to be marketed on an identity preserved basis. The mill that had pioneered in the first large scale utilization of genetically high protein winter wheats found these Seed Research Associates varieties to meet their needs so well they started contracting for production of genetically high protein wheat.

Since this first high protein wheat grain was marketed in 1974 the premium for 16% protein has averaged over 50¢ per bushel, at an average cost of less than 2¢ for nitrogen for each pound of protein produced. In most cases the nitrogen that has been used has been much more than paid for by additional yield.

IMPORTANCE OF WHEAT PROTEIN CONTENT IN FOREIGN AND DOMESTIC MARKETS

Paul J. Mattern

Foreign Protein Requirements

There are three types of foreign buyers who have specific protein requirements.

1. Those wishing high protein and baking quality to substantially increase baking potential of low protein indigenous wheats. If domestic production is high they want the highest protein possible and best cost relationships.

2. Those importing total wheat needs would require a lower total protein level.

3. Those who, by tradition, have imported higher protein levels because environmental conditions aren't controlled in the bakeries, may use imported wheat alone or with rather small amounts of domestic wheats.

Many of these buyers have been specifying protein content. Traditionally, the spring wheats have had much of the market for the highest protein levels.

Because general baking quality per unit of protein has improved during the last 20 years in the HRWW area, lower protein wheats still maintain adequate loaf volume potential even with their lower protein content. Certain baking procedures, such as the Chorleywood System have also decreased flour protein requirements by several tenths of a percent.

Domestic Protein Requirements

Protein quality, or any other specific baking quality, to a domestic user is the thing he can blend in rather small amounts -- or at a reasonable price -- to bring a low cost or local wheat supply to a point at which it will produce an acceptable flour product.

Mills producing bakery flours have traditionally used certain wheat growing areas to achieve a milling blend. However, wheat varieties and quality factors have changed in both spring and winter growing areas. Many mills in the HRWW area have traditionally purchased some spring wheat to increase protein or other factors. Recently, mixing times have increased in both spring and winter growing regions. Mills found mixing times getting critical on the long side when longer mixing spring wheat was added for protein adjustment.

What will happen if everyone gets into the act to increase the protein content of their HRW wheats, and simultaneously increase mixing times?

The quality wheat item could become a shorter mixing component at a medium to low protein content. Spring wheats may become somewhat lower in protein content due to increases in yield potential. Winter wheats may also be increasing in protein content from genetic sources and cultural practices especially if there is a price incentive.

We have already seen a premium offered for lower spring wheat protein several years ago. I can envision a situation in which wheat variety, fertilizer treatment, and the growing environment all cooperate to maximize protein content. This could bring a premium for low protein content wheat. Most wheat workers believe that there will always be enough low protein wheat. However, it may not be in the area of greatest price advantage for certain flour mills.

Mills like one in Buhler, Kansas, which produce low protein biscuit flours would not like to see protein contents increase in their normal area of purchase.

The future seems to be in a state of flux. Spring wheat regions are looking at higher yielding types and at increased winter wheat production, both of which will lower protein contents in that area.

Perhaps the most significant fact is that there is no long range organized plan for an orderly assessment of what would be most economic for a typical wheat flow pattern for both domestic and foreign needs. Such a plan should consider both protein and mixing characteristics for existing markets.

HIGH PROTEIN FROM A COMPLEX WINTER WHEAT CROSS

V. A. Johnson, K. Wilhelmi
and S. Kuhr

Selections from a complex winter wheat cross have exhibited high grain protein content in combination with other useful traits in tests at Lincoln, Nebraska and Yuma, Arizona. Performance of the lines in 1975 and 1976 Nurseries at Lincoln is compared with that of Centurk and Lancota in Table 1.

Wheats from 5 different countries were combined in the cross from which the lines were selected.

Parent Variety	Country of Origin
Favorit	Romania
Cirpiz	Turkey
Jang Kwang	Korea
Atlas 66/Comanche	USA
Velvet	Sweden

All survived the 1974-75 winter at Lincoln with full stands and minimal leaf damage. However, in the more severe 1975-76 winter, moderate to heavy loss of stands occurred but spring recovery was good. The lines appear to combine high grain protein potential with large seed size, short plant height, excellent yield potential and strong dough mixing properties.

The lines also were evaluated under irrigation at Yuma, Arizona (Table 2). All produced good yields of grain with substantially higher protein content than the check varieties. Their seed size was substantially higher than the check varieties. High protein was associated with minimal depression of lysine per unit protein. On an adjusted basis, lysine content was fully comparable to that of the check varieties.

The lines are being used extensively in hybrid combinations with other sources of high protein, high lysine and high productivity.

Table 1. Performance of promising high protein lines at Lincoln, Nebraska (1975 and 1976).

Variety or Pedigree	Plot number	1976 Performance (duplicate plots)[1] Grain yield	100-k weight	Seed rating	Plant height	Winter survival[2]	1975 Performance (single plots) Grain yield	Protein content	Winter survival[1]	Mixing Time	Mixing Tolerance
		q/ha	g		cm		q/ha	%		min	
Centurk	$\bar{x}$ of several plots	55.0	2.08	G	114	9	35.9	15.6	9	2-2/3	4
Lancota	"	44.7	2.51	VG	122	8	37.5	17.5	9	2-1/3	3
Favorit/5/Cirpiz/4/Jang Kwang//At66/Cmn/3/ Velvet	10334	39.1	3.08	VG	102	2	44.4	19.1	8	3-1/3	4
" "	10336	39.2	3.19	G	103	2	39.0	18.6	8	3	4
" "	10337	39.6	3.15	VG	98	2	40.0	18.1	8	2-2/3	4
" "	10338	39.6	3.13	G	102	2	40.5	18.2	8	3	3+
" "	10339	39.7	3.09	G	99	3	39.7	18.2	8	3	4-
" "	10341	38.6	3.18	VG	100	2	41.1	18.1	8	3	4
" "	10342	38.0	3.12	G	97	2	40.7	18.5	8	4	4
" "	10456	41.2	3.49	VG	103	4	40.1	18.5	8	4	3+
$LSD_{.05}$		8.4					--				

1/ Grain protein analyses not completed.

2/ Winter survival ratings
9 = 100% survival, minimal leaf damage
8 = 100% survival, light leaf damage
4 = 51-75% survival
3 = 21-50% survival
2 = 6-20% survival

Table 2. Performance of Favorit/5/Cirpiz/4/Jang Kwang//At 66/Cmn/3/ Velvet high protein lines in irrigated duplicate plots at Yuma, Arizona in 1976.

Variety or Pedigree	Plot number	Grain yield	100-k. weight	Protein content	Lysine content Unadj.	Lysine content Adj.
		q/ha	g	%	%	%
Centurk	x̄ of 14 plots	55.0	3.59	11.6	3.3	3.2
Lancota	"	44.7	3.73	12.9	3.2	3.2
CI13449	"	50.2	3.05	12.1	3.3	3.4
Favorit/5/Cirpiz/ 4/Jang Kwang//At 66/ Cmn/3/Velvet	10334[1/]	39.5	4.32	14.0	3.3	3.3
"	10336	41.6	4.31	13.6	3.3	3.4
"	10337	40.7	4.31	14.1	3.1	3.2
"	10338	42.3	4.31	14.8	3.2	3.4
"	10339	-	-	-	-	-
"	10341	41.7	4.54	14.2	3.1	3.3
"	10342	43.0	4.64	14.5	3.1	3.3
"	10456	45.5	4.38	14.6	3.1	3.3
"	10343[2/]	50.8	4.51	14.3	3.2	3.3
"	10436	48.0	4.54	14.3	3.2	3.3
"	10437	48.2	4.49	14.6	3.1	3.2
"	10439	49.2	4.57	14.2	3.2	3.3
"	10444	50.6	4.55	14.1	3.2	3.4
"	10457	50.2	4.26	14.3	3.1	3.2
"	10459	49.4	4.58	14.6	3.0	3.2
"	10460	53.8	4.52	14.2	3.0	3.1
$LSD_{.05}$		12.3				

[1/] Plot numbers 10334-10456 also harvested at Lincoln, Nebraska (see Table 1).
[2/] Plot numbers 10343-10460 harvested only at Yuma, Arizona.

EFFECTS OF LOCATIONS AND MOISTURE STRESS ON YIELD AND YIELD COMPONENTS

M. R. Thomas and E. L. Smith

The effects of four moisture-stress treatments on four winter wheat cultivars (Osage, Caprock, Triumph 64, and Bezostaya 1) were studied in 1974-75 at Stillwater, Lahoma, and Altus, Oklahoma. Plots were 4 rows, 3.0 m in length. The 2 center rows comprised the test rows and, in all cases, were seeded at the same rate (67 kg/ha). Stress levels were imposed by adjusting the seeding rate of the 2 outside "guard" rows of each plot. Stress levels were: 1) 16.82 kg/ha (15 lbs/A), 2) 67.28 kg/ha (60 lbs/A), 3) 134.52 kg/ha (120 lbs/A), and 4) 269.04 kg/ha (240 lbs/A). Above-average rainfall was recorded at all locations during this study which tended to reduce the effectiveness of stress imposed by this procedure.

At Stillwater, significant differences among cultivars were observed for yield and the components of yield. Significant differences due to stress levels were observed for yield, tiller number, and seeds/spike; but not for kernel weight. At Lahoma and Altus, significant differences among cultivars were observed for yield and the components of yield; but significant differences among stress levels were observed only for seeds/spike. The results indicated that of the 3 yield components studied, kernel weight was the least sensitive to moisture stress and location effect while seeds/spike was the most sensitive.

An examination of the highest yielding variety at each location revealed that different components were operating to make yield at the different locations; the greatest contrast was between the Lahoma and Altus locations. Bezostaya 1 was the highest yielding cultivar at Lahoma. It had the lowest tiller number, but the highest number of seeds/spike and the highest kernel weight. Osage was the highest yielding cultivar at Altus. It had the highest tiller number and intermediate values for seeds/spike and kernel weight. Comparative tillering patterns between the Lahoma and Altus tests suggested that these 2 locations may have represented an optimum maximum condition (Lahoma, average tiller number of all 4 cultivars = 72.0) and an optimum mimimum condition (Altus, average tiller number of all 4 cultivars = 49.2) for this trait. At or near the upper limit (Lahoma) extra tillering did not appear to be important and in fact may have reduced yields. At or near the lower limit (Altus) extra tillering appeared to be very important to yield.

DRYLAND ROOT STUDIES

J. R. Welsh

In a series of root studies conducted under dryland conditions at the Akron Research Center over a five-year period, we were unable to find any relationship between semi-dwarf genes and rooting patterns or moisture depletion patterns. We sampled a wide range of environments with these five years and used a diverse array of adapted and non-adapted winter wheat cultivars and included in our last study a set of near isogenic height lines involving Scout, Wichita, and Trapper.

Since we were unable to find any relationship between the height genes and moisture depletion patterns or root development, we feel that the root systems on semi-dwarf materials are likely adequate to completely use the limited amount of moisture available in this environment. We have been concerned about the relationship of our information with that of other workers including Dr. McKay from Sweden who reported mirror image development of root and shoot growth.

We are now beginning to believe that we are forcing the semi-dwarf genotypes into adequate root development by virtue of the fact that roots will grow only where there is adequate moisture for them to develop. This means that even the genotypes that may have shorter root systems under ideal conditions will be forced to push deeper and deeper into the profile as moisture depletion is completed in the upper levels.

It is entirely possible that under ideal moisture conditions and without the effect of competition from neighboring plants the semi-dwarfs could have different root development patterns from the tall genotypes. This has not been established with any certainty with respect to the materials that we have tested, however.

We have completed the root studies phase of our research at the present time. We are now concentrating our efforts in the area of water use efficiency to try and identify genotypes which do a better job of using the limited water available in the eastern Colorado dryland winter wheat environment.

WINTERHARDINESS

John Erickson

Introduction

Winterhardiness is a complex trait and relative to specific areas and conditions. Unlike yield, where highest is best, the degree of winterhardiness desired is the minimum necessary to provide protection for expected conditions.

Historical trends

John Schmidt of Nebraska presented data showing the general decline of winterhardiness over the past 40 years. In 1938 the cultivars Cheyenne and Turkey were being recommended as far south as Texas. Survival data showed Kharkof, Cheyenne, Kanred and Nebred to have approximately the same winterhardiness, with Yogo and Minter at a higher level. The release of Pawnee, Wichita, Comanche and Triumph in the 1940's resulted in reduced winterhardiness below Kharkof. Scout and its derivatives released in the 1960's also were less winter-hardy than Kharkof. Some releases of the 1970's, such as Sage, Gent, Lindon and Vona apparently are less winter-hardy than the Scout types. Improved management practices appear to be a major factor in permitting production of less winter-hardy cultivars.

Winterhardiness requirements

A representative from each state outlined specific requirements as follows:

Texas - Earl Gilmore:
About 90% of the wheat is produced in the High Plains and Rolling Plains of northwestern Texas. Winterhardiness is not a serious problem with all cultivars being adequate with the exception of Agent and Fox. Day neutral or insensitive types such as Sturdy may start spring regrowth too early in central Texas and suffer frost injury.

Oklahoma - Ed Smith:
About 90% of the wheat in Oklahoma is produced west of Oklahoma City. The Panhandle area has a higher winterhardiness requirement. Agent, Sturdy and Caprock may suffer injury in the Panhandle unless grown under irrigation. Insensitive types can be hurt by cold periods in February. A combination of dessication and cold causes the most injury.

Kansas - Ron Livers:
Increased winterhardiness is needed from southeastern to northwestern Kansas. This results from a combination of increased altitude and latitude. The recommended cultivars range from Sturdy and Chanute in the southeast to Lancer and Trapper in the northwest. Cold tolerance

in the hardened state is needed in addition to daylength sensitivity to prevent too early regrowth. Regrowth damage can occur in March with top growth frozen, frost at the jointing stage will result in stem breakage later and frost in the boot stage will result in sterility. At Hays there is about a 6-week period of frost vulnerability and late frosts occur about three years in ten.

Colorado - Jim Welsh:
Wheat is grown at altitudes of 3000 to 4000 feet. Management, such as stubble mulch tillage and deep furrow seeding, is very important. Scout types and Centurk are the major cultivars. Less winter-hardy cultivars such as TAM 101 appear to do well also. The new releases, Lindon and Vona, are less winter-hardy, but perform well under good management.

Nebraska - John Schmidt:
Northern and western Nebraska need a higher winterhardiness level. Lancer is the most winter-hardy cultivar required. Proper management is very important for successful production. A combination of cold and drouth can cause severe damage. The ability of newer cultivars to recover after damage is apparent.

South Dakota - Darrell Wells:
Variable weather conditions exist in South Dakota and result in quite a range of cultivars which may be grown. The southwestern part of the state is milder and the northeastern area is the most severe. Good management allows production of TAM 101, Centurk, Sage, and Gent although Lancer is the most popular variety. Complete winterkilling may occur in the northeastern area unless seeded into stubble. Usually it is too dry to get good stand establishment under stubble conditions.

North Dakota - John Erickson:
Winter severity increases from the southwest to northeast portions of the state. Most of the wheat grown in North Dakota is spring type, but some winter wheat has been grown in the southwestern corner for many years. In the last few years production has expanded north and east. The cultivar Winoka has adequate winterhardiness for the extreme southwest, but a higher level as possessed by Froid and Roughrider is needed further north and east. Good management is essential and stubble seeding is recommended east of the Missouri River.

Montana - Allan Taylor:
About 70% of the winter wheat is grown in the north central portion. Winalta and Cheyenne are the leading cultivars, with Cheyenne having about the minimum winterhardiness required. The new cultivar, Marias, is intermediate between Cheyenne and Winalta. The acreage of Centurk is increasing, but it may not have adequate cold tolerance. Maintaining snow cover is very important to protect the seedlings. Good spring recovery is essential as all top growth frequently is frozen back.

Canada - Brian Fowler:
About 300,000 acres of winter wheat are produced in western Canada. Most of this is grown in the Lethbridge area of Alberta. Winalta has been the most popular cultivar, while Sundance is more winter-hardy and has allowed expansion further north and east in recent years. A small acreage of winter wheat is grown in southwestern Saskatchewan, but further north the snow cover is not reliable and only rye will survive. In the Park area of northern Saskatchewan the snow is deeper and stays in place so winter wheat is being grown on a limited scale.

General
A discussion followed in which Jim Welsh presented some economic data on expected gains from higher yields and incorporated loss figures from lower winterhardiness. With a 10% yield increase, losses of about 9% to winterkill would be the break-even point. Careful testing under actual conditions was the basis for recommendations.

John Schmidt indicated that stability of production was more important in some areas.

Virgil Johnson felt that breeders may have been too conservative in the past, partly because of a system of strong recommendations to farmers. Providing more complete information to the farmers may allow them to make better decisions.

Winterhardiness sources

John Erickson presented some data on the results of screening the USDA World Wheat Collection for winterhardiness. About a dozen entries, mostly originating in the USSR, have superior winterhardiness to cultivars such as Froid, Minter, etc. However, they all have very poor agronomic, disease and quality characteristics. They have been crossed with better agronomic types in an effort to transfer their winterhardiness into suitable forms. Some crosses to other species, primarily *Aegilops*, have been made in an effort to transfer winterhardiness to common wheat.

Darrell Wells reported on some reciprocal crosses between Pawnee and YTO-117. Pawnee backcrossed into YTO-117 cytoplasm six or seven times had winterhardiness similar to YTO-117, as did YTO-117 backcrossed into Pawnee cytoplasm. Pawnee in YTO-117 cytoplasm was later and darker green than Pawnee and had less leaf and stem rust.

Evaluation methods

Allan Taylor gave results of evaluating winterhardiness based on traits other than differential survival. Prostrate growth habit in fall and spring, dark green plant color and spring regrowth vigor were correlated with winterhardiness where differential survival did not occur. Artificial freezing of field-grown materials gave good differential when a chemical dessicant was included in the procedure.

Brian Fowler reported on artificial freezing using the LD_{50} temperature as a measure of winterhardiness. This method was effective in separating very hardy from non-hardy, but field testing gave better differential. Frontier rye had an LD_{50} of -29C, while Sundance had an LD_{50} of -17C. Rye has greater winterhardiness earlier and maintains it longer than wheat. An octoploid Triticale of Kharkof MC22 by Frontier was no more winter-hardy than its wheat parent. Winterhardiness is lost when soil temperatures increase in the spring. Date of seeding is very important, early seeding results in more vigorous growth and better survival. Snow mold can be a problem.

Comparative Winterhardiness of Commonly-grown Hard Red Winter Wheat Varieties, 1938-1977.

J. W. Schmidt

It is difficult to compare winterhardiness of wheat varieties over a long period of years. Conditions change, the check varieties may change and the growth patterns of current varieties may be different from those grown earlier. Yet when one observes the current world-wide, commonly-grown winter wheats, one is forced to conclude that they are not so winterhardy as those grown 40 years ago. This is not to say that hardy wheats are not available but these are not the dominant wheats. In the United States the currently popular varieties are not equivalent in hardiness to Turkey, Cheyenne, Tenmarq, and Blackhull--the suggested and commonly grown wheats in Oklahoma, Kansas, Texas and Nebraska forty years ago. Similarly in Europe, especially Eastern Europe, only Mironovskaya 808 of the very widely grown wheats is similar in hardiness to earlier varieties and to those grown in Northern or Central Plains.

There are a number of reasons why less hardy varieties are grown. Production practices today are much superior to those in use 40 years ago. Better seedbed preparation and better seeding equipment provide a material protection not available 40 to 50 years ago. Also, the recovery potential of many of the less hardy wheats is considerable, allowing damaged stands to produce respectable yields if weather conditions are at all favorable. Finally, combining high levels of winterhardiness with early maturity and superior yielding ability has not been easy and high yield potential has outweighed superior winterhardiness.

But the decline in winterhardiness is fairly evident in the newer varieties for the Central and Southern Great Plains. With some exceptions, this decline has been progressive. Are we approaching the vulnerability line at which we can anticipate that large acreages of the newer, more wintertender varieties may succumb to a rather severe winter? Perhaps it is time genetically to shore up our defenses against winter damage. Fortunately, the development of winter wheat breeding programs in the Northern Great Plains and Southern Canada is bound to provide valuable germplasm materials for breeding for improved winterhardiness.

DISEASE HAZARDS TO HARD RED WINTER WHEAT: SUMMARY OF SESSION

F. J. Gough

Discussion of hard red winter wheat diseases centered around major virus diseases, leaf spotting diseases other than rusts, and diseases caused by fungi commonly associated with root and crown rots. Myron Brakke and A. L. Scharen briefly addressed the problem relative to virus and leaf spotting diseases, respectively. Earl Hansing reported on the use of non-mercurial fungicides for controlling seed and seedling disease as well as control of bunt and loose smut. Don Mathre reported on his observations of Cepholosporium stripe. Those presentations prompted lively discussion from the floor concerning distribution, current status, and probable future impact of the diseases on wheat production. The following is a summation of contention by the conferees as recalled and interpreted by the writer.

Virus Diseases. -- Wheat streak mosaic virus (WSMV), soil-borne mosaic virus (SBMV), and barley yellow dwarf virus (BYDV) are the most serious virus diseases in the region. The importance of WSMV is expected to decrease as virus and mite resistant germplasm (CI 15321 and CI 15322) derived from *Agropyron elongatum* and virus resistant germplasm (CI 15092) derived from *A. intermedium* becomes available in commercial cultivars. The resistance to SBMV already in some cultivars (Chanute, Comanche, Homestead, Palo Duro, Satanta, Tascosa, Yukon) has not been fully exploited. SBMV appears to be spreading south and west in Oklahoma and consequently may become more important, especially if it is transmitted to irrigated land of the High Plains of Texas and Oklahoma. BYDV, possibly the most important disease of wheat in Central United States, consists of many strains, some of which require specific aphid vectors. Strain-vector relations and the frequent paucity of definitive symptoms (light green, yellow or reddish color is easily confused with nutritive disorders) confounds study of the disease and contributes to an under assessment of disease incidence. Early infection increases winter kill. Readily available resistance in unknown, but some winter cultivars, e.g. Centurk and Parker, are tolerant. In South Dakota, tolerant lines with a 75% yield advantage over checks have been selected. Attempts to select for transgressive segregates were unsuccessful.

Leaf and Root Diseases. -- Short wheats, especially those derived from 'Norin' germplasm, often are more severely damaged by mildew, Septoria blotches, and bacterial blight than tall wheats. Fortunately, the relation of plant height to disease severity is not directly correlated in all genotypes. Cultural practices such as minimum tillage and continuous cropping often results in exposing seedlings to contiguous inoculum sources and enhances losses caused by facultative pathogens of roots, stems, and foliage. Increased efforts to develop resistant cultivars and to broaden efficacy of fungicide formulations are immediate needs for disease control.

CONTROL OF BUNT (STINKING SMUT), LOOSE SMUT, AND SEED DECAY AND SEEDLING BLIGHTS OF WHEAT BY TREATING THE SEED PRIOR TO PLANTING WITH NON-MERCURIAL FUNGICIDES

Earl D. Hansing

Hexachlobenzene and pentachloronitrobenzene have continued to be highly effective as seed treatments for control of bunt (*Tilletia foetida*). In addition based on extensive tests during the last few years 3-Carboxanilido-2,4,5-trimethylfuran has been highly effective for control of this disease. None of these fungicides are effective for controlling seed decay and seedling blights. Therefore, these fungicides are used in combinations with such fungicides as captan, carboxin, ethazole, maneb, and thiram for the additional control of these diseases.

Carboxin has continued to be highly effective for control of loose smut (*Ustilago tritici*). It has also been effective for control of seed decay and seedling blights, as well as moderately effective for control of bunt.

Extensive research has been continued on control of seed decay and seedling blights (*Fusarium* spp., *Helminthosporium* spp., *Pythium* spp. et al fungi). Pathogenic fungi may be in or on the seed as well as in the soil. Captan, carboxin, ethazole, maneb and thiram, used singly as well as in combinations, have continued to be highly effective in control of these diseases; thus, resulting in healthier stands of plants and potentially higher yields of grain. Research has been continued with flowable formulations, using fungicides singly and in combinations of two or more with excellent results. During the last few years several flowable fungicides have been registered and are being used commercially to treat wheat seed.

During the last few years extensive research has been conducted with Evershield formulations. Evershield has been patented and registered with the Environmental Protection Agency for seed treatment of all crops. It is a stable cream-colored emulsion. The formulation contains a binder to inhibit dust formation. The fungicide adheres to the seed; and although the coating breaks down after the seed is planted, the fungicide remains close to the seeds in the soil. Most fungicides can be formulated in an Evershield concentrate, resulting in 30% by weight of active ingredient. Evershield formulations are compatible with one another. Extensive research has been done using this process for application of fungicides both individually and in combinations with excellent results.

In general bunt (stinking smut) has been kept well under control primarily due to an extensive seed treatment program with 40% of the seed treated before planting. However, during the last few years this disease has become slightly more prevalent and severe in Kansas than it was a decade ago. Less than one percent of the fields have been heavily infected; however, for the individual wheat grower a high infection has resulted in a high financial loss. For each percentage of bunted spikes his yield has been reduced equivalently; thus, if he had 25% infected he would have a 25% reduction in yield. In addition elevators have rejected grain infected with bunt since they did not wish to mix it with bunt-free seed, thus resulting in 5 to 10 times as many bushels grading smutty when they sold grain to a larger terminal.

Although smut may be washed off before it is used for food, it is not practical to wash large quantities of grain for sale to other countries. Many of these countries do not wish to buy smutty seed since some of it may be bought and planted by wheat growers, thus possibly establishing either a new disease or a new physiological race of the pathogen in their country. Consequently, some wheat growers not only had a high reduction in yield, but since the grain was not accepted at the elevator they had to sell it at a reduced price for animal feed. Although bunted grain is not poisonous to animals it is not as palatable; therefore, they may not gain weight as rapidly. In addition it should not be fed to dairy cattle since the chemical trimethylamine (smell of fish) will get into the milk.

EPIDEMICS OF VIRUS DISEASES IN KANSAS WHEAT

C. L. Niblett

Since 1973 Kansas wheat yields have been reduced an estimated 88.6 million bushels due to three virus diseases. These are wheat streak mosaic (WSM), soil-borne wheat mosaic (SBMV), and barley yellow dwarf (BYD). Yield reductions by WSM were 15, 30, 1.5 and 1 million bushels for 1973-1976. The recent dramatic reduction in severity resulted from dry summers in 1974 and 1975. This prevented development of volunteer wheat which harbors the virus and its mite vector. Varieties resistant to the mite, the virus, and the mite and virus are being developed.

Yield reductions by SBWM are becoming more severe and were estimated at 5, 5, 15, and 16.1 million bushels for 1973-1976. The most severely affected area is the south central region of Kansas. The disease appears to build up with continued cropping of Scout-type wheats and has occurred on successive years in irrigated sand in southwest Kansas. The disease has not occurred in adjacent fields which are fallowed on alternate years. Resistance to SBWM seems to be resistance to the fungal vector rather than the virus. Resistant selections are being increased for release in 1977.

Yield reductions by BYD were estimated at 15 million bushels in 1976. The previous epidemic of BYD occurred in 1959 and since then the disease has been of minor importance. The mild fall and winter of 1975 and spring of 1976 permitted the aphid vectors to be very active and survive in large numbers. The resulting disease occurred in epidemic proportions in New Mexico, Texas, Oklahoma, Kansas, Missouri, Arkansas, New York and Illinois and was prevalent in Maryland and Maine. Isolates of BYDV from Kansas were characterized by W. Rochow (USDA, Cornell University) as extremely severe and of the nonspecific type (vectored by several aphid species). BYD may have the greatest potential for destruction of any of the virus diseases of wheat. This is due to the numerous weed and cultivated grass hosts and the number of aphid vectors (14).

Some resistance to BYD has been identified in wheat, but it must be incorporated into Great Plains cultivars. Results from experiments at the University of Illinois are shown in the following table. These results demonstrate the marked susceptibility of some Great Plains wheats and possible resistance in others. Many adopted and introduced wheats are being evaluated at Illinois in 1977.

EFFECT OF BYD ON WHEAT YIELD (HARD WHEATS)[a]

Wheat or line	% Reduction Fall inoculation	% Reduction Spring inoculation
Bezostaya	53.7	35.6
Buckskin	48.7	32.1
Centurk	16.6	7.7
Cloud	60.2	29.1
Gage	62.5	31.1
Gent	48.5	10.5
Homestead	41.5	26.7
Kharkof	55.0	12.7
Lancota	90.3	24.1
Parker	9.5	29.1
Pronto	53.1	5.8
Sage	28.5	+3.4
Scout 66	43.2	34.0
Sentinel	30.9	12.6
Trison	34.0	15.7
MV-69-06	36.2	30.9
MV-69-16	19.3	+1.5
MV-B-1	33.8	6.5
OK 696731	41.2	19.7
TX 69A565	42.1	13.5
Average	45.6	18.7

[a] Data provided by Drs. H. Jedlinski and C. M. Brown (Department of Plant Pathology, ARS, USDA and Department of Agronomy, respectively, University of Illinois).

LEAF-SPOT DISEASES OF WHEAT IMPORTANT IN THE HARD RED WINTER WHEAT BELT

A. L. Scharen

Most leaf-spot diseases are caused by facultatively parasitic fungi, but recently bacteria have been implicated in some leaf disorders. One disease, powdery mildew, caused by an obligate parasite, Erysiphe graminis DC f. sp. tritici Em Marchal, is included among the general leaf-spot group in the HRWW region. Other important leaf-spotting organisms are: 1) Septoria nodorum Berk.; 2) Septoria tritici Rob. in Desm.; 3) Septoria avenae Frank f. sp. triticea T. Johnson; 4) Pyrenophora trichostoma (Fr.) Fckl.; 5) Pseudomonas syringae Van Hall; and 6) Xanthomonas translucens (Jones, Johnson and Reddy) Dowson.

All of these organisms and the diseases they cause are greatly influenced by the environment, especially rainfall, relative humidity, and temperature. Some new environmental aspects that may be causes of increased losses from leaf-spot diseases in recent years are: 1) The advent of shorter wheats with tightly closed canopies; 2) the application of larger amounts of fertilizer, especially nitrogen; 3) increased acreages of irrigated wheat; 4) minimum-tillage, or no-tillage culture; and 5) changes in rotations or continuous cropping.

Considerable research will be required in order to understand the effects on diseases of changing cultural practices, and to permit recommendations of disease control methodology.

WHEAT INSECTS -- SUMMARY OF SESSION

K. J. Starks

Field research in western Kansas indicates that Orthene, Phosvel, Monitor, and Lorsban are as effective as the endrin standard for pale western cutworm control in winter wheat (DePew). Greenbug numbers of 400 to 1666/ft. of row in irrigated wheat were controlled and grain yields increased with dacamox, zolone, Bay 39007, lorsban, parathion, penncap M, dimethoate, dicrotophos and carbofuran. Fewer greenbugs were caught in traps, per year and at different times of the year, during the past six years than during the previous 18, even though field numbers remained numerous (Daniels).

Resistant sources, genetics, and procedures were discussed for the Hessian fly and cereal leaf beetle (Gallun). In Kansas 2% of plants were infested by Hessian fly and 30% of fields were infested (60% of fields were planted to a resistant variety). Nebraska had 0.5% of plants and 17% of fields infested (Centurk, moderate R, had the highest number of infested fields). Oklahoma had 10% of plants and 15% of fields infested (Hatchett). Resistant sources, including wheat, are now available for all of the greenbug's economical hosts (Starks). Wheat curl mite resistance of wheat-Agropyron lines C.I.15321 and C.I.15322 is controlled by the same gene(s) or gene(s) closely linked to those for resistance to wheat streak mosaic virus. Salmon which has a translocation involving rye chromosome 1R gave dominant resistance in the F_1 in a Salmon-Sage cross, and resistance comparable to Salmon was recovered in about 8% of F_3 lines tested, suggesting that two linked genes may be involved (Harvey).

The wheat curl mite, when transferred from wheat to several plants of a second grass species may 1) colonize most or all of them (complete adaptation), 2) colonize only a small number (partial adaptation), 3) or colonize none (no adaptation). When adaptation is partial, mites surviving on the second grass host are completely adapted but are only partially adapted when returned to wheat (Staples).

Tests with caged greenbugs, English grain aphids, and oat-bird cherry aphids on Protor wheat in 1975 and 1976 showed that densities of only 25 aphids/tiller for one week can cause substantial yield loss. Losses in several components of yield were as high as 45%, depending on aphid density and plant growth stage at the time of infestation (Kieckhefer). About 2½ million acres of wheat were sprayed for army cutworm in 1976 in Oklahoma. The pest has only one generation/year and is favored by mild, dry winters, with damage to wheat depending on larval numbers and size in relation to plant growth (Burton).

APHID EXPERIMENTATION IN SOUTH DAKOTA

R. W. Kieckhefer

Greenbugs, *Schizaphis graminum* (Rondani), English grain aphid, *Macrosiphum avenae* (F.), and *Rhopalosiphum padi* (L.) infest spring and winter wheat and other cereal crops in South Dakota each year. Experiments with caged infestations of these aphids in spring wheat (var. Protor) during 1975 and 1976 have shown that densities of only 25 aphids/tiller, feeding for one week, can cause substantial losses in yield. Losses in several components of yield ranged as high as 45% loss depending upon aphid population density and stage of growth at the time of infestation.

WHEAT NUTRITION, PHYSIOLOGY AND PRODUCTION

R. A. Olson (leader), C. R. Fenster, E. Kerr,
Lowell Klepper, G. A. Peterson, and G. A. Wicks

Solving the Problems of Ecofallow

Ecofallow is a system of controlling weeds and conserving soil moisture in a cropping system with minimum disturbance of crop residues and soil. Recent studies indicate that where adequate weed control is obtained with herbicides, moisture conservation and crop yields are as good as or better than with conventional fallow methods. In a wheat-fallow rotation at North Platte during 1963-69 comparing no tillage and herbicides to conventional tillage, the no-till plots had the least weed growth, most soil water stored, the highest amount of surface mulch and the highest grain yields. The conventional fallow yielded 40 bu/A; stubble mulch fallow 43 bu, and no-till fallow, 47 bu. A similar study at Sidney during 1969-76 produced 38 bu/A with bare fallow, 37 bu with stubble mulch fallow, and 38 bu with ecofallow. Stubble mulch sorghum yielded 51 bu/A in a sorghum-fallow rotation at North Platte during a 9-year period while ecofallow without tillage yielded 73 bu. Farmers in southwestern Nebraska have reported as much as 40 bu/A increases in corn and sorghum yields with ecofallow over conventional dryland cropping practices and the system is expected to be used on 32,000 acres in 1977.

Compared with conventional tillage the accumulations of vegetative residues on the soil surface create a physical problem for machine operations. Lower soil temperatures due to reflected radiant energy, reduced surface evaporation and insulation retard early germination and plant development and may retard nitrate-nitrogen production. The usually wetter surface soil may delay timely planting under cool conditions in medium to fine textured soils, but the lower evaporation loss of moisture can mean better stands under dry conditions.

Residues may be a possible source of phytotoxic substances capable of inhibiting germination and plant development. Left on the soil surface or only partially buried after the crop is planted they may also supply inoculum of a pathogen for a disease outbreak. On the other hand residues on the soil surface may reduce losses from diseases by producing a more vigorous crop that can tolerate disease, or create a favorable microenvironment for development of desirable soil microorganisms. Residues on the soil surface may improve the habitat for rodents, birds and other small animals causing damage to newly sown grain in some cases.

Crop varieties and cultural practices have been developed for conventional tillage. Genetic materials along with rates and dates of seeding, depth of planting, row spacing, furrow depth, kinds, rates and placement of fertilizer need to be evaluated in the new ecofallow system. Improved herbicides and application methods are needed for efficiently controlling weeds during the fallow and crop periods without damaging residual effects.

Foliar Fertilization

Much interest has been generated by the spectacular results achieved by Iowa State researchers with foliar fertilization of crops during the grain filling stage. For verification under Nebraska conditions a series of experiments on the major grain crops of the area were conducted at the Mead Field Laboratory in 1976. The crops growing in the experimental areas were adequately fertilized by soil treatment for the top yields normally obtained. The foliar treatment was made in three increments spaced about ten days apart beginning with the first evidence of grain formation. Total amount of nutrients applied was as indicated in Table 1.

It will be noted that yield increases were not obtained in any of the experiments and rather a decided yield reduction from foliar treatment occurred with soybeans. Rather severe burning was noted with the latter, only slight leaf burning with the others.

There were, however, significant increases in protein content from the foliar applications with all crops. A lighter test weight of wheat from the treatments without yield loss indicated that more kernels of grain had been formed which might have been reflected in yield increase in a year without the desiccating weather conditions experienced in 1976.

Treatments will be made across all varieties in the IWWPN at Yuma and Lincoln during 1977 for evaluating genotypic variations in response to foliar fertilization. Treatments will be made in the evening or early morning to alleviate the tissue burning hazard.

Improving Nitrogen Utilization Capabilities of Wheat

Nitrate is the primary form of nitrogen available for assimilation by wheat into protein. Before protein can be synthesized, nitrate must be reduced. The rate-limiting enzyme in this reductive process is nitrate reductase. We, at Nebraska, have attempted to identify genetic sources of high nitrate reductase activity (NRA) to be used as progenitors of high protein wheats. With an *in vivo* assay, NRA of selected experimental lines has been analyzed for two generations. Results from this study show that the assay is sufficiently reliable to consistently classify a high, intermediate or low NRA wheat from one year to the next. Approximately ten homogeneous experimental lines (highs) have been identified that are capable of NR activities of over 16 μmoles, gram fresh weight^{-1}, hour^{-1}.

Work has also been initiated using the Dickey-john Infra-alyzer to detect disappearance of vegetative protein and accumulation of grain protein in the spike. This study will be used in an attempt to identify "protein-efficient" wheats, those that are capable of synthesizing large amounts of vegetative protein and later translocating this protein to the grain.

An Update on Soil Test Calibrations for Winter Wheat in Nebraska

Fertilizer recommendations for winter wheat in Nebraska are made on the basis of soil tests. The test for N is the NO_3^--N content of the plant root zone and the test for P is the Bray and Kurtz No. 1 extractable P in a plow layer sample. Both of these tests have been field calibrated over a period of years which began in 1948. Recommendations have been continuously updated as the data bank grew. A switch from an N mineralization soil test to root zone NO_3^--N occurred in 1968 when it became apparent that the latter test was superior to the former under the field conditions that prevail today. Accuracy of the N recommendations has therefore been repeatedly checked and adjustments made to improve them. In general the N recommendations have been accurate on most soils that are not severely eroded or that are formed in loess parent material. Most of the "misses" with respect to a recommendation for N on wheat have been in the Panhandle area of the state. Even there they are quite dependable on the loess-derived Keith soils. However, on the soils formed in the sandy limestone parent materials such as the Rosebud and Canyon series, the recommendations are in error. These soils may be "missed" because they have a lower water holding capacity than do the Keith soils and because they are very P deficient. Coupled with the Rosebud soil problem is one of delays in maturity caused by the N fertilizer. This occurs on Keith soils as well and often causes a "missed" recommendation. A delay of a few days in physiological maturity forces the grain filling period into a hotter and drier part of the growing season.

Phosphorus recommendations are quite accurate for all soils except the calcareous ones. On calcareous soils our recommendations tend to be too low for a given soil test category. All recommendations to the grower are such that he can choose either a broadcast or row application method. Currently row applied recommendations are one-half those for the broadcast method at a given soil test level.

One of the key problems facing us is that of getting more consistent predictions of N and P needs for soils in the western areas of Nebraska. Delays in maturity due to application of N fertilizer must be dealt with. This delay causes grain fill to occur at a hotter, drier time as mentioned previously. Perhaps more emphasis needs to be placed on selecting varieties that have a more favorable maturity-climatic relationship when grown under optimum N and P conditions.

A second problem has been the accuracy of the row versus broadcast recommendations for P. The 2:1 relationship is accurate in many instances and then totally wrong in others. Recent field, greenhouse, and laboratory experiments have pointed out that soil pH may be a useful indicator in determining what the relationship between row and broadcast rates should be. At present it appears that the higher the soil pH the greater the probability that row applied

P will be more efficient than broadcast. Current field experiments involving a range in soil pH from 5.8 to 8.2 are aimed at testing this hypothesis.

Soil Testing Recommendations from Different Laboratories

Field experiments have been conducted in Nebraska during the past four years comparing crop responses to the fertilizers recommended by four commercial soil testing laboratories and by the UN-L Extension Service. Crops involved have been irrigated corn, potatoes and sugar beets and summer fallow wheat grown on different soils throughout the state. In each of the approximate 30 experiments conducted to date there was substantial variation in number of nutrient elements and rates recommended with a usual 2:1 range in costs for recommended fertilizers among the laboratories. But in no case has there been a significant difference in yield of crop from the different treatments, the minimum recommendation always affording greatest economic return.

Table 1. Crop response to foliar fertilization at the Mead Field Laboratory, 1976.

Crop & Fertilizer	Grain Yield	Protein	Grain Moisture
	bu/a	%	%
Wheat			
0 + 0 + 0 + 0	74	15.8	12.3
60 + 15 + 30 + 6	73	16.4	12.2
60 + 0 + 30 + 6	70	17.8	12.1
60 + 15 + 0 + 6	74	17.2	12.1
Corn			
0 + 0 + 0 + 0	160	8.3	24.9
50 + 10 + 12 + 5	159	9.3	24.6
50 + 0 + 12 + 5	155	9.7	22.0
50 + 10 + 0 + 5	161	9.6	23.8
50 + 10 + 12 + 0	159	9.5	23.8
Grain Sorghum			
0 + 0 + 0 + 0	124	7.8	14.9
40 + 8 + 10 + 4	122	9.3	14.1
40 + 0 + 10 + 4	128	9.7	13.5
40 + 8 + 0 + 4	123	9.8	13.0
40 + 8 + 10 + 0	127	9.5	14.1
Soybeans			
0 + 0 + 0 + 0	46	37.8	10.6
80 + 8 + 24 + 4	36	42.4	9.1
80 + 0 + 24 + 4	31	41.8	8.6
80 + 8 + 0 + 4	31	43.4	9.3
80 + 8 + 24 + 0	31	42.8	8.6

Grain H_2O @ harvest always less w/treatment

POPULATION BREEDING - GERMPLASM VARIABILITY

Byrd C. Curtis

In any plant breeding program the breeder should attempt to describe the environment under which the products of today's crosses will be grown. What will be the environment for winter wheat in 1992? Will it be the same as today or will it be greatly different? Yesterday we heard Dr. Massengale say that there is likely to be more irrigated wheat in the future. With the possibility of diminishing underground water supplies, it is logical that the reduced supply might be better utilized for wheat than for crops of corn and sorghum that require heavier irrigation. Foliar application of fertilizers and ecofallow (no-till) are examples of possible changes. Weather modification is a distinct possibility. Thus, what will the wheat growing environment be like in 1992?

What will be the architecture of the wheat plant to meet the 1992 environment? If there is a change in architecture, can it be created rapidly enough by current conventional breeding methods?

My experience and study tells me that we need to add or substitute another breeding approach to our programs - population breeding. We need to develop source populations that will give us the desired lines and hybrids of the future. We should do more offensive breeding and less defensive breeding in future years.

A source population is one containing a suitable frequency of desired genes for the stated objective and has been sufficiently intermated to dissipate mechanisms and linkage blocks to facilitate recombination for selection of the desired genotype. Note that the key word is this definition is OBJECTIVE. Source population breeding is a powerful method if the objective is clearly stated and efforts are concentrated to attain the objective.

Dr. Neal Jensen at Cornell University (Crop Sci. 10:629-735. 1970) has carefully studied cereal breeding over the past 25 years and has published some interesting suggestions for source materials in cereal crops. These are not necessarily new ideas because in corn and other cross-pollinated crops variations of his scheme have been used for several years. They are new to cereal breeding however, because as Jensen pointed out, cereal breeding programs today still rely on basic hybridizing procedures which may be described as a repetitive cycling of a two-parent cross followed by selfing generations and line selection. According to Jensen, this conventional system produces hybrid populations having three general characteristics of an undesirable nature.

1. Size of gene pool is small due to the limitations of the two-parent cross.

2. The accumulation of linkage blocks is favored. Linkage blocks are a stabilizing force in breeding, facilitating the re-assembly of genes for character complexes of known desirability. But stability and convenience may be an exorbitant price to pay for the severe restrictions strong linkage places upon genetic variability and recombination possibilities. The conventional system is only mildly disturbing to the stability because (a) the exposure to different gene arrangements occurs infrequently, and (b) the sequential crosses have large elements of recurrent or backcrossing strategy.

3. Inbreeding or lack of intermating beyond the initial cross strictly limits the recombination options. Linkage is intensified and soon forecloses any options of genetic recombination outside the narrow family lines of descent.

To meet and overcome the challenges posed by the aforementioned deficiencies Jensen proposed a diallel selective mating system as a supplement to conventional breeding systems for autogamous or self pollinating crops. This system envisages the formation of a composite hybrid population from the simultaneous crossing of multiple parents - in numbers as needed to provide genes to meet an objective - followed by intermating and application of recurrent selection principles.

Jensen proposed a complete or partial diallel cross of parent lines to provide a stated capacity of 21 F_1 combinations which would be used in a further diallel mating prior to selective mating or recurrent selection programs. The 21 F_1 combinations can be formed by a diallel cross of seven parents or by using the F_1's of up to 42 parents or any other combination as desired by the breeder. If the diallel makes use of 3- or 4-way crosses, 63 or 84 parents could be used. The F_2 or product of the 21 F_1 diallel crosses can be bulked for selection in a conventional manner or can be entered into a random mating or recurrent breeding cycle.

In using this system with wheat in our Cargill program, one plan is to make the diallel of the F_1 and then follow with one to three generations of random intermating prior to beginning recurrent selection breeding. We have four winter wheat and two spring wheat source material populations under way. One of the winter wheat populations is for a production or yield objective. It includes 13 high yielding parents from 13 different producing areas of the world. These were crossed 1 x 2, 2 x 3, 3 x 4, ... 12 x 13, 13 x 1 to obtain F_1's for making the diallel. The diallel has been completed and intermating is underway. Four intermatings are planned prior to any field selection for completion of the first cycle. Number of recurrent cycles to make is yet to be determined.

COLORADO STATE UNIVERSITY WHEAT BREEDING SCHEME

J. R. Welsh

With the advent of small plot harvesting equipment and rapid, accurate seeding systems, we have adopted a policy of performance testing in all generations including the F_2. Our primary source of selection pressure is drought tolerance. We have very few diseases to contend with. We have been unable to establish any relationship between various morphological characters and yield under our widely diverse environmental conditions. We therefore feel that yield performance in a framework of satisfactory quality is the only real criterion that we can use to advance our populations.

Attached is a diagram of our breeding program system. We devote 4,000 plots per location to this program each year. We have four dryland locations at which this material is tested. All 4,000 plots at each location are harvested and weights of all plots and test weights of the first replication are taken in the field at the time of harvest. We also have a concurrent head row or plant row program at Fort Collins under irrigation. Because the harvest at this site is delayed and because yields are very high, it is possible for us to collect all of our dryland data and computer analyze it prior to selection of head rows. In any population to be advanced, all head rows at Fort Collins are taken for individual yield testing the following year.

We make no attempt to visually select for anything other than stem rust resistance and then only at a very low level for that disease. We can impose quality testing at all stages of this program and use population bulk quality evaluations as a major means of eliminating part of the F_2 populations from further testing.

We have found this system to be very efficient and appears to be doing a good job of advancing the most promising material for us.

CSU BREEDING PROGRAM
FLOW SHEET

350 CROSSES

F_1 SPACED

350 F_2 BULKS
(1050 Yield Plots)

SELECT 100 POP'S,

100 F_2 ADVANCED
(300 Yield Plots)

SELECT
50 POP.S

100 SPACED POPS

Pull 150 plants/pop. selected. Bulk part of each plant, plant part in plant rows.

50 F_3 BULKS
(150 Yield Plots)

SELECT
10 POP.S

7500 F_3 PLANT ROWS

Keep 40 plant rows/pop. selected, pick 10 heads per row, and cut row in bulk.

400 F_4 BULKS
(1200 Yield Plots)

SELECT
15 POP.S

4000 F_4 HEAD ROWS

Keep all 10 head rows/pop. selected, select 5 heads/ row, and cut row in bulk.

150 F_5 BULKS
(450 Yield Plots)

SELECT
5 POP.S

750 F_5 HEAD ROWS

Keep all 5 head rows per pop. selected.

TOTAL: 3150 YIELD PLOTS
+ CHECKS

25 ENTRIES FOR ADVANCED
YIELD TESTING

BREEDING FOR MULTIPLE PEST RESISTANCE

E. L. Smith

Leaf rust, greenbugs, wheat streak mosaic virus, soil borne mosaic virus, and Hessian fly are serious or potentially serious pests of wheat production of Oklahoma and other parts of the Southern Great Plains. Breeding for resistance to leaf rust, SBMV and Hessian fly have been important objectives in many breeding programs in the H.R.W. Wheat Region for the past 30 years or so. Recently, parental stocks with greenbug resistance (Amigo) and WSMV resistance (C.I.15322) have been developed.

Traditionally, in breeding for disease and insect resistance in this region we have dealt with pests one at a time; if resistance to more than one pest was obtained, it was considered a bonus. Since it is often desirable to develop a wheat cultivar with resistance to two or more pests, SAES and ARS wheat workers (breeders, geneticists, pathologists, entomologists) at Stillwater have initiated a cooperative program to deal systematically with multiple pest resistance breeding. In this program certain 2-pest resistance combinations as well as several 3-pest combinations will be developed. We propose to do the screening in early generations, F_2 and F_3, utilizing sufficiently large populations to provide opportunities for selection of desirable agronomic and quality traits among lines carrying multiple pest resistant genes in the homozygous condition. Some adjustments in our current screening procedures will have to be made to accommodate multiple pest screening of the same plants, which is necessary if the program is to proceed in an efficient manner. Initially we will be dealing with eight 2-pest combinations:

1. Leaf Rust + Greenbug (LR24 or LR19 + Amigo)
2. Leaf Rust + WSMV (LR24 + C.I.15322)
3. Leaf Rust + SBMV (LR24 or LR19 or LR9 + KS73112)
4. Leaf Rust + H. Fly (LR24 or LR19 + H_3 fly resistance)
5. Greenbug + WSMV (Amigo + C.I.15322)
6. Greenbug + SBMV (Amigo + KS73112)
7. Greenbug + H. Fly (Amigo + H_3 fly resistance)
8. SBMV + H. Fly (KS73112 + H_3 fly resistance)

RISK CONSIDERATIONS IN VARIETAL RELEASE

J. R. Welsh

Winter hardiness is always a prime consideration in the release of hard red winter wheat varieties. It is important, however, to carefully consider the alternative risk features involved in the determination of minimum levels of winter hardiness (or other risk factors) which can be accepted and still provide the producer with a reasonable assurance of additional production and financial return. In the consideration of release of Lindon and Vona, two hard red winter semi-dwarf varieties, the following calculations were made. On a 1 million acre base with a 30-bushel yield average for standard varieties, a 5% yield improvement has been assigned to Lindon and a 10% yield improvement to Vona. A base price of $2.50 per bushel was used as the wheat value. Lindon would account for 1.5 million additional bushels, or $3.75 million additional income, annually. Vona would account for 3 million additional bushels or an additional $7.5 million annually.

In the case of Lindon, with a hypothetical loss of 2% annually (20% every ten years) from winter kill, this would result in 20,000 acres loss each year. This would mean 630,000 bushels loss or $1.57 million loss annually. The net gain, however, at this level of winter kill would still be $2.18 million annually or $21.8 million additional income during a ten year period. At a 4% loss (40% once in ten years) the annual loss would be 1.26 million bushels or $3.15 million. This would still result in a net gain to the producer of $600,000 each year or $6 million additional income in ten years.

With Vona at a 10% yield improvement, a 2% annual (20% every 10 years) winter kill would mean 660,000 bushels or $1.65 million loss annually. This still results in a net gain annually to the producer of $5.85 million or $58.5 million in ten years. At the 4% loss (40% every ten years) 1.32 million bushels would be lost annually or $3.3 million. This still results in a net gain of $4.2 million annually or $42 million in ten years.

A critical question is the amount of winter kill that can be tolerated before the producer breaks even. In the case of Vona, this has been calculated to be 9% average each year or 90% once every ten years. This level of winter kill is very unlikely in this variety.

It is the contention of the Colorado State University program that plant breeders have been overly cautious in their release of high-yielding material which has any degree of risk attached. This is contrary to the advice of our producers who indicate that adequate description of potential hazards is all they require in their management decisions. They are willing to assume much higher levels of risk for potential added income than we have been willing to allow them to do. We have terminated our practice of variety recommendation and are simply using our variety test performance data as a description of the material along with all of the variety description that we can provide. We feel that this is a much more realistic approach than trying to protect them through highly conservative variety release and recommendations.

IN SUPPORT FOR NEW KNOWLEDGE AND TECHNIQUES

E. G. Heyne

I cannot define the ideal ideotype of wheat for the Southern Great Plains nor do I know which is the best single breeding technique to develop the ideal ideotype. More than one ideotype probably is needed and we know that for any breeding technique someone can demonstrate the development of a successful cultivar.

Much of our breeding efforts have been "defensive", that is, we are continually "putting out fires". A problem occurs (disease, insect damage), and we build into our germplasm a protective device. In the Southern Great Plains this often has been a case of adding to the Turkey "frame" another character. This has been a fruitful endeavor. However, we have not described the ideal ideotype and in fact may have been biased for a type that really isn't one that best fits our present day wheat production systems, let alone what we may be needing fifteen years from now. I suggest you check Ed Smith's idea for a good place to start on describing a suitable ideotype for the Southern Great Plains (Proceedings 14th HRWW Workers Conference 1974, p 29).

The progress of cultivar development has been slow but steady. I don't advocate dropping what we are doing but suggest we take some time to look at different ways to do things. In other words, use various procedures so our work is not dependent upon one approach. If you don't agree with me at least encourage others to try something different, especially the younger research workers. Of course the work must be well planned and often of necessity be empirical but let's search for better ways and better ideotypes.

We don't have enough Agent's and Amigo's. Somehow we must find time to look at and think about and try some different approaches. We can criticize the diallel approach, question the evolutionary approach, and doubt the MSFRS population breeding scheme, but that doesn't get something better unless we test some of these ideas. I will venture a prediction that a good share of the future improvement that comes about in breeding will be due to new Amigo's, different techniques (some we haven't even thought of), and new concepts of an ideal ideotype. This is what I refer to as "offensive breeding". Defense may be said to win games but the offense scores the points and good strategy is to use both.

CHALLENGING THE MYTHS OF HYBRID WHEAT

Marijan Jošt and Milica Glatki-Jošt

The hybrid wheat program at Zagreb was initiated in 1966. Because of lack of time we do not intend to give a review of our work and results. We would like only to point out some conclusions which have come from our work.

In the short history of hybrid wheat research and breeding, two myths have been established and generally accepted:

1. Common wheat plants with male sterility induced by timopheevi cytoplasm appear to be similar to those of their fertile counterpart without having any undesirable side effects.

2. Inefficient pollen fertility restoration is one of the main unsolved problems in hybrid wheat breeding.

Recent evidence indicates that these opinions are wrong.

Side effects of timopheevi cytoplasm -- Recent reports of Tsunewaki and Endo (1973), Washington and Maan (1974), Doig et al. (1975) and Jönsson (1976) showed that differences between A and B lines were determined in a number of traits. At Zagreb, comparative studies were conducted on 11 A-lines and their fertile counterparts during a three-year period, 1973-1975. Twenty-six characters of 33 examined showed significant differences between A and B lines. Some characters are of minor importance, so we will list only a few we consider to be more important. Deleterious effects of timopheevi cytoplasm are:

- Lower germination
- Lower winterhardiness
- Lower seedling vigor
- Longer vegetation
- Leaf and stem rust susceptibility
- Delayed maturity
- Inclination to preharvest sprouting
- Faster loss of germination ability

However, we found that A-lines were superior to fertile counterparts in:

- Number of tillers per plant
- Number of spikelets per spike
- Leaf chlorophyll content during grain filling stage

Also, there is evidence that, during the grain filling stage, flag leaf photosynthesis was higher in a pollen sterile form of wheat than in the fertile counterpart (Apel et al., 1973). As you can see, although some side effects are advantageous, most are undesirable.

Also, we discovered that some genotypes responded more sensitively to timopheevi cytoplasm than others. Thus, Etoile de Choisy had the greatest deviation in number of heads per plant and 1000 kernel weight. The lowest deviations were found for Besostaja 1 (Figure 1). Our opinion is that existing undesirable side effects of T. timopheevi cytoplasm may be reduced by the use of convenient specific nucleoplasmic interaction. Relating to this, a high value of ms-Besostaja 1 is to be emphasized. In our A-line breeding program, efforts are directed to find out such interactions.

R-line breeding -- Fertility restoration ability of 21 different Rf-sources was studied over a three-year period using three male-sterile tester lines. The best pollen fertility restoration came from the common wheat cultivar Primépi (94%), followed by CH I x $9E1^3$ (91%) and PI 277013 (84%). All of the 21 Rf-sources tested are poor agronomic types when grown under our environment, and Primepi, so far the most efficient restorer, is not adequate in restoring pollen fertility.

So, with the objective of combining different Rf-genes and improving the ability of pollen fertility restoration and agronomic type, we started crossing different Rf-sources in 1968. We carried our lines through the F_6 generation, selecting the best agronomic type by the pedigree method. The first tests of these R-lines were conducted at several locations in 1974. The F_1 test cross with R-line Primépi was used as a check. Three R-lines, among those tested, showed significantly better restoration ability at all locations.

In the fall of 1976, two of these lines were tested in the greenhouse of Pioneer Research at Hutchinson. A hard-to-restore spring wheat, T-1, was used for the ms-tester. Even in a sterile environment and on a hard-to-restore ms-line, both R-lines showed complete restoration. In the same test, Texas R-line and Rf Mir^4 S^{11} from Martonvásár (Hungary) only partially restored pollen fertility (Table 1). These Zg R-lines have complete restoration and very good combining ability, but possess some undesirable characteristics such as low winterhardiness and tall straw.

In 1975, we selected better restorers. Some have increased grain protein content, but still all are too tall (Table 2).

In 1976, we selected a number of short R-lines, but a majority of these selections proved to be inadequate in pollen fertility restoration. However, a few of the best R-lines from this group have 20% better restoration ability than the check R-line Primépi and, in addition, are about 40 cm shorter (Table 3). Although difficult, it is possible to combine good fertility restoration and dwarfness in the same genotype.

Finally, we now have the desired plant type and adequate fertility restoration. Last year, in cooperation with Pioneer Research at Hutchinson, we started an extensive crossing program with the objective of diversifying germplasm and widening the genetic base of our R-lines. We hope that such cooperation will be profitable to both sides.

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Table 1. Ability of pollen fertility restoration of four R-lines tested in sterile environment - Hutchinson (greenhouse) Fall, 1976.

R-line	Origin	Seed set %* $\bar{X}$	Seed set %* Range
Texas R-line	USA	34.9	0 - 61
Rf Mir.[4] Sll	Hung.	51.3	0 - 76
Zg 2152/73 Rf	Yu.	83.2	64 - 103
Zg 2153/73 Rf	Yu.	92.3	62 - 132

* Two kernels per spikelet = 100%
cms-tester line = spring wheat T-1

Table 2. Pollen restoration ability of some R-lines selected in 1975, and tested in fertile (Zagreb) and sterile (Berlin) environment.

R-line	Seed set (%)* Zagreb	Seed set (%)* Berlin	Grain Protein %
Zg 2921/75 Rf	116	94	11.67
Zg 2968/75 Rf	135	--	12.69
Zg 2991/75 Rf	107	95	11.82
Zg 3013/75 Rf	114	98	11.46
Zg 3051/75 Rf	111	90	14.11
Primepi (Check)	92	80	-

* Bagged heads, two kernels per spikelet = 100%

Table 3. Average pollen restoration ability and height of some R-lines selected in 1976, and tested on two cms-testers in sterile environment (greenhouse - fall 1976).

R-line	Seed set (%)*	Height (cm)
Zg 437/76 Rf	110	80
Zg 473/76 Rf	105	90
Primépi (Check)	90	120

* Two kernels per spikelet = 100%

THE IMPORTANCE OF TEMPERATURE AND DAY LENGTH RESPONSES BY WINTER WHEAT

K. B. Porter

Vernalization requirements, response of winter wheat to temperature and day length, and the interrelationship of these have always been of interest to winter wheat breeders. The recent extensive use of day neutral or day length insensitivity in spring wheats intensified the use of spring-winter crosses in winter wheat improvement. You are of course familiar with the release of Lindon and Vona by Colorado -- and of their performance in the SRPN. Additional selections from winter-spring crosses were entered in the 1976 SRPN. These include KS73112 and TX73A2798.

TX73A2798, a Red River 68/Trapper selection, appears to be day neutral and less sensitive to day length than the Colorado or Kansas lines.

You can see in Table 1 why we became interested in TX73A2798 and why we entered it in the SRPN. It equaled the yield of Scout 66 on dryland and produced 95 bushels per acre, 125% the yield of Scout 66, in Bushland irrigated trials, and at Chillicothe its yield was 136% the yield of Scout in 1975. You can see that its performance was as poor in 1976 as it was good in 1975. Why?

Table 1. Yield of TX73A2798, R. R. 68/Trapper

	Kg/Ha	% Scout 66
Bushland, TX		
Dryland 1975	2413	103
Irrigated 1975	6348	125
Irrigated 1976	3258	72
Chillicothe, TX		
Dryland 1975	3733	136
Dryland 1976	2332	84

Departures from normal daily mean temperatures for the months of January to June at Chillicothe and Amarillo in 1975 and 1976 are given in Table 2. These temperatures were good for wheat -- particularly the cool months of May and June. Both years are similar except for the month of February when temperatures were substantially below normal in 1975 and equally above normal in 1976. We had no loss of stand, winter damage or loss from late frost either year. I attribute the low 1976 yield to the lack of tillers which may have been associated with an early change of growth habit by TX73A2798 in the warm February.

Table 2. Departures from normal mean temperature

	Jan	Feb	Mar	Apr	May	June
Bushland						
1975	-1.5	-6.7	-3.8	-4.2	-2.6	-1.9
1976	-1.0	5.9	-1.3	0.3	-5.1	-1.7
Chillicothe						
1975	2.8	-2.9	1.0	-1.9	-1.1	-2.8
1976	2.5	8.7	5.0	-0.3	-4.6	-2.8

In looking at TX73A2798, Vona and KS73112 in the region we find all are much less winterhardy than Sage in trials in South Dakota and Nebraska, Table 3. Nevertheless, it is in the northern portion of the region that these SRPN entries excelled in 1976, Table 4. From Kansas south the yields of TX73A2798 and Vona were lower or only equal to those of Sage. No distinct north-south yield trend was observed for KS73112.

Table 3. Percent survival, 1976

	3-Sta.[1/] Avg.	Mead Nebr.	Clay Center Nebr.
Kharkof	98	99	95
Sage	96	81	88
KS73112	84	73	70
Vona	83	62	73
TX73A2798	65	55	81

[1/] Uniform Winterhardiness Nursery, Southern Materials Section.

Table 4. Average SRPN yield, 1976

	Percent of Sage		
	TX73A2798	Vona	KS73112
S. D.	117	108	88
Nebr.	111	107	102
Colo.	127	127	115
Kan.	84	76	92
Okla.	83	99	107
Texas	86	100	109

Mean temperatures from South Dakota to Texas in 1976 are given in Table 5. February temperatures were from 9 to 11 degrees above normal at all locations and in Kansas, Oklahoma and Texas February mean temperatures were as high as March temperatures which were somewhat above normal. February temperatures in the northern part of the region, although unusually warm, were sufficiently low to prevent or restrict premature spring growth. In the area from Kansas south, changes in growth habit which normally would take place in March would have taken place a month earlier in February, except for varieties requiring the longer March days or possibly restricted by a response involving both temperature and day length. No restrictions were placed on TX73A2798 and little on Vona. However, yields of KS73112 in the south suggest that its response to the warm February temperatures were different and somewhat delayed as compared to those of TX73A2798 and Vona.

Table 5. Mean temperatures and departures, 1976

	Jan	Feb	Mar	Apr	May
Huron	14.5	28.2	32.1	48.0	55.0
	(2)	(10)	(2)	(2)	(-2)*
Lincoln	24.3	36.9	39.2	54.3	59.0
	(2)	(9)	(3)	(3)	(-3)
Concordia	35.2	42.3	41.9	54.9	60.1
	(3)	(11)	(3)	(2)	(-3)
Wichita	32.0	45.5	46.2	57.6	60.3
	(1)	(9)	(3)	(1)	(-6)
Okla. City	39.0	52.2	52.4	61.5	63.7
	(2)	(11)	(4)	(1)	(-5)
Dallas	47.2	59.3	59.7	65.6	68.7
	(3)	(10)	(4)	(0)	(-5)

*Departure

Recognizing obvious hazards there is still evidence that selections from winter-spring crosses might represent higher yield potentials in winter wheat. To exploit any such potential greater knowledge of temperature and light responses is not only desirable but a necessity.

Some questions I have:

1. Do we really need day length insensitivity to increase yield potential?

2. Can we maintain mid- and late-winterhardiness and still have a high degree of insensitivity to day length?

3. Is vernalization requirement an important consideration in breeding winter wheats?

4. Can we use temperature and light responses to increase total production by breeding wheats for smaller areas of adaptations?

5. Is it practical to consider developing varieties for special situations -- such as for planting after corn or sorghum or for double cropping systems?

6. Can we develop or do we already have dual purpose or facultative varieties?

Finally, aren't temperature and light responses important enough to at least attempt to classify the entries in the SRPN with respect to vernalization requirement, day length response and even response to temperature? The first two could be done in a general way with a minimum effort while responses to temperature would require more effort and input. Such information in addition to performance data would be of value and could give important stimulus and direction to more detailed studies.

A PROPOSAL FOR HYBRID WHEAT USING CONVENTIONAL COMMON WHEAT CULTIVARS AS THE R-LINE PARENTS

S. S. Maan, T. Sasakuma, N. D. Williams

In a recent publication in Crop Science, we have proposed a new sterility system to produce hybrid wheat (Franckowiak, Maan, and Williams. 1976. Crop Sci. 16:725-728). In the proposed system, conventional common wheat cultivars can be used as the R-line parents, and breeding emphasis would shift to the development of B-lines to maintain and increase the male-sterile A-lines.

In contrast to the present emphasis on the breeding of R-lines and the difficulty encountered in the differentiation of R-line plants producing 90 or 100% fertile pollen from the testcross progenies, the desirable B-lines would be expected to produce completely male-sterile progeny when crossed with A-line plants. In practice, it would be a lot easier to detect and to discard B-line plants which produce even as little as 1 seed/head, than it is to select R-line plants producing completely fertile hybrids.

The first requirement for the proposed new sterility system is an alien cytoplasm that is different from that of common wheat, but is fully compatible with the chromosomal complement of wheat. Apparently, the cytoplasms of several *Aegilops* species, including those of *Aegilops squarrosa*, *Ae. cylindrica*, *Ae. ventricosa*, *Ae. juvenalis*, and *Ae. crassa* may meet this requirement. The common wheats with the cytoplasm of these species are fully fertile and have normal growth habit. Preliminary field data indicate that common wheat lines having *Ae. squarrosa* cytoplasm may yield equal to or slightly less than the comparable cultivars (Tables 1 and 2). Additional field tests are under way to confirm these data. That the cytoplasms of these species differ from that of common wheat is apparent from their interactions with *T. durum* genomes (Maan, 1976. Crop Sci. 16:757-761). We have genetic evidence indicating that one arm of a D-genome chromosome (ID?) has genes controlling differential nucleo cytoplasmic interactions between these cytoplasms and *T. aestivum* or *T. durum* genomes.

We used hard red spring wheat cultivar Chris having *Ae. squarrosa* cytoplasm as the initial material to induce mutations for male sterility by EMS treatment of seed. The M_1 plants were grown in the greenhouse and M_2 were grown in the field at Fargo, North Dakota. Several male-sterile

Table 1. Mean grain yield (in grams) of eight hard red spring wheat cultivars and lines and their isogenic alloplasmic counterparts with Aegilops squarrosa cytoplasm (K. A. Lucken, 1976, unpublished).

	ND487	ND508	Olaf+	ND507	ND517	Kitt	ND537 sib	Olaf‡	Overall means (LSD 10.92)
1§	393.0¶	478.3	448.0	375.3	364.0	482.3	448.8	431.8	427.7
2	413.5	481.3	470.8	423.0	374.3	486.3	446.8	457.3	444.1
3	418.5	no data	441.0	423.8	387.8	480.5	448.0	444.5	440.2
Means (LSD=36.97)	408.3	479.8	453.3	407.3	375.3	483.0	447.8	444.5	

§ 1, 2, and 3 are F_3 bulks from (squarrosa)/9*ND487, ND487//(squarrosa)/8*ND487, and experimental ND487, respectively. The F_3 bulks represented composite seed from 10 to 50 backcross F_1 plants, after five or more backcrosses with the respective male parents. Alloplasmic Chris having Ae. squarrosa cytoplasm was used as the source of Ae. squarrosa cytoplasm to develop these isogenic lines by the recurrent backcross method. Randomized blocks, 4 reps, 4 row plots, two 8 ft. rows harvested. In general, F_3 bulks having Ae. squarrosa cytoplasm and 8 hard red spring wheats (listed above) as male (line 1) yielded significantly less than F_3 bulks from reciprocal crosses (line 2) or controls (line 3).

¶ C.V. 4.90 LSD for 24 individual means = 30.87.

Table 2. Grain yield and test weight of cultivar Chris, and lines derived from reciprocal crosses between euplasmic and alloplasmic Chris. (R. H. Busch, 1976, unpublished).

	Yield (g/plot)			Test weight (lb/bu)		
	Av.+	Range‡	s^2	Av.	Range	s^2
Chris lines	446	410-492	534	60.2	59.3-60.9	.15
Cis//Ae. bicornis/Cis	445	411-481	493	60.1	59.2-60.6	.12
Ae. bicornis/Cis	158	94-200	729	52.3	49.7-53.6	1.28
Ae. squarrosa/Cis (20)	401	288-458	1513	59.2	56.8-60.3	.76
Cis/Ae. squarrosa/Cis	438	386-490	1011	60.0	57.9-61.2	.62

+ $LSD_{.05}$ for approximately 20 times per group = 15g and .4 lb/bu.

‡ $LSD_{.05}$ for individual means = 67g and 1.8 lb/bu.

Experimental Procedure - Twnety lines were randomly derived from reciprocal crosses listed above and advanced by single head descent for several generations until seed increase, in Mexico. A 10 X 10 simple lattice was grown at two locations in 1976. The Chris cytoplasms yielded similarly, with Ae. squarrosa cytoplasm lines yielding singificantly less. Ae. bicornis lines were quite low yielding. Certain lines in Ae. squarrosa cytoplasm did not differ significantly from the best yielding lines in Chris cytoplasm. No lines in bicornis cytoplasm approached the lowest yielding lines in Chris cytoplasm. (Waldron check plots varied less than 40 g).

mutants were obtained. In general, one or two recessive genes appeared to control sterility in these mutants. One mutant had a single dominant gene for male sterility and gave 1:1 segregation for completely male-sterile and true breeding fully fertile plants. We have confirmed that the expression of this dominant sterility gene is fully stable under the field conditions and it could be useful in bulk breeding methods for wheat improvement.

For hybrid wheat, we proposed to develop the maintainer B-lines by transferring ms-gene to euplasmic common wheat. B-lines will be selected for complete self-fertility and they should produce completely male-sterile A-lines in *Ae. squarrosa* cytoplasm. Therefore, the induced mutant gene (ms ms) is supposed to be specific for *Ae. squarrosa* cytoplasm, and would not create sterility when transferred to the common wheat cultivars. To accomplish this, the heterozygous (Ms ms) plants having *Ae. squarrosa* cytoplasm could be crossed as male to male-sterile plants, and self-fertile homozygous (ms ms) plants producing completely male-sterile testcross progeny could be saved as potential maintainer B-lines for use in a hybrid wheat breeding program.

Dr. T. Sasakuma has testcross plants growing now. If desirable B-line plants are not obtained among those available now, we plan to repeat EMS treatment for screening of additional male-sterile mutants.

Once the B-line is obtained, the maintainance and increase of male-sterile A-lines, and production of hybrid wheat seed would be done essentially the same way as is now done with the present system based on the *T. timopheevi* source of male-sterility.

The development of this male-sterility system has been outlined in the above quoted article.

ORIGIN OF 'AMIGO' (C.I.17609) GREENBUG RESISTANT WHEAT GERM PLASM

E. E. Sebesta and E. A. Wood, Jr.

In 1966 a greenbug-resistant strain of rye from Argentina (Insave F.A.) which has a single dominant gene for greenbug resistance, was crossed with susceptible 'Chinese Spring' wheat. The chromosome complement of the primary wheat-rye hybrid was doubled with the use of colchicine the following year. During 1967-68 the doubled hybrid (Gaucho) was crossed with an experimental selection of wheat (Tcs/63PC42-4).1/ The F_2 progenies from this cross were screened for resistance to the greenbug and resistant plants backcrossed to 'Teewon' wheat in 1969-70. During 1970-71 the F_1's were tested for resistance. Individual spikes from resistant plants were x-rayed at the mature pollen stage and used as males in crosses with a selection of wheat (Teewon Sib). Tests for resistance to greenbugs were conducted on X_1 (1971-72) and X_2 families in 1972-73. The X_2 family designated 73G132 segregated with a ratio of 28 resistant plants to 11 susceptible with a P value of 50-70% for a 3 to 1 ratio. This indicated transfer of the genetic material for greenbug resistance from rye to wheat. In 1973-74 X_3 populations were tested for resistance and random plants from homozygous resistant families were crossed with several varieties or selections of wheat. During 1974-75 tests for resistance to greenbugs were made on X_4's to determine stability of resistance. All were resistant. During (1975-76) X_5 lines of 73G132 were screened for resistance and also the F_2 families derived from crosses of the X_3 plants. The X_5 material continued to breed true for resistance and was saved for germ plasm release. The F_2 families again segregated with acceptable fit to 3 to 1 ratios. These results showed that the 73G132 material can be used with conventional breeding procedures for wheat improvement.

Cytological studies made on X_3 and X_5 plants of 73G132 stock showed 21 pairs of chromosomes, the same as in bread wheat. Twenty-one pairs of chromosomes, with normal meiosis

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1/ Teewon = TAP48, C.I.13014/Wi/(F_1Xr)/Wi/3/Tmp64
Gaucho = CS/Insave F.A. rye (doubled)
63PC42-4 = Wi//(Wi/TAP48 F_1Xr)
Teewon Sib = OK66C3190

were also observed in random F_1 plants from crosses of the 73G132 material with wheat. The observations verify transfer of greenbug resistance from Insave F.A. rye to wheat.

The $73G132X_5$ series is classed as a red winter wheat. It is mid-season in maturity, mid-tall, awned and has white straw and chaff. It is resistant to the prevalent strain (Biotype C) of the greenbug with resistance controlled by a single dominant gene. Recent work has shown this material is also resistant to the wheat curl mite (Wood-personal communication).

Seed of a composite of resistant X_5 lines was released as germ plasm under the name of 'Amigo' (C.I.17609) in September, 1976.

Seed of Amigo will be distributed on request in breeders' lots of 15-20 seeds as long as supply lasts. Requests for seed should be sent to Sebesta, ARS, USDA, Agronomy Department, Oklahoma State University, Stillwater, Oklahoma 74074.

TRANSFER OF A GENE FROM AN ALIEN CHROMOSOME INTO WHEAT BY USING THE PH/PH MUTANT

R. C. Wang and G. H. Liang

Procedures to utilize the ph/ph mutant for developing translocation lines through induced homoeologous pairing and gene recombination are introduced. (1) A mono-5B plant, used as female, is crossed with a disomic substitution line possessing desirable genes in the alien chromosomes. (2) Hybrids having the character to be transferred and having 41 chromosomes (19"+3') are pollinated by the ph/ph mutant. (3) Progeny with the desired character and 41 chromosomes are selected. These plants, having 19"+ph'+W'+A' chromosome complement, may give rise to genetic recombination involving the gene to be transferred. (4) Such 41 chromosome plants are crossed with (a) 42 chromsome wheats and (b) ph/ph mutant. From (a), translocation plants showing 21 bivalents may be isolated. From (b), two types of plants, 19"+ph'+W'+A' and 19"+ph/ph+W'+A', will be used for the next cycle of crossing and subsequent screening for possible translocations.

This method saves time and space because it does not require field work. The primary advantage is that the translocation, being restricted to the homoeologous chromosome, is most likely a useful type. Also, genetic information may be derived from the intensive cytogenetic work required for this method. Results from our work on transferring resistance to wheat streak mosaic virus from the disomic substitution line, CI 15092, into wheat serve as an example of the usefulness of this approach.

SEARCH FOR TRANSLOCATIONS FROM CI15092 FOR IMMUNITY FROM WSMV

Harnek S. Sandhu and Darrell G. Wells

Six translocations tracing back to different gametes borne on monosomic addition plants grown from irradiated seed have been tentatively identified. The 21" + 1' plants had been used as male parents onto Centurk, the recurrent parent. The occurrence of 3I to 1S segregations identified translocations in the succeeding generations. Some derived lines expected to be homozygous immune do continue to segregate, however, 3% to 12% of susceptibility. Incomplete cytological observations have identified normal meiotic behavior and 21" of chromosomes in some translocation lines. Size of seed among lines varies from smaller than Centurk to larger than Centurk. Maturities are not fully known but at this time appear to vary from early as Centurk to later than Centurk. Similarities between translocation stocks are not yet known.

CHARACTERISTICS OF PAWNEE AND YTO-117 AND THEIR GENOME EXCHANGE LINES

Darrell G. Wells

Genomes were exchanged between the cytoplasms of Pawnee and Yogo-Turkey-Oro, Montana sel. 117, using 5 and 6 backcrosses. Hardiness characteristics were of principal interest. Little has been learned so far about their hardiness except that in 1974 at Williston, ND, in the UWN, Pawnee showed 40% average survival while YTO-117 and the two genome exchanges averaged 70% survival. In South Dakota, Pawnee with YTO-117 cytoplasm was M-15% to leaf rust in 1975 while the other 3 lines were S-100%. Pawnee with YTO-117 cytoplasm also showed less stem rust than the other 3 lines. Pawnee with YTO-117 cytoplasm was taller and later than Pawnee with its own cytoplasm. The 4 lines have become mixed and are being purified.

A CENTER FOR THE COLLECTION, STORAGE AND DISTRIBUTION OF WHEAT ANEUPLOIDS

Gordon Kimber

In simplistic terms, a wheat aneuploid is a plant that does not have the euploid chromosome number. There are many types of aneuploids ranging from monosomics where one chromosome is present only once instead of twice, to complex types where more than one chromosome may be monosomic or chromosome misdivision products may be present or alien chromosomes may be present also. In some cases of more complex aneuploids, more than one chromosome condition may be present at the same time.

Aneuploids are very important in studies of wheat genetics, evolution and breeding. Monosomics, for example, allow the demonstration of the fact that genes are on chromosomes and they also can be used in manipulations designed to introduce desirable genes from related species into wheat. Aneuploids known as telocentrics are of fundamental importance in determining the evolutionary relationships of wheat. Following studies of this type, more logical attempts at introducing practically advantageous genes into wheat breeding programs may be made. The substitution of entire wheat chromosomes from one species to another has allowed the genetic analysis of wheat with a precision unmatched in any other cultivated crop.

The purposeful production of particular aneuploids is difficult, time consuming and costly. However, the maintenance of aneuploids is relatively cheap and simple. Seed stocks may be kept at low temperatures almost indefinitely and thus the storage of the small quantities of seed which are usually needed for aneuploid studies is simple and cost effective. The major expense would be the salary of a competent cytogeneticist who would grow, test, verify, catalogue and store the seed.

Some progress is being made with this project. Laboratory and greenhouse facilities are already available and stocks are being maintained on a part-time basis (and have been so for several years). Attempts were made to enlist the help of the F.A.O. but they were unsuccessful. Some progress in obtaining funding for a cytogeneticist position has been made but until this is accomplished, the storage and maintenance of this vital genetic and cytogenetic resource is conducted on a part-time and perhaps incomplete basis. It appears that an appointment should be made before costly, valuable and even perhaps irreplaceable stocks are lost.

Minutes

HARD RED WINTER WHEAT REGIONAL BUSINESS MEETING

Lincoln, Nebraska
February 10, 1977

Meeting called to order by Chairman E. L. Smith at 8:30 a.m.

Members present:

R. E. Atkins, Iowa
L. E. Browder, ARS (Kansas)
L. I. Croy, Oklahoma
B. C. Curtis, Cargill (Colorado)
A. L. Diehl, Northrup-King (Nebraska)
J. R. Erickson, North Dakota
R. E. Finkner, New Mexico
E. C. Gilmore, Texas
F. J. Gough, ARS (Oklahoma)
E. D. Hansing, Kansas
C. Hayward, Pioneer (Kansas)
E. G. Heyne, Kansas
V. A. Johnson, ARS (Nebraska)
B. J. Kolp, Wyoming
P. J. Mattern, Nebraska
O. G. Merkle, ARS (Oklahoma)
M. R. Morris, Nebraska
K. B. Porter, Texas
J. W. Schmidt, Nebraska
E. E. Sebesta, ARS (Oklahoma)
E. L. Smith, Oklahoma
G. A. Taylor, Montana
N. A. Tuleen, Texas
D. G. Wells, South Dakota
J. R. Welsh, Colorado
H. C. Young, Jr., Oklahoma

Members absent:

R. Bequette, DeKalb (Kansas)
M. K. Brakke, ARS (Nebraska)
N. E. Daniels, Texas
L. H. Edwards, Oklahoma
K. Finney, ARS (Kansas)
G. E. Hart, Texas
J. Hatchett, ARS (Kansas)
W. J. Hoover, Kansas
R. W. Livers, Kansas
R. A. Olson, Nebraska
L. W. Rooney, Texas
A. L. Scharen, ARS (Montana)
L. W. Schruben, Kansas
E. L. Sharp, Montana
V. R. Stewart, Montana
R. W. Toler, Texas
B. B. Tucker, Oklahoma

Minutes of the April 8, 1974 meeting at College Station, Texas, having been distributed to committee members and printed in the Conference Proceedings without suggestions for change, were declared approved by Chairman Smith.

Enlargement of the Hard Red Winter Wheat Regional Committee

Chairman Smith reviewed the circumstances that led to enlargement of the Hard Red Winter Wheat Improvement Committee. As shown in the summarization that follows some disciplines and groups were not represented or were poorly represented prior to 1976.

Regional Wheat Improvement Committee

Discipline	Membership Old (29)	New-1976 (43)
Ag Economics	1	1
Agronomy	3	3
Cytogenetics	3	4
Entomology	1	2
Genetics and Breeding	13	17
Pathology	4	8
Plant Physiology	0	1
Quality	3	5
Soils and Fertility	1	2
Total	29	43
Affiliation		
State	28	30
ARS	1	9
Private Industry	0	4
Total	29	43

The National Wheat Improvement Committee (NWIC), at its annual meeting in 1975, made the decision to enlarge its membership from 9 voting members to 17. This was done to allow broader representation on the NWIC with regard to discipline and affiliation (SAES, ARS, Private Industry). In order to comply with the new membership structure of the NWIC, executive action was taken by Chairman Smith and Secretary Johnson in 1976 to enlarge membership on the H.R.W. Wheat Improvement Committee. A list of 14 candidates for regional membership including ARS and Private Industry workers was drawn up and administrators of these candidates were requested to appoint them to the regional committee. Following this action, regional committee members B.C. Curtis and H. C. Young, Jr. were elected by mail ballot as "at-large" representatives to the NWIC. V. A. Johnson, J. R. Welsh and K. B. Porter served as the Committee on Nominations for this special election.

Wheat Workers Code of Ethics

A wheat workers code of ethics (see below) developed by the National Wheat Improvement Committee was discussed and approved. The code already has been approved by the Hard Red Spring Wheat Improvement Committee.

Statement Developed by the National Wheat Improvement Committee (NWIC)
10/27/76

WHEAT WORKERS CODE OF ETHICS FOR DISTRIBUTION OF GERMPLASM

The timely interchange of seed or plant materials of unreleased stocks has made a significant contribution to progress in the genetics and breeding of wheat. Historically, this distribution, which is a form of communication between scientists, was almost entirely between workers in the USDA and State Experiment Stations. Broad undercurrents of change in recent years have introduced new elements which today play an increasingly important role. These elements are the development and growth of wheat breeding as a commercial enterprise, the increasing complexity and ingenuity found in the application of genetic principles and breeding techniques to the development of new wheat varieties, and the development in the United States and other countries of a national policy and law governing plant protection.

Mutual interests of all engaged in wheat improvement are fostered by that climate which engenders the greatest freedom of communication and sharing of breeding materials while, at the same time, provides adequate safeguards to the distributor. Such a climate exists and rests on a foundation of trust among breeders created through long years of working together. To maintain this climate through these changing times, and to perpetuate it for the future, the National Wheat Improvement Committee (NWIC) believes that the present moment calls for the establishment of guidelines -- a statement of ethics -- to express standards of conduct and moral posture to which wheat workers can subscribe.

Guidelines for germplasm exchange must include the basic facts that (1) seeds of unreleased wheat lines are owned, usually by a breeder, who is responsible to his constituency which may be a public or private agency, and (2) distribution exposes the owner and seeds to potential problems and hazards stemming from uses outside these guidelines. Guidelines should recognize the question of equity and provide adequate safeguards that would encourage the sharing of germplasm. The following statement, subscribed to by the NWIC, represents a reasonable system for distribution of seedstocks of unreleased germplasm of wheat:

"This seed is being distributed in accordance with the 'Wheat Workers Code of Ethics for Distribution of Germplasm' developed by the National Wheat Improvement Committee 10/27/76. Acceptance of this seed constitutes Agreement."

1. The originating breeder, station or company has certain rights to the unreleased material. These rights are not waived with the distribution of seeds or plant materials but remain with the originator for disposal at his initiative.

2. The recipient of unreleased seeds or plant material shall make no secondary distributions of the germplasm without the permission of the owner/breeder.

3. The owner/breeder in distributing unreleased seeds or other propagating material, grants permission for use (1) in tests under the recipient's control, (2) as a parent for making crosses from which selections will be made, and (3) for induction of mutations. All other uses, such as testing in regional nurseries, increase and release as a variety, selection from the stock, use as parents in commercial F_1 hybrids or synthetic or multiline varieties, require the written approval of the owner/breeder.

4. Plant materials of this nature entered in crop variety trials shall not be used for seed increase. Reasonable precautions to insure retention or recovery of plant materials at harvest shall be taken.

5. The distributor of wheat germplasm stocks may impose additional restrictions on use or may waive any of the above.

Earl Gilmore suggested that the clarity and intest of the code would be enhanced by the following minor changes:

- Modify the initial portion of #3 to read as follows:
  3. The owner/breeder in distributing unreleased seeds or other propagating material, grants permission <u>to the party receiving the material for its use in</u> (1) - - - - -

- Modify last sentence of #3 to read as follows: All other uses - - - - - - stock, use as parents in commercial F_1 hybrids <u>or components of</u> synthetic or multiline varieties, - - - -

The suggested modifications will be referred to the National Wheat Committee.

<u>Regional Nurseries</u>

V. A. Johnson reviewed currently grown regional nurseries. <u>SRPN and NRPN</u>: By action of the regional committee in 1971, the maximum number of entries in these nurseries has been limited to 30. In the last 2 years it was necessary to exceed the limit of 30 to accommodate candidate varieties submitted by cooperating states and seed companies. It was voted to increase the maximum number of entries to 40 in each of the nurseries. Thirty entries are considered to be a more desirable nursery size and it was suggested that there be continuing effort to hold the SRPN and NRPN to this size.

It was voted to require that cooperators entering more than a single variety in the SRPN or NRPN assign a priority ranking to their candidate varieties to aid the regional wheat improvement leader in the event that all of the candidate varieties cannot be accommodated.

Entries in the SRPN and NRPN are subjected to seedling rust tests at Manhattan, Kansas and St. Paul, Minnesota, soil-borne mosaic at Hutchinson, Kansas, and to hessian fly evaluation at Lafayette, Indiana. Since seed treatment can affect seedling rust reactions, cooperators are asked to submit only untreated seed of entries for the SRPN and NRPN.

The status of fee testing of privately-developed wheat varieties in some states was reviewed.

Regional Hybrid Winter Wheat Nursery: The nursery was organized in 1976 in response to requests from some cooperators that such a nursery be organized. The 1977 hybrid nursery includes 8 privately developed and 8 Texas hybrids and is grown at 13 sites in Texas, Oklahoma, Kansas, Colorado, and Nebraska.

The Hybrid Nursery will be continued and Hutchinson, Kansas will be added to the regional test sites in 1978.

Soil-borne Mosaic Nursery: no changes
Uniform Winterhardiness Nursery:
  Southern Materials Section -- no changes
  Northern Materials Section -- no changes
Regional Reports -- no changes

Permissible use of data from regional nurseries by states and private seed companies was discussed. Limitations on use of such data are unclear. The chairman of the Hard Red Winter Wheat Committee will appoint a committee to:

1. Review the status of regional data use and formulate acceptable guidelines,
2. Consider the question of nursery recipients,
3. Who will have access to nursery data,
4. Numbers and priorities of nursery entries,
5. Source of nursery entries (state, federal, commercial, etc.), and
6. Consider other matters pertinent to the regional testing program for consideration by the HRWW regional committee at its next meeting.

National Wheat Improvement Committee Report (Lee Briggle)

The National Wheat Improvement Committee (NWIC) represents wheat research workers in the State Agricultural Experiment Stations, the Agricultural Research Service of USDA, and those involved with improvement of wheat in private industry. The Committee thus far has been very effective in dealing with problems of national scope. Coordination of our National ARS Small Grains Research Program is made much easier and more effective by input and advice from members of the NWIC. We want to maintain that cooperative relationship for mutual benefit.

An important part of the NWIC activity during the past two years has been development of a Proposal in support of the ARS Small Grains World Collection Program, as explained by Dr. B. C. Curtis, Chairman of the NWIC Germplasm Subcommittee, and by Dr. J. G. Moseman, Chairman of the Plant Genetics and Germplasm Institute, Beltsville, Agricultural Research Center. I want to express our appreciation to the NWIC members, particularly those on the Germplasm Subcommittee, for that support. May we emphasize that the added support will be for the entire Small Grains World Collection Program, including barley, oats, and rice, in addition to wheat. Research workers involved with those other commodities are also in support of an expanded ARS program.

Another NWIC subcommittee has responsibility for scheduling special subject matter reviews or workshops. A workshop dealing with Septoria on wheat was held in May 1976 at Experiment, Georgia. Another dealing with Barley Yellow Dwarf Virus is planned for late spring in 1977. A third workshop on winterhardiness is under consideration by the NWIC workshop subcommittee, chaired by Dr. G. Allan Taylor.

Dr. E. L. Smith has served as chairman of the NWIC for the past three years. He has done an outstanding job, and we wish to express our appreciation.

Report from Wheat Germplasm Sub-committee of the NWIC
(B. C. Curtis)

The Wheat Germplasm Sub-Committee is continuing its efforts to develop a plan to characterize the USDA collections of wheat, barley, oats and other small grains for better utilization by breeders. The Sub-Committee and representatives from ARS and other critical disciplines will meet in Boulder, Colorado on Mary 8, 1977 to work on details of sites for growing the entries and data collection, data summaries to include computerization, and the preparation of a proposal to submit to ARS, USDA for long range funding and support. The objective is to have a rough draft of this proposal prepared by April 1, 1977. Details of the work of the NWIC Sub-Committee on Germplasm can be found in the minutes of the NWIC meeting held at Lincoln, Nebraska, October 27-28, 1976.

The Milling Oats Improvement Association under the direction of Mr. Scott Hackett, General Mills, Inc., has offered $1000 - $2000 as initial support to getting the Germplasm project established.

L. W. Briggle asked that researchers who have screened portions of the Wheat Collection for resistance to diseases, insects, etc. send such information to Dr. Joe Craddock at Beltsville, Maryland.

Report from Plant Genetics and Germplasm Institute
(J. G. Moseman)

The NWIC Germplasm Subcommittee identified a need for expanding the effort on the evaluation of accessions and documentation of data on the ARS Small Grains Collection in the Germplasm Resources Laboratory, Plant Genetics & Germplasm Institute, Beltsville Agricultural Research Center. The Germplasm Resources Laboratory has responded to that identified need by reorienting their research programs to make funds available to establish a position for a scientist who will be responsible for the evaluation of accessions and documentation of data on the collection. We would appreciate knowing of any agronomist, geneticist, or botanist who may be interested in applying for this position.

Hard Red Winter Wheat Breeders Field Day

The 1976 Breeders Field Day was held at Hays, Kansas. In 1977 breeders will meet at Stillwater, Oklahoma on May 26. A Kansas Wheat Field Day on May 27 at Hutchinson will permit breeders to participate in both events. The hosts of the Breeders Field Days are urged to keep the activities relatively unstructured to permit maximum time in the field and opportunity for casual field observations and information exchange among the breeders.

Wheat Newsletter

Kenneth Porter reported that there is sufficient money in the Wheat Newsletter Fund to cover the costs of printing and distributing the 13th Newsletter in 1977. Contributions for the 1978 Newsletter should be sent to Dr. K. B. Porter. Dr. E. G. Heyne, co-editor of the Newsletter, urged that contributors try to meet the February 1 deadline for submission of information for the Newsletter.

Report from Committee on Cereal Viruses (C. L. Niblett)

At the previous meeting in College Station, Tx, Chairman Smith appointed a committee of M. Brakke, C. Niblett (Chairman), E. Sebesta, R. Toler and H. Young to assess the virus disease situation in the Great Plains. The committee recognized wheat streak mosaic (WSM) and soil-borne wheat mosaic (SBWM) as the major problem. We recommended the immediate funding by the USDA of two professional positions. One would investigate virus-host relationships. The other would investigate virus-vector relationships. These recommendations were transmitted to the USDA by V. A. Johnson and M. Eversmeyer.

In the spring of 1976, R. J. Cook, USDA Plant Pathologist, viewed the spectacular epidemic of SBWN in the southern Great Plains and carried his concern and photographs to H. Graumann. Through the efforts of R. J. Cook, L. Briggle and W. Dowler, a position to study the virus-vector relationships of SBWM was established in the USDA preliminary budget and site visits were made to Manhattan, KS and Lincoln, NE. However, the position was not included in the final USDA budget.

A personnel transfer and an addition has increased the number of scientists working on virus-related problems. J. Hatchett (USDA) transferred to Manhattan, KS. His research involves the wheat curl mite (vector of WSMV) and the hessian fly. J. Martin was hired at Hays, KS under funds provided by the Kansas Wheat Commission. His research involves WSM, SBWM and several other wheat diseases.

Wheat virus diseases are still very destructive in the Great Plains, but the importance of each virus varies annually. This is shown by the following loss data from Kansas. In 1973 and 1974, WSM caused losses of 15 and 30 million bushels. But losses were only 1.5 and 1 million bushels in 1975 and 1976 due to dry summers and scarce volunteer wheat the previous year. Losses to SBWM were 5 million bushels each in 1973 and 1974, but increased to 15 and 16.1 million bushels in 1975 and 1976. Barley yellow dwarf, which occurred in trace amounts since 1959, was epidemic in 1976, causing losses estimated at 15 million bushels. These data indicate the destructive potential of the virus diseases of wheat and the necessity of increased personnel and research funding to truly solve these problems.

Tenure of Regional Committee Officers

The following recommendations from the Committee on Nominations and Tenure of Office (R. E. Finkner, chairman, G. M. Paulsen, and E. E. Sebesta) were approved:

1. There shall be an election of officers each term (term is intended to mean the 3-year period between regional conferences).
2. The Chairperson and "at-large" representative to the National Wheat Improvement Committee shall be limited to two consecutive terms. The Regional Secretary is excluded from this requirement.

Next Regional Conference

It was voted to accept an invitation from J. R. Welsh to hold the 15th Hard Red Winter Wheat Workers Conference in 1980 at Fort Collins, Colorado.

Election of Officers and "At-large" NWIC Representatives

The following were elected by ballot:

Chairman -- J. E. Welsh
Secretary -- V. A. Johnson
At-large NWIC Representative -- B. C. Curtis
H. C. Young, Jr.

Thanks are extended to the outgoing chairman, E. L. Smith, for his dedication and efforts during the last 3 years in the dual role as Chairman of the Hard Red Winter Wheat Committee and Chairman of the National Wheat Improvement Committee.

Meeting adjourned at 11:30 a.m.

V. A. Johnson
Secretary

RESOLUTION 1

of the

Fourteenth Hard Red Winter Wheat Workers Conference

Whereas, many valuable chromosome and genetic stocks involving wheat and related genera are available for genetic studies, some of which have a direct bearing on plant breeding; and

Whereas, the development of some of these materials, such as chromosome substitution lines, involves much effort in terms of time, labor, and money; and

Whereas, at the present time there is no organized plan for the preservation of these materials; therefore,

Be it resolved, that those in attendance at the 14th Hard Red Winter Wheat Workers Conference be recorded in support of a proposal to establish a center at the University of Missouri-Columbia for maintaining chromosome and genetic stocks of wheat, wild species related to wheat, and lines which combine wheat chromosome complements with whole or partial chromosomes from related genera.

Also, be it resolved, that this resolution be brought to the attention of the National Wheat Improvement Committee, and that this committee be urged to seek sources of funding for the center.

Submitted by Rosalind Morris, Darrell Wells, and Bernard Kolp

RESOLUTION 2

of the

Fourteenth Hard Red Winter Wheat Workers Conference

Whereas, the Small Grains Germplasm Collections maintained by the Agricultural Research Service at Beltsville, Maryland constitute a reservoir of inestimable value for future improvement of wheat and other small grains; and

Whereas, the value of these collections is determined in large part by the accessibility of material in the collections to all persons engaged in wheat improvement activities; and

Whereas, accessibility is enhanced by development of reliable descriptors to guide potential users of the collection in selection of materials, and development of an efficient and rapid information retrieval system; and

Whereas, there has been inadequate support for desired maintenance and management of the collections;

Be it resolved, that the Hard Red Winter Wheat Improvement Committee endorse the efforts of the National Wheat Improvement Committee and the Plant Genetics and Germplasm Institute to strengthen the maintenance and management of the Small Grain Collections to make them more accessible and useful to small grains breeders and other users.

Submitted by V. A. Johnson

RESOLUTION 3

of the

Fourteenth Hard Red Winter Wheat Workers Conference

Be it resolved that the Hard Red Winter Wheat Workers express their appreciation to Dr. Martin Massengale, Vice-Chancellor, the Nebraska Agricultural Experiment Station, and the University of Nebraska-Lincoln Extension Division, for the use of their facilities and for serving as host for this conference; to the Local Arrangements Committee for their hospitality during and preparation for this conference; to Dr. E. G. Heyne and the Program Committee for their excellent program planning, and to Dr. Ed Smith, chairman of the Hard Red Winter Wheat Committee.

Be it further resolved that the Hard Red Winter Wheat Workers express their appreciation to each of the Discussion Leaders and to each of the participants who made this type of "Unstructured" Conference a success.

Be it further resolved that the Hard Red Winter Wheat Workers express their sincere appreciation to Drs. V. A. Johnson, R. A. Olson, and A. P. Roelfs for their reports on their 1976 trip to China.

Be it further resolved that the Hard Red Winter Wheat Workers express their most sincere appreciation to Drs. A. M. "Dick" Schlehuber and W. Q. Loegering for their continued interest, support and guidance in winter wheat research.

Submitted by Darrell Wells, Bernard Kolp, and Rosalind Morris

SUMMARY OF DECISIONS BY THE CEREAL RUST NURSERY WORKSHOP
February 7, 1977
Lincoln, Nebraska

Attending: L. W. Briggle, W. M. Dowler, M. G. Eversmeyer, J. R. Rowell, H. C. Young, Jr., V. A. Johnson, L. E. Browder, A. P. Roelfs, M. D. Simons, R. F. Line, D. V. McVey, J. D. Miller, R. A. Kilpatrick, J. G. Moseman, F. J. Gough, P. G. Rothman, Roger Smith, Larry Singleton.

INTRODUCTION

The development of rust resistant cultivars comes about through plant breeding programs. This workshop considered objectives, methods, and procedures which support, directly or indirectly, breeding for rust resistance in wheat and oats in the United States and other countries.

<u>Uniform Rust Nurseries</u>
<u>Objectives</u>:

(1) Provide information on the occurrence and severity of rusts in different geographical areas.
(2) Study pathogenic specialization in the rust fungi via data from direct observations and through analysis of pathogenicity in rust collections made in the nurseries.

<u>Decisions</u>:

(1) Researchers working with different, specific rusts will be responsible for developing plans, assembling seed stocks, requesting collections for pathogenicity assays, and working with R. A. Kilpatrick in coordinating the nurseries as follows: A. P. Roelfs -- wheat stem rust and P. G. Rothman -- oat stem rust; R. F. Line -- wheat stripe rust; L. E. Browder -- wheat leaf rust; and M. D. Simons -- oat crown rust.
(2) Nursery sites will be limited to those areas that regularly have naturally-occurring rust development or are considered of special importance to the workers in the program, and to those areas where ARS or state personnel can make observations and take notes.
(3) Sections of each nursery will be developed to be used especially for the study of each rust.
(4) The number of entries in each nursery will be limited to 30 for each rust to be studied.
(5) Data sheets will continue to be sent to R. A. Kilpatrick who will provide individuals listed above copies of the data sheets on their receipt in Beltsville.
(6) The nurseries will be grown in areas where no artificial inoculum is to be used.
(7) The Uniform Wheat Rust Nurseries are to be the first 90

entries in the International Nursery. Locations receiving the International Nursery and at which artificial inoculations are <u>not</u> made, will not receive the Uniform Nursery.

Methods and Procedures:

(1) Seed will be assembled at leaf-, stem-, stripe-, and crown-rust laboratories and sent to R. A. Kilpatrick who will divide the lots and distribute sets to cooperators, together with appropriate planting lists.
(2) ARS personnel, to the limit of resources available, will be responsible for observations, note-taking, and collections in these nurseries. It is recognized that there are no ARS cereal pathologists in some important rust areas.
(3) Individuals in specialty rust laboratories will be responsible for requesting collections from particular lines, for stimulating the making and submission of collections, and for analyses of pathogenicity in those collections.
(4) R. A. Kilpatrick will continue to assemble and distribute nursery reports.

International Rust Nurseries
Objectives:

(1) Search for and distribute seed of sources of resistance.
(2) Test advanced materials in breeding programs to a wide range of pathogenicity.

Decisions:

(1) The use of an international rust nursery as a "screening nursery" by plant breeders is to be discouraged. "Screening", as used here, means evaluation of large numbers of lines from the same cross and family. Screening <u>should not</u> be construed to mean submission of advanced breeding lines for tests on a world-wide basis.
(2) Cooperators will be requested to submit lists of candidate entries in order of descending priority along with an indication of why they wish the entries to be tested. Also, a statement by the cooperator as to which of the previous year's entries should be continued in the current year will be required; otherwise the nursery coordinator may drop an entry after two years of testing or at his discretion.
(3) The international nursery will be available to anyone, within the constraints of the "Code of Ethics for Germplasm Exchange" as adopted by the NWIC, who is willing to cooperate by making rust observations and submitting results of those observations. If no data are provided and no reason is given by a cooperator for not submitting data, a special

request from him will be necessary to receive the nursery the following year.

(4) The feasibility of reporting only summary information and making detailed information available only on request in the yearly reports will be considered. The use of coefficients of infection (CI) and average CI's was discussed but no firm decisions were reached. It was agreed to further consider this along with data reporting systems.

(5) The stripe rust nursery will be combined with the "regular" International Rust Nursery.

Methods and Procedures:

These will remain essentially unchanged with R. A. Kilpatrick requesting entries; assembling and distributing seed; assembling and analyzing data, and reporting results. The Uniform Rust Nursery of each crop will be included in the International Rust Nursery for that crop.

PARTICIPANTS

C. W. Alexander
1610 Stony Brook Pl.
Columbia, MO 65201

Richard E. Atkins
Agronomy Bldg.
Iowa State University
Ames, IA 50011

Bonnie Austin
1231 West 8th
Loveland, CO 80537

Ed Banning
Pioneer Hi-Bred Int'l., Inc.
Route #2
Hutchinson, KS 67501

Gerald L. Barger
110 Federal Bldg.
Columbia, MO 65201

Earnest E. Barnes
1831 Woodrow
Wichita, KS 67203

Robert K. Bequette
1831 Woodrow
Wichita, KS 67203

Lerance Bolte
515 College
Manhattan, KS 66502

Myron Brakke
Route 1
Crete, NE 68333

L. W. Briggle
USDA, ARS, NPS
417, Bldg 005, BARC-W
Beltsville, MD 20705

Lewis E. Browder
Plant Pathology
Kansas State University
Manhattan, KS 66506

Robert Bruns
P.O. Box 30
Berthoud, CO 80513

Robert L. Burton
USDA Oklahoma State Univ.
Stillwater, OK 74074

Bob Clarkson
Pioneer Hi-Bred Int'l., Inc.
Route 2
Hutchinson, KS 67501

L. I. Croy
Oklahoma State University
Stillwater, OK 74074

Byrd Curtis
1909 Osage St.
Ft. Collins, CO 80521

Norris E. Daniels
Tex Agri. Experiment Station
Bushland, TX 79012

Maria Isabel Da Silva
337 Keim Hall
East Campus, UNL
Lincoln, NE 68583

Les J. DePew
2015 N. 6th St.
Garden City, KS 67846

Joao Carlos A. Dias
3053 T Street
Lincoln, NE 68503

Allen L. Diehl
1303 Florida Ave.
York, NE 68467

Robert E. Dolphin
1107 Ridge Rd.
Columbia, MO 65201

Edwin Donaldson
Box 226
Lind, WA 99341

August Dreier
325 Keim Hall
East Campus, UNL
Lincoln, NE 68583

Bill J. Roberts
2540 E. Drake Road
Ft. Collins, CO 80521

Thomas Roberts
404 Humboldt, Suite G
Manhattan, KS 66502

Larry Robertson
P.O. Box 30
Berthoud, CO 80513

J. B. Rowell
Cereal Rust Lab

A. Robert Shank
Box 41 K
Seward, NE 68434

Mike Shanley
Pioneer Hi-Bred Int'l., Inc.
Route 2
Hutchinson, KS 67501

Merle Shogren
2000 Blue Hills
Manhattan, KS 66502

W. H. Sill, Jr.

Roland F. Line
NW 1815 Deane
Pullman, WA 99163

Ronald W. Livers
Hays Experiment Station
Hays, KS 67601

W. Q. Loegering
106 Curtis Hall
Columbia, MO 65201

Donald V. McVey
Cereal Rust Lab
University of Minnesota
St. Paul, MN 55108

Greg Maack
515 E. Drake Rd. #208A
Ft. Collins, CO 80521

S. S. Maan
Agronomy Dept.
ND State University
Fargo, ND 58102

Joe Martin
Hays Experiment Station
Hays, KS 67601

Don Mathre
Plant Pathology Dept.
Montana State University
Bozeman, MT 59715

Paul J. Mattern
202 KCR Bldg.
East Campus, UNL
Lincoln, NE 68583

Richard Mellon
1831 Woodrow
Wichita, KS 67203

Owen G. Merkle
USDA, ARS, Agronomy Dept.
Oklahoma State University
Stillwater, OK 74074

James D. Miller
ARS, USDA
North Dakota State Univ.
Fargo, ND 58102

Rosalind Morris
Agronomy Dept.
University of Nebraska
Lincoln, NE 68583

John G. Moseman
USDA, ARS, NER, PGGI,
Rm. 127, Bldg. 001, BARC-W
Beltsville, MD 20705

Lewis A. Nelson
1505 Gentry Blvd.
Gering, NE 69341

C. L. Niblett
Plant Pathology Dept.
Kansas State University
Manhattan, KS 66506

Mark T. Nielsen
1851 Todd Rd.
Manhattan, KS 66502

Scott Nykaza
725 Griffith Dr., #4
Manhattan, KS 66502

Dolores W. Painter
930 Humboldt
Manhattan, KS 66502

Sam Patil
3722 Piney Grove Dr.
Lafayette, IN 47905

Gary M. Paulsen
Agronomy Dept.
Kansas State University
Manhattan, KS 66506

Alan R. Pedersen
Crop & Soil Science Dept.
Michigan State University
East Lansing, MI 48823

Kenneth Porter
6308 Jameson
Amarillo, TX 79106

Mike Rice
Pioneer Hi-Bred Int'l., Inc.
Route 2
Hutchinson, KS 67501

Don Tipton
Pioneer Hi-Bred Intl. Inc.
Route 2
Hutchinson, KS 67501

Neal Tuleen
3522 Midwest
Bryan, TX 77801

Max Urich
Pioneer Hi-Bred Intl., Inc.
Route 2
Hutchinson, KS 67501