PROCEEDINGS

EIGHTEENTH HARD RED WINTER WHEAT WORKERS CONFERENCE

JANUARY 30 - FEBRUARY 2, 1989

TEXAS A & M UNIVERSITY
RESEARCH AND EXTENSION CENTER
DALLAS, TEXAS

Sponsored by
THE HARD RED WINTER WHEAT
IMPROVEMENT COMMITTEE

In cooperation with
TEXAS AGRICULTURAL EXPERIMENT STATION
TEXAS A & M UNIVERSITY SYSTEM

UNITED STATES DEPARTMENT OF AGRICULTURE

Agricultural Research Service

and

State Agricultural Experiment Stations

in the

Hard Red Winter Wheat Region

PROCEEDINGS

OF THE

EIGHTEENTH HARD RED WINTER WHEAT WORKERS CONFERENCE

Texas Agricultural Experiment Station
Texas A&M University
Research and Extension Center
Dallas, Texas
January 30 - February 2, 1989

Report not for publication[1]

Texas Agricultural Experiment Station
Texas A&M University System

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CONFERENCE PROGRAM

<u>January 31</u>

Conference Opening..............................R. G. Sears, Chairman, Hard Red Winter Wheat Improvement Committee

Welcome..J. A. Reinert, Resident Director, TAES-Dallas

Session I
<u>Russian Wheat Aphid Research</u>

Discussion Leader...............................J. A. Webster, USDA-ARS, Oklahoma State University

"Host Plant Resistance at Stillwater"
- J. A. Webster and Cheryl Baker, USDA-ARS, Plant Science Research Lab, Oklahoma State University, Stillwater

"Russian Wheat Aphid and Wheat Breeding Programs"
- Allan Taylor, Montana State University, Bozeman
- Jim Quick, Colorado State University, Fort Collins
- E. Souza, University of Idaho, Moscow
- Dave Worral and Roy Scott, Texas A&M University, Vernon/Chillicothe

"Plant Damage and Russian Wheat Aphid:Host Interactions"
- Bob Burton, USDA-ARS, Plant Science Research Lab, Oklahoma State University, Stillwater

"Alternate Hosts of Russian Wheat Aphid"
- Dean Kindler, USDA-ARS, Plant Science Research Lab, Oklahoma State University, Stillwater

Session II
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Discussion Leader...............................George Ham, Kansas State University

"State Release Policies"
- Joe Martin, Kansas State University, Hays
- Jim Peterson, USDA-ARS, University of Nebraska, Lincoln
- Gerald Ellis, Colorado State University, Fort Collins
- Paul Sebesta, Texas A&M University, College Station
- Ed Smith, Oklahoma State University, Stillwater

"Genetic Distance Committee Report"
- John Erickson, Hybritech Seed International, Wichita, KS

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<u>Wheat Disease Research</u>

Discussion Leader................................Dave Marshall, Texas A&M University

"Effect of the Conservation Reserve Program on Tan Spot and Root Diseases of Wheat"
- Bill Bockus, Kansas State University, Manhattan

"Evaluation of Hard Red Winter Wheat for Reaction to Wheat Soilborne Mosaic Virus and Wheat Streak Mosaic Virus"
- Bob Hunger, Oklahoma State University, Stillwater

"Breeding for Leaf Rust Resistance and Diversifying Wheat Varieties"
- Dave Marshall, Texas A&M University, Dallas

February 1
Session IV
<u>Wheat-Rye Translocations</u>

Discussion Leader................................Bob Graybosch, USDA-ARS, University of Nebraska

"1A/1R, Pentosans, and Baking Quality"
- Merle Shogren, USDA-ARS, U.S. Grain Marketing Research Lab, Manhattan, KS

"Apparent Cause of Dough Stickyness - A Preliminary Report"
- Debi Rogers and Carl Hoseney, Kansas State University, Manhattan

""1B/1R and Baking Quality; Industrial Perspectives and Concerns"
- Mark Sterns, Campbell-Tagert, Dallas, TX

"A Study on Siouxland Quality Characteristics"
- Paul Mattern, University of Nebraska, Lincoln

"Relationships Between Protein Solubility Parameters, 1B/1R, and Baking Quality"
- Bob Graybosch, V. Hansen, and C. J. Peterson, University of Nebraska, Lincoln

Session V
<u>Wheat Classification</u>

Discussion Leader................................Rollie Sears, Kansas State University

"Progress Report on the Wheat Classification Task Force Committee"
- Rollie Sears, Kansas State University, Manhattan

"Hard White Wheat Classification Progress and Utilization of Hard White Wheats"
- Bob Bequette, Kansas State University, Manhatton

CURRENT STATUS OF THE RUSSIAN WHEAT APHID AND PROGRESS IN PLANT RESISTANCE RESEARCH

JAMES A. WEBSTER

The Russian wheat aphid, Diuraphis noxia (Mordvilko), or sometimes simply called the RWA, is a new threat to North American wheat production since the last Hard Red Winter Wheat Workers Conference. Since its initial detection in Texas in 1986, it has now spread to 15 western states in the United States. Infestations have not yet been found in Nevada or North Dakota, but RWA populations were located in the Canadian provinces of Alberta and Saskatchewan during the summer of 1988. The first occurrence of the RWA in South America was reported in Chile, also in 1988. The pest was reported in Russia and nearby Mediterranean countries around 1900, and in South Africa in 1978 where it has caused yield losses between 30 and 60% (Walters 1984). The South Africans have conducted extensive research with the RWA during the last 10 years, and its common name was also coined in South Africa. During the early 1980's the RWA appeared in Mexico. How it arrived in Mexico or whether it came from South Africa or Russia is unknown. However, because the RWA migrates with the prevailing winds, we can be fairly certain that the U.S. RWA population came from Mexico. ARS scientists at Stillwater were aware of the destructive nature of this pest and had accumulated information from South Africa and Mexico some time before it was found in the United States. This information was immediately distributed to the industry until research results from the United States became available.

The RWA is small (<2.3 mm) with a convex, elongate body (Stoetzel 1987). Males have not been found in South Africa or North America, but there is mention of them in an old scientific report from Russia. Thus, apparently all RWA reproduction in South Africa and North America is by parthenogenesis.

Plant damage symptoms are quite characteristic and typically consist of stunting, white or purple longitudinal streaks of the leaves, and an inward rolling of the leaf edges. Young infested plants have a flattened, prostrate appearance, while in older plants the awns often become trapped in the curled flag leaves, causing the heads to bend (Walters 1984). In a 1988 Great Plains Agricultural Council Report (Morrison et al. 1988), it was estimated that losses caused by the RWA in 1987 amounted to $53 million, including direct damage and control costs. Damage estimates for 1988 are not yet available, but it appears that losses will be greater than the 1987 estimates.

Extensive research on grain aphids, particularly the greenbug, has been conducted at Stillwater since the 1940's. Thus, the Plant Science Research Laboratory was the logical site to begin the ARS Russian wheat aphid program. Initially, there was a gradual redirection of the plant resistance program, followed by the aphid/host interaction program. Programs involving studies on alternate hosts and biocontrol have been added more recently. Currently, 80% of the cereal insect project at Stillwater is directed toward the RWA, with five scientists in the Wheat and Other Cereal Crops Research Unit spending a portion of their research efforts on this pest.

Techniques of rearing the RWA and mass screening wheat lines for RWA resistance have been adapted from greenbug techniques outlined by Starks and Burton (1977). Instead of planting 10 rows of 20-30 seeds in each test flat, we plant 5 seeds in each of 60 "hills" in a test flat. Each hill contains a different test entry, and there are six susceptible entries in each flat. We may miss some variability within a test line with this method, but we feel that the chances of detecting RWA resistance are better by testing a few plants of a large number of lines rather than testing a large number of plants from only a few lines. The hill plot method appears to work well; however, we plan to conduct tests to compare the two testing methods. It appears to us that it is more difficult to evaluate germplasm for RWA resistance than for greenbug resistance. It also seems more difficult to uniformly infest the plants in the flat. In the greenbug tests uniformity of the infestation can be encouraged by gently sprinkling the flats with water. This does not always seem to be true for the RWA, however. We may need to control the RWA infestation levels more carefully than is done in greenbug tests. In addition, it may help to plant susceptible "spreader rows" in the flat.

Webster et al. (1987) reported that greenbug-resistant wheat lines are not resistant to the RWA. More recently, it has been found that the wheat lines PI 137739 (SA 1684) from Iran and PI 262660 (SA 2199) from Russia, which were reported by DuToit (1987) to be resistant in South Africa, have not held up to our RWA cultures. However, there are now RWA colonies at several other research locations in the United States, and it would probably be a good idea to test these lines with other RWA populations.

The plant material that we have tested so far has come from the USDA-ARS National Small Grain Collection or from individual plant breeders. Entries tested from the ARS collection include Triticum monococcum (98 lines), T. dicoccoides (436 lines), T. aestivum (bread wheats) with cultivar names or experiment station designations (3176 lines), the triticale collection (731 lines), and about 5 entries each of 19 Triticum species. We are also testing a large collection of over 20 wheat species maintained at our laboratory. In addition, we have tested materials submitted by plant breeders from at least six other locations.

Probably the most significant thing we have found in the ARS collection to date is the resistance in seven triticale lines. Resistant plants have been saved for crossing and further tests, but how they will work out in the wheat breeding program remains to be seen. Three of the lines are from Dr. Qualset's program in California. They are CI 81, CI 82, and CI 87, and have 'Snoopy' rye and 'Eskisehir' wheat in their backgrounds. Individual plants of Snoopy and Eskisehir were tested and appear to be susceptible, so we are not sure of the source of resistance. They are octoploids (2n=56) and are winter habit. The other four lines are from Russia and seem to have a higher level of resistance. They are PI 386148, PI 386149, PI 386150, and PI 386156. They are also listed as winter habit, but are reported to be hexaploids, with the exception of PI 386150 which is listed as an octoploid. We have no information about the parentage of these Russian lines. There are also some Triticum tauschii (Coss.) lines from our Stillwater collection that have been saved for future tests.

We believe that substantial progress has been made in RWA plant resistance research in wheat considering the newness of the program, and we remain optimistic about future releases of RWA-resistant wheat germplasm.

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INTERSPECIFIC BREEDING FOR RUSSIAN WHEAT APHID RESISTANCE

CHERYL A. BAKER, OWEN G. MERKLE, AND RITA A. VEAL

In the three years since the Russian wheat aphid, Diuraphis noxia Mordvilko, (RWA) was first detected in the United States, it has spread rapidly and has now been identified in 15 states as well as 2 Canadian provinces. Economic damage to wheat production has been extensive. Because the insect is protected from natural predators and chemical pesticide applications by the characteristically rolled leaf, host plant resistance and the development of RWA-resistant germplasm has been a major objective of the USDA-ARS lab in Stillwater, OK.

We have identified resistance to this aphid in three different species: Triticum tauschii (Coss.) Schmal. (diploid, genome D), Triticum umbellulatum (Zhuk.) Bowden (diploid, genome U), and both hexaploid (ABR) and octoploid (ABDR) Triticales (X Triticosecale Wittmack). The strongest level of resistance appears to be in several of the Triticales.

Crosses were made between all resistance sources and several different types of spring wheat [Chinese Spring, due to its high level of crossability with other species and genera; Bobwhite, a spring wheat with good agronomic qualities, a durum wheat, Triticum turgidum L. (tetraploid, AB)].

Interspecific incompatibility in these crosses results in endosperm deterioration and embryo death if the seeds are allowed to develop normally. To avoid this, an embryo rescue technique must be performed. This technique involves aseptic excision of the hybrid embryo from the seed, followed by embryo culture on a simple nutrient media. Following rescue, and depending on the cross involved, one of two possible procedures is followed. The first procedure involves embryo rescue and immediate plant regeneration. This procedure was attempted with all possible cross combinations. Twenty-eight percent of the embryos had successful plant regeneration, and approximately 30% of these (8% of total rescued embryos) developed to maturity. All but two of the plants were self-sterile and had to be backcrossed to wheat. The backcrossed seed is being grown this spring for seed increase, preferably through selfing, prior to flat test screening for RWA resistance.

The second procedure involves embryo rescue followed by callus culture and delayed plant regeneration. This method was used primarily for both the Triticale crosses and selfed Triticale seed. Callus culture is known to cause genomic instability and results in greater numbers of mutations and spontaneous translocations. If the resistance found in the Triticale is carried on a chromosome within the R genome, a desirable translocation may be found in a plant regenerated from callus. This would make the incorporation of resistance into an acceptable wheat background much more feasible. So far, three series of plants have been brought out of callus culture at 6-week time intervals. These plants are being raised for seed increase prior to resistance screening.

Wheat-related species and Triticales vary tremendously in their interspecific crossing ability and in their response to embryo and callus culture. The techniques used are ones developed for wheat culture, and it may be beneficial to optimize this system for Triticale or interspecific hybrid culture.

At this stage, we do not yet know whether we have been successful in making an interspecific transfer of resistance genes. Screening tests late this spring or early summer should give a much better indication as to how successful these procedures have been.

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BREEDING FOR RUSSIAN WHEAT APHID TOLERANCE AT COLORADO STATE UNIVERSITY

J. S. QUICK, K. KABWE, W. MEYER, AND F. PEAIRS

The Russian wheat aphid was discovered in Baca County, southeastern Colorado, in 1986. Since discovery, the aphid has cost Colorado wheat producers an estimated $50 million. The aphid has been found in all wheat-producing counties in Colorado and is potentially a serious constraint to production and wheat quality by reducing grain yield and test weight.

The breeding program has considered the following sources of germplasm:

A. Among adapted cultivars

- from currently or recently grown regional varieties

B. Among unadapted wheats

- from introductions from other countries or regions; early generation lines or breeding populations

C. Tolerance from related species

- crosses with triticale or rye
- crosses with *T. monococcum*, *tauschii*, *umbellulatum*

D. DNA transfer from oats or non-crossable species

- this opportunity requires high technology genetic engineering, is a long shot at best, and will not speed up the breeding process, but will provide alternative sources of resistance

Our laboratory screening includes insect rearing and seedling infestation and evaluation (started October 26). The symptom assessment utilized a 1 to 9 score which combines leaf curling and chlorosis. The results after 17 days are:

Tolerant	Moderately Tolerant	Susceptible
PI372129 Col 37 (oat) *T. monococcum* (PI266844)	Tx 33 (triticale)	All adapted wheats

Assessment of symptoms over days showed that the ranking of entries was essentially fixed seven days after infestation. Since only small differences exist among adapted cultivars, it may be necessary to express these differences in terms of time.

The CSU short term plans include the evaluation of non-vernalized and vernalized wheats, triticales, and related species, the determination of the effect of RWA feeding on survival during vernalization and the effect of plant growth stage on susceptibility, the evaluation of segregating progeny of PI372129 crosses, and the progeny of crosses with tolerant triticale. PI372129 has several deficiencies - soft, white grain, late maturity, excessive height, and very weak straw. We estimate that tolerant cultivars will be produced in about eight years, but breeding progress prediction assumes the following:

1. No change in insect biotypes.
2. Expression of wild relative tolerance in wheat types.
3. No difficult deleterious genetic associations.
4. Adequate funding.

RUSSIAN WHEAT APHID RESISTANCE WORK IN IDAHO

E. SOUZA, C. M. SMITH, R. ZEMETRA, AND S. HALBERT

Three research projects in Idaho are investigating resistance in bread wheat to the Russian wheat aphid (RWA) (Diuraphis noxia). The RWA is a severe pest on cereals in souther Idaho and was identified during 1988 in northern Idaho. During spring 1988, a test conducted in Parma, Idaho found that field evaluations could be used for RWA susceptibility tests. Four different infestation treatments of eight diverse wheats were examined. Plots were evaluated for severity of toxin-induced chlorosis, using a 0 to 9 visual scale, and the percentage of infested tillers. Evaluations were made four times between early tillering and the soft dough stages. The highest infestation ratings occurred in treatments where each plot had been infested at early tillering using greenhouse-reared aphids. There were no significant differences between treatments using RWA infested spreader rows infested at early tillering and naturally occurring infestation. Significant differences were noted among cultivars for RWA susceptibility ratings. Soft white spring cultivars were generally more susceptible than hard red spring cultivars. No interaction between levels of susceptibility and infestation treatments were found, indicating that in years of similar natural infestations greenhouse-reared populations would not be needed for field evaluation. The USDA International Wheat Observation Nursery and 70 northwestern breeding lines were evaluated for seedling resistance in replicated greenhouse trials at Moscow. Plants were infested at the 3 leaf stage by placing infested leaf pieces in the sheath of the first leaf. Plants were scored 21 days after infestation for leaf rolling, leaf folding, and chlorosis. 'TAM 200,' 'Florida 302,' and 'Fundulea 4' appear the least susceptible with total ratings of 0.9, 3.0, and 3.0, respectively (0 = no damage, 6 = heavy damage). A third research program selects for resistance to the RWA toxin using embryonic callus of the soft white winter cultivar Daws. Preliminary research indicates that saline solution extracts of freeze-dried RWA when added to culture media significantly reduces fresh weight accumulation and induces necrosis of calli. Research is planned to evaluate RWA susceptibility in Idaho breeding lines and approximately 1,500 central Asian wheats using greenhouse and field trials. Greenhouse antixenosis tests of the least susceptible genotypes are in progress, antibiosis and tolerance tests are planned. Initial purification the RWA toxin using HPLC is planned as part of the tissue culture selection program.

COMPARISON OF THREE TECHNIQUES FOR STUDYING ANTIBIOSIS TO RUSSIAN WHEAT APHIDS

R. A. SCOTT, W. D. WORRALL, AND W. A. FRANK

The Russian wheat aphid (Diuraphis noxia Mordvilko) (RWA), has become an established pest of wheat (Triticum aestivum L. em. Thell) and other small grains in the United States. Resistance to RWA has not yet been found in wheat, but is being sought in many breeding programs. The techniques presently used in RWA antibiosis studies are modifications of those used for the greenbug [Schizaphis graminum (Rondani)]. While they may be appropriate, there is a need to evaluate and compare these techniques for specific use with RWA, since the behavior patterns of RWA appear to be different from the greenbug. The embryo count and nymph count techniques were compared, and a new technique designated as the colony count was evaluated and compared with these. These evaluations were done using resistant and susceptible triticale lines selected from earlier screening tests. Our main objectives were to determine if the embryo count and colony count provided comparable information to actual fecundity counts, and whether or not they could be used as suitable alternatives. The nymph count involved periodic counts of nymphs produced by a single adult, while the embryo count involved recording mean number of embryos produced by different RWA on a single plant. The colony count involved a single count of all RWA produced on a single plant from an initial infestation of one RWA. Numbers of nymphs per adult (nymph count) obtained were larger than the number of embryos per adult (embryo count). Significant rank correlations of 0.79 ($P = 0.01$) were obtained between embryo and nymph counts. Significant rank correlations were also obtained between the colony and nymph counts ($r_s = 0.58$, $P = 0.05$). However, colony count and embryo count ranked the lines differently. Mean separation of the nymph count and embryo count techniques identified line differences more effectively than the colony count technique, although lines with superior levels of antibiosis were identified by all three techniques. Total number of aphids (including both nymphs and adults), and total number of nymphs obtained from the colony count ranked the lines exactly the same ($r_s = 1.00$, $P = 0.01$). This indicated that when using the colony count, separation of nymphs and adults was not necessary. Although all three techniques were appropriate for use with RWA, the embryo and colony counts were more practical. The embryo count technique was preferred to the colony count since the information it provided was more closely correlated with the actual fecundity counts. The amount of time spent on embryo counts was only 1/4 of the total time spent on actual nymph counts. Colony counts also took less time than nymph counts, but more than embryo counts.

VARIATIONS IN PLANT DAMAGE CAUSED BY RUSSIAN WHEAT APHID

W. D. WORRALL, LEANNE BUSH AND J. E. SLOSSER

In 1986, 17 collections of Russian wheat aphid (RWA), Diuraphis noxia (Mordvilko), were made from 11 counties in West and Northwest Texas. Each of these colonies was cloned from a single nymph and maintained on caged pots of 'TAM-105' wheat. Two tests were conducted to determine whether or not resistance or tolerance would be identified among genotypes of hard red winter wheat, whether all RWA collections responded identically to the set of host plants used and whether a single measure of damage could be identified. Measurements included plant height, expressed as a percent of an uninfested check, plant damage rating (1-10 scale with 10 representing plant death), and aphid reproduction expressed as the number of nymphs produced from a single adult in a given period of time. Results indicated that differences in resistance exist in hexaploid hard red winter wheats although immunity was not identified. The germplasm line TXGH10989 was significantly less damaged by RWA than 'TAM-107' and TAM-107 was significantly less damaged by RWA than the germplasm line TX78V2290-36-1. No single measure of RWA damage was sufficiently precise to delineate all differences in host plant resistance although reduction in plant height was the best overall objective measurement. A combination of objective and subjective measurements was necessary to more closely define resistance and colony differences. Significant differences existed between sources of RWA. These differences were significant both within and among counties of origin. Although the differences were quantifiable and significant, the data are not yet sufficient to designate any of the individual colonies as biotypes. Results of these and previous studies suggest that a set of standard genotypes can be established which could serve as a set of differentials similar to those used for leaf rust testing in wheat. TX78V2290-36-1 could serve as a highly susceptible check and TXGH10989 could serve as a moderately resistant check.

IMPACT OF RUSSIAN WHEAT APHID FEEDING DAMAGE TO WHEAT SEEDLINGS

JOHN D. BURD AND ROBERT L. BURTON

The Russian wheat aphid, Diuraphis noxia Mordvilko, has become established throughout the central and western wheat and barley producing areas of the United States. Incontrovertible economic damage from the RWA poses a serious threat to an already unstable cereal industry. Efforts to combat this pest must first focus on understanding the basic nature of feeding damage imposed on the host plant. Putative damage scenarios based primarily on field observations give little insight into the specific components of plant damage. A series of studies has been conducted to extricate visible damage symptoms into succinct plant response components which would provide focal points for future studies of specific RWA induced physiological dysfunctions associated with yield loss.

Using TAM W-101 wheat seedlings, we evaluated several parameters as indicators of RWA feeding damage. As a result, we have found that RWA feeding causes an apparent delay in tillering and leaf initiation and a reduction in growth rates, leaf area, and root and shoot length and biomass. Probably the most significant factor relating to plant damage is leaf rolling. Leaf rolling occurred independent of other visible damage symptoms commonly associated with RWA infestations, such as chlorotic lesions, purple discoloration, and longitudinal white streaking in Texas. Throughout our tests, we observed no rolling of expanded leaves. Instead, it was observed that RWA feeding prevented the unrolling of newly formed leaves. Concomitant to the rolled-leaf condition, we have also found that there is a significant reduction in turgor in the rolled portion of the leaves. Moreover, after the aphids were removed, the leaves remained in a tightly rolled condition. Consequently, the leaf rolling caused by feeding may be the most important symptom of damage since it traps new leaves and prevents new growth.

ALTERNATE HOSTS AND SELECTION FOR RESISTANCE TO THE RUSSIAN WHEAT APHID WITHIN GRASS GENERA

DEAN KINDLER AND TIM SPRINGER

Russian wheat aphid (Diuraphis noxia Mordvilko) economic importance on barley (Hordeum vulgare) and wheat (Triticum aestivum) depends, in part, on its ability to utilize plant species as alternate and oversummering hosts. Land Grant Colleges and the USDA-Soil Conservation Service (SCS) currently recommend many warm- and cool-season grasses for more efficient use of rangelands, land reclamation projects, and prevention of soil erosion. By 1990, over 40 million acres will be taken out of crop production and planted to grasses under the Conservation Reserve Program (CRP). Most CRP acres are located in the wheat and barley production areas of the United States, i.e., the Southern Plains, Northern Plains, and Mountain regions, where large amounts of highly erodible marginal croplands exist (U.S. Dep. Agric., Office of Information, 1988). Few, if any, of the grass species being utilized in reseeding programs have been evaluated for host suitability and harboring of major grain crop pests.

This study was conducted to determine survival and reproduction of the Russian wheat aphid on warm- and cool-season grasses, legumes, and forbs. Plant Materials Centers, USDA-SCS, provided most seed used for study. The USDA-ARS Plant Science and Water Conservation Laboratory and the Oklahoma Agricultural Experiment Station, Oklahoma State University, Stillwater, OK, supplied additional seed. Host suitability was determined on 2-4 weeks old plants infested with 10 late instar Russian wheat aphids. After 14 days, aphids ad surviving progeny were removed from plants and counted. Results are presented in Table 1.

The Russian wheat aphid survived on 98% of 48 cool-season grass species, 50% of 32 warm-season grass species, and 0% of 27 legumes and 17 forbs. Jointed goatgrass (Triticum cylindricum) was the most suitable host, followed by barley, European dunegrass (Elymus arenarius), and little barley (Hordeum pusillum). Russian wheat aphid survived equally well on several cool-season grass species when compared with wheat. Warm-season grass compared with wheat were poor hosts for Russian wheat aphid. Many cool-season grasses were as preferred or more preferred than the most preferred warm-season grass species. Russian wheat aphid importance in North America has increased because it can survive on a broad host range of cool- and warm-season grass species that commonly occur throughout the barley and wheat production areas. Grasses offer a variety of alternate habitats which could serve as reservoirs for this important crop pest.

From seed provided by the Regional Plant Introduction Station, Pullman, Washington, we are evaluating and identifying Russian wheat aphid resistance in these genera: Agropyron (1270 entries), Elymus (308 entries), Hordeum (106 entries), and Secale (24 entries). The selection criteria for resistance to Russian wheat aphid has been to select genotype that do not exhibit feeding damage such as leaf streaking, leaf rolling, and the trapping of a new leaves. In addition, we are selecting plants that are either tolerant to high populations of Russian wheat aphid which would normally kill wheat, barley, rye, and oats or genotypes that support low or no populations of Russian wheat aphid. Although many of the entries are very susceptible to Russian wheat aphid, we have identified high levels of resistance to Russian wheat aphid in Agropyron and Elymus. Some of the resistant entries will cross with wheat and/or barley, and plans are made to "wide crossing" resistant lines to these important cereal crops.

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U.S. Dep. Agric., Office of Information. 1988. USDA reports total CRP crop acreage base from signups. USDA News Rel. 03-25-88. 2 pp.

Table 1. Mean Russian wheat aphid counts after a 14-day infestation period.

Scientific Name	Common Name	Mean count[a]	SEM[b]
COOL-SEASON GRASSES			
Triticum cylindricum (Host) Ces.	Jointed Goatgrass	597.50	42.13
Hordeum vulgare L.	Barley	352.37	52.39
Elymus arenarius L.	European Dunegrass	287.75	136.61
Hordeum pusillum Nutt.	Little Barley	255.50	19.25
Vulpia myuros (L.) K. C. Gmel.	unknown	237.50	109.08
Bromus mollis L	Blando Bromegrass	212.50	27.54
Triticum aestivum L.	Wheat	192.50	41.83
Bromus arvensis L.	Field Bromegrass	192.00	41.02
Agropyron intermedium (Host) Beauv.	Intermediate Wheatgrass	186.00	7.62
Agropyron elongatum (Host) Beauv.	Tall Wheatgrass	155.75	15.39
Oryzopsis hymenoides (Roem. & Schult.) Ricker	Indian Ricegrass	149.25	35.59
Elymus triticoides Buckl.	Beardless Wildrye	132.75	27.25
Agropyron trachycaulum (Link) Malte	Slender Wheatgrass	124.16	25.35
Agropyron riparium Scribn. & Sm.	Streambank Wheatgrass	115.75	65.54
Elymus giganteus Voh	Mammoth Wildrye	114.75	21.80
Elymus angustus Trin.	Altaii Wildrye	102.25	55.79
Agropyron spicatum (Pursh) Scribn. & Sm.	Bluebunch Wheatgrass	96.75	16.53

Table 1. Continued

Agropyron repens X spicatum	Hybrid Wheatgrass	96.37	9.76
Psathyrostachys juncea	Russian Wildrye	81.75	65.32
Agropyron dasystachyum (Hook.) Scribn.	Thickspike Wheatgrass	81.25	47.30
Agropyron cristatum (L.) Gaertn.	Crested Wheatgrass	73.50	29.97
Festuca rubra L.	Red Fescue	72.75	19.09
Festuca pratensis Huds.	Meadow Fescue	62.25	28.99
Stipa viridula Trin.	Green Needlegrass	59.75	43.80
Festuca ovina duriuscula (L.) Koch	Hard Fescue	57.75	10.34
Bromus inermis Leyss.	Smooth Bromegrass	56.75	90.27
Poa ampla Merr.	Big Bluegrass	55.75	29.98
Avena sativa L.	Oats	53.50	24.28
Agropyron smithii Rydb.	Western Wheatgrass	53.43	9.83
Bromus tectorum L.	Downy Bromegrass	46.00	30.04
Alopecurus arundinaceus Poir.	Creeping Foxtail	39.41	18.26
Bromus rubens L.	Red Bromegrass	38.25	12.71
Lolium perenne L.	Perennial Ryegrass	31.80	1.92
Secale cereale L.	Cereal Rye	29.87	20.16
Poa arida Vasey	Plains Bluegrass	29.75	34.77
Elymus cinereus Scribn. & Merr.	Basin Wildrye	27.50	18.66
Koeleria cristata (L.) Pers.	Prairie Junegrass	19.25	16.03
Lolium multiflorum Lam.	Annual Ryegrass	17.00	3.74
Poa juncifolia Scribn.	Alkali Bluegrass	17.00	7.07
Festuca arundinacea Schreb.	Tall Fescue	12.50	11.82

Table 1. Continued

Dactylis glomerata L.	Orchardgrass	12.29	8.21
Puccinellia airoides (Nutt.) Wats & Coult.	Nuttall's Alkaligrass	5.25	4.99
Poa compressa L.	Canada Bluegrass	5.25	2.06
Agropyron trichophorum (Link) Halacsy	Pubescent Wheatgrass	4.75	3.10
Agrostis alba L.	Red Top	2.75	4.86
Poa pratensis L.	Kentucky Bluegrass	0.87	1.18
Phalaris arundinacea L.	Reed Canarygrass	0.25	0.50
Oryzopsis coerulescens (Desf.) Hack	Mediterranean Ricegrass	0.00	
WARM-SEASON GRASSES			
Leptochloa dubia (H.B.K.)	Green Sprangletop	92.75	20.98
Bouteloua gracilis (H.B.K.) Griffiths	Blue Grama	59.13	21.45
Pennisetum typhoides (N.L. Burm.) Stapf & Hubb.	Pearl Millet	31.21	8.31
Eragrostis tef (zucc Trotter)	Tef	29.25	21.64
Bouteloua curtipendula (Michx.) Torr.	Sideoats Grama	28.68	7.27
Bouteloua eriopoda (Torr.) Torr.	Black Grama	27.12	8.39
Buchloe dactyloides (Nutt.) Engelm.	Buffalograss	26.66	16.92
Panicum texanum Buckl.	Texas Panicum	22.00	23.64

Table 1. Continued

Eragrostis trichoides (Nutt.) Wood	Sand Lovegrass	21.50	19.07
Spartina pectinata Link	Prairie Cordgrass	19.75	4.11
Brachiaria platyphylla (Griseb.) Nash	Broadleafed Signalgrass	19.50	27.60
Sporobolus airoides (Torr.) Torr.	Alkali Sacaton	19.16	9.16
Sorghastrum nutans (L.) Nash	Indiangrass	11.85	13.87
Cynodon dactylon (L.) Pers.	Bermudagrass	11.50	12.77
Eragrostis cuperba	Wilman Lovegrass	9.25	2.99
Eragrostis lehmanniana Nees	Atherstone Lovegrass	7.50	10.66
Sporobolus wrightii Munro ex Scribn.	Big Sacaton	5.50	3.70
Panicum virgatum L.	Switchgrass	1.00	1.41
Andropogon gerardii Vitman	Big Bluestem	0.00	
Bothriochloa caucasica (Trin.) Hubb.	Caucasian Bluestem	0.00	
Bothriochloa ischaemum (L.) Keng	Yellow Bluestem	0.00	
Dichanthelium clandestinum (L.) Gould	Deer Tongue	0.00	
Dichanthium Willem.	Old World Bluestem	0.00	
Digitaria sanguinalis (L.) Scop.	Crabgrass	0.00	
Echinochloa crusgalli (L.) Beauv.	Barnyardgrass	0.00	

Table 1. Continued

Eragrostis curvula (Schrad.) Nees	Weeping Lovegrass	0.00
Panicum coloratum L.	Kleingrass	0.00
Panicum dichotomiflorum Michx.	Fall Panicum	0.00
Paspalum notatum Flugge	Pensacola Bahia	0.00
Pennisetum orientale (Willd.) L. C. Rich.	Lourisagrass	0.00
Schizachyrium scoparium (Michx.) Nash	Little Bluestem	0.00
Setaria glauca (L.) Beauv.	Yellow Foxtail	0.00
LEGUMES		
Arachis hypogaea L.	Peanut	0.00
Astragalus cicer L.	Cicer Milkvetch	0.00
Cassia obtusifolia L.	Sicklepod	0.00
Coronilla varia L.	Crownvetch	0.00
Desmanthus illinoensis (Michx.) Macm.	Illinois Bundleflower	0.00
Desmodium illinoense Gray	Tick Clover	0.00
Indigofera miniata Ortega	Western Indigo	0.00
Indigofera pseudotinctoria	Falsearil Indigo	0.00
Lathyrus latifolius L.	Perennial Peavine	0.00
Lathyrus sylvestris L.	Flat Pea	0.00
Lespedeza capitata Michx.	Roundhead Lespedeza	0.00

Table 1. Continued

Lespedeza cuneata (Dumont.) G. Don	Sericea Lespedeza	0.00
Lespedeza daurica (Laxm) Schindl.	Prostrate Lespedeza	0.00
Lespedeza stuevei Nutt.	Stuves Lespedeza	0.00
Lespedeza tomentosa	Wooly Lespedeza	0.00
Lespedeza virgata (L.) Britt.	Virgata Lespedeza	0.00
Lotus corniculatus L.	Birdsfoot Trefoil	0.00
Lotus penduncul atus Cav.	Big Trefoil	0.00
Medicago sativa L.	Alfalfa	0.00
Oxytropis riparia Litv.	Ruby Valley Paintvetch	0.00
Petalostemon candidum (Willd.) Michx.	White Prairieclover	0.00
Petalostemon purpureumy (Vent.) Rydb.	Purple Prairieclover	0.00
Pisum sativum L.	Austrian Winterpea	0.00
Trifolium fragiferum L.	Strawberry Clover	0.00
Trifolium incarnatum L.	Crimson Clover	0.00
Trifolium vesiculosum Savi	Arrowleaf Clover	0.00
Vicia dasycarpa Ten.	Woolly Pod Vetch	0.00
FORBS		
Atriplex nuttallii Wats.	Nuttall's Saltbush	0.00
Brassica rapa L.	Rape	0.00
Chenopodium album L.	Lambs Quarter	0.00

Table 1. Continued

Echinacea angustifolia DC.	Black Samson	0.00
Engelmannia pinnatifida Gray ex Nutt	Engelmann's Daisy	0.00
Helianthus annuus L.	Common Sunflower	0.00
Helianthus maximiliani Schrad	Maximilian Sunflower	0.00
Heliopsis helianthoides (L.) Sweet	Rough Oxeye	0.00
Jacquemontia tamnifolia (L.) Griseb.	Small Flower Morning-glory	0.00
Liatris punctata Hook.	Dotted Gayfeather	0.00
Liatris pycnostachya Michx.	Thickspike Gayfeather	0.00
Menodora longiflora (Engelm.) Gray	Showy Menodora	0.00
Penstemon cobaea Nutt.	Cobaea Penstemon	0.00
Ratibida pinnata (Vent.) Barnh.	Grayhead Prairie Coneflower	0.00
Salvia pitcheri Torr.	Pitcher's Sage	0.00
Sida spinosa L.	Prickly Sida	0.00
Silphium laciniatum L.	Compass Plant	0.00

[a] LSD (0.05) = 48.73; mean counts represent each plant species replicated 4 times

[b] SEM = Standard error of the mean; data were analyzed using PROC ANOVA (SAS Institute, 1985).

EFFECT OF THE CONSERVATION RESERVE PROGRAM
ON TAN SPOT AND ROOT DISEASES OF WHEAT

W. W. BOCKUS

The Conservation Reserve Program (CRP) is a government program which encourages crop producers to take cropland which is highly erodible out of production. These fields are converted to grasses, trees or wildlife cover for a minimum of ten years with the owners receiving a payment from USDA. In Kansas approximately 2.5 million acres have been signed up for this program with about 1.5 million acres of these coming out of wheat production. Furthermore, about 99% of the CRP acres in Kansas have been planted with various grass species. Since these native and introduced grasses serve as additional hosts for many wheat pathogens, what effect will this program have on wheat diseases?

Several root pathogens of wheat that have broad host ranges will be likely to carry over and multiply on grasses. These include the causal agents of take-all, Rhizoctonia root rot, Cephalosporium stripe, Pythium root rot, and common root and crown rot. These pathogens can infect roots and rhizomes of wild grass species to maintain their inoculum levels in the soil. Some of them also produce spores or other propagules which survive in soil for long periods of time. However, this infected debris and soilborne spores are relatively stationary; they do not move to any great extent from field to field. Thus, plantings of grasses in the CRP are not expected to directly effect the occurrence of root diseases in wheat fields surrounding CRP fields. Nevertheless, there is potential for severe root disease if fields are taken out of the CRP and planted immediately to wheat. It is recommended that a nonhost crop such as corn, milo or soybeans be planted on these fields and then production of wheat resumed.

Tan spot is a foliar disease of wheat that also can infect many wild grass species. The causal agent of this disease produces airborne spores which can blow from field to field. Although there is one report of spores traveling up to 50 miles, dissemination is usually a quarter mile or less. Even though there needs to be more research in this area, populations of grasses in waterways, ditches, roadsides, or fallow fields have not been associated with outbreaks of tan spot. Thus, it is anticipated that the CRP will not result in an increase in tan spot severity in fields of wheat adjacent to CRP fields. The CRP fields will probably not add any more spores to the air mass than if those fields had been in wheat production.

EVALUATION OF HARD RED WINTER WHEATS FOR REACTION TO WHEAT STREAK MOSAIC VIRUS AND WHEAT SOILBORNE MOSAIC VIRUS

ROBERT M. HUNGER AND JOHN L. SHERWOOD

Visual assessment of symptoms and the enzyme linked immunosorbent assay are being used to evaluate the reaction of hard red winter wheats (HRWW) to wheat streak mosaic virus (WSMV). Results from two years of replicated field tests using mechanical inoculation of WSMV demonstrate the severe effects of fall infection by WSMV on 7 varieties of HRWW (Table 1 and 2). Inoculation with WSMV in the spring resulted in symptom development and positive ELISA values in 1987 but not in 1988. The reason for this difference may have been due to the later inoculation date in 1988 as compared to 1987. Reports in 1986 and 1987 indicated that Pioneer 2157 may have some resistance to WSMV as indicated by less severe symptoms in fields of Pioneer 2157 growing adjacent to fields of other wheats with severe symptoms of WSMV. Results from our trials indicate Pioneer 2157 is as susceptible to WSMV as the other varieties in our tests (Table 1 and 2), which suggest that Pioneer 2157 may have resistance to the vector (wheat curl mite) rather than the virus. In 1988, the HRWW 'Rall' demonstrated resistance to WSMV as indicated by symptomatology and ELISA readings (Table 2). Rall was released in 1976 by State and Federal personnel at Oklahoma State University and resulted from a single plant selected for tolerance to WSMV from the variety 'Scout'. Further studies are being conducted to collaborate these results.

Procedures to evaluate wheat lines and individual plants in the field and in the growth chamber-greenhouse for reaction to wheat soilborne mosaic virus (WSBMV) have been developed using visual assessment of symptoms and ELISA. For the field evaluation, emerging seedlings planted in a disease nursery are irrigated with 2.5-5.0 cm of water just as coleoptiles are emerging through the soil surface. Symptom severity is evaluated and foliage is collected for testing by ELISA in February or March. For the growth chamber-greenhouse test, individual seeds or groups of seeds are planted in soil from the disease nursery and emerging seedlings are maintained at saturation for 3 days at 10-15°C in a growth chamber. Seedlings are evaluated for symptoms and foliage collected for ELISA in 6-8 weeks. Resistant seedlings are transplanted either to the field or into pots in the greenhouse for maturation. This system for the past 2 years has enabled the identification of 58 plants with resistance to WSBMV from 3 advanced lines segregating for reaction to WSBMV. Currently, these 58 plants are being tested for homozygosity of reaction to WSBMV using the system described.

ELISA, which is based on antigen-antibody interaction, detects the capsid (coat protein) of the virus in plant samples. Development and use of monoclonal antibody to detect WSBMV has improved the sensitivity, uniformity, and consistency of ELISA with WSBMV and has facilitated differentiation between resistant and susceptible lines or individual plants. Combining ELISA with visual assessment of symptoms gives the ability to confirm the presence or absence of virus capsid and thereby increases the reliability of the visual assessment. Further investigations will be directed toward identifying the mechanism(s) of resistance to WSBMV using visual assessment of symptoms (to evaluate disease severity), ELISA (to determine amount of capsid production), nucleic acid hybridization (to determine amount of viral nucleic acid production), and isolation of intact virus particles by electrophoresis (to determine amount of virus particle production).

Table 1. Reaction of six hard red winter wheats to inoculation with wheat streak mosaic virus (WSMV) in the fall and spring, 1986-87

Cultivar and Time of Inoculation	Reaction to WSMV 4-16-87 Rating[a]	ELISA[b]	5-13-87 Rating[a]	ELISA[b]	Yield (g)[c]
Century					
not inoculated	0.0	0.087	0.0	0.072	737.1
fall	1.7	0.260	3.0	0.331	138.4
spring	0.0	0.143	1.3	0.159	514.0
Chisholm					
not inoculated	0.0	0.053	0.0	0.085	529.7
fall	1.3	0.181	2.7	0.270	202.5
spring	0.0	0.157	1.3	0.095	436.8
Pioneer 2157					
not inoculated	0.0	0.098	0.0	0.042	507.1
fall	1.3	0.233	3.0	0.294	144.6
spring	0.0	0.097	1.0	0.131	461.3
Souixland					
not inoculated	0.0	0.086	0.0	0.097	428.7
fall	1.3	0.321	3.0	0.297	149.8
spring	0.0	0.186	1.0	0.234	415.5
Tam 108					
not inoculated	0.0	0.084	0.0	0.074	657.8
fall	0.7	0.166	1.7	0.343	257.5
spring	0.0	0.192	0.7	0.059	496.4
Vona					
not inoculated	0.0	0.176	0.0	0.114	399.2
fall	2.7	0.261	3.0	0.318	56.1
spring	0.3	0.287	1.7	0.174	341.6
LSD	---	0.105	---	0.095	51.3

[a]Each value is the mean of 3 replications of plants rated as follows:
0=No symptoms
1=Leaves mostly light green with a few yellow streaks
2=Plants slightly stunted; leaves with mixed green and yellow streaks
3=Plants stunted; leaves with severe yellow streaking and a few green streaks or green islands

[b]Each value is the mean of 3 replications

[c]Each value is the mean of 3, 3.05 m rows of wheat plants

Table 2. Reaction of eight hard red winter wheats to inoculation with wheat streak mosaic virus (WSMV) in the fall and spring, 1987-88

	Reaction to WSMV					
Cultivar and	4-6-88		5-18-88			
Time of Inoculation	Rating[a]	ELISA[b]	Rating[a]	ELISA[b]	Yield (g)[c]	TKW (g)[d]
Century						
not inoculated	0.0	0.007	0.0	0.002	235.6	35.9
fall	2.3	1.731	3.0	2.000	31.1	16.5
spring	0.0	0.007	0.3	0.001	202.8	23.2
Chisholm						
not inoculated	0.0	0.033	0.0	0.010	272.1	28.7
fall	1.3	1.669	3.0	2.000	58.1	22.7
spring	0.0	0.017	0.3	0.002	194.7	28.5
Pioneer 2157						
not inoculated	0.0	0.008	0.0	0.002	245.1	27.9
fall	1.7	1.439	3.0	2.000	75.5	35.5
spring	0.0	0.002	0.3	0.004	217.6	26.9
Rall						
not inoculated	0.0	0.005	0.0	0.000	179.9	34.7
fall	1.0	0.369	0.0	0.000	143.3	31.7
spring	0.0	0.001	0.0	0.002	220.6	30.8
Siouxland						
not inoculated	0.0	0.071	0.0	0.009	200.8	41.4
fall	1.0	1.667	2.7	2.000	49.8	23.0
spring	0.0	0.020	0.7	0.092	195.5	27.7
Tam 108						
not inoculated	0.0	0.003	3.0	0.000	323.9	24.6
fall	1.7	1.726	0.0	2.000	64.1	32.3
spring	0.0	0.012	0.7	0.000	271.0	29.5
Triumph 64						
not inoculated	0.0	0.006	0.0	0.000	171.9	34.1
fall	1.0	1.335	2.3	1.892	82.2	30.4
spring	0.0	0.006	0.0	0.001	184.4	33.1
Vona						
not inoculated	0.0	0.009	0.0	0.000	231.8	20.2
fall	2.0	1.664	3.0	1.782	42.7	19.9
spring	0.0	0.008	0.0	0.000	207.8	20.8
LSD (P=0.05)	---	-----	---	-----	77.0	11.6

[a]Each value is the mean of 3 replications of plants rated as follows:
0=No symptoms
1=No stunting; leaves mostly light green with a few yellow streaks
2=Plants slightly stunted; leaves with mixed green and yellow streaks
3=Plants stunted; leaves with severe yellow streaking and a few green streaks or green islands

[b]Each value is the mean of 3 replications, with 3 readings/replicate

[c]Each value is the mean weight of grain harvested from 3, 3.05 m rows of wheat plants

[d]Each value is the mean weight of 3, 100 kernel samples extrapolated to 1000 kernel weight

THE BREEDING AND DEPLOYMENT OF WHEAT VARIETIES WITH LEAF RUST RESISTANCE

DAVID MARSHALL

Breeding wheats with long-lasting leaf rust (caused by *Puccinia recondita* Rob. ex Desm.) resistance is a major goal of the wheat improvement program at the Texas Agricultural Experiment Station. We have sought to incorporate both minor-effect resistance genes (slow-rusting genes), and major-effect genes (*Lr* genes) into high-yielding germplasm. Many of these genes have been crossed into lines that have 'Sturdy' as a recurrent parent because of the durable-nature of the leaf rust resistance in Sturdy. Concurrent with this breeding effort, we have conducted extensive surveys throughout Texas on the virulence structure of the *P. recondita* population (Marshall, 1988 and 1989). The information on virulence has allowed us to determine which *Lr* gene combinations are most apt to be highly effective and durable.

Of equal importance to the breeding of leaf rust resistant wheat varieties is their deployment. We have conducted epidemiological and genetic studies on the spread of leaf rust spores among different wheat varieties. This information has allowed us to develop a simple plan of varietal diversification for Texas wheat producers (Marshall and Sutton, 1989).

References

Marshall, D. 1988. Characteristics of the 1984-85 wheat leaf rust epidemic in central Texas. Plant Disease 72: 239-241.

Marshall, D. 1989. Virulence of *Puccinia recondita* and cultivar relationships in Texas from 1985 to 1987. Plant Disease 73: 306-308.

Marshall, D., and R. L. Sutton. 1989. Choosing a disease resistant wheat variety. TAES Miscel. Pub. (In Press).

1A/1R, PENTOSANS, AND BAKING QUALITY

MERLE SHOGREN

The creation of the hard red winter cultivar Amigo was the work of the late Dr. Emil Sebesta. Amigo involves the translocation of the short arm of the 1R chromosome from rye to the long arm of the 1A chromosome of wheat. Dr. Sebesta's efforts were designed to create resistance to biotype C greenbug. Additional resistance to diseases such as powdery mildew and the mite which carries the wheat streak mosaic virus are exhibited. In regard to baking quality, evidence presented demonstrated that (1) cultivar differences in bake absorption at the same protein level were due in large part to pentosan contents, (2) pentosan content is a heritable trait, and (3) the genetic information to produce higher pentosan contents likely was also transferred from rye to the hard winter wheat Amigo. TAM-107 has exhibited the highest bake absorption of any modern hard winter wheat cultivar and its mixogram curve suggests great tolerance to overmixing, a feature which might reduce tendencies to produce sticky doughs.

Eighteenth Hard Winter Wheat Workers Conference
Dallas, Texas
January 31-February 2, 1989

1A/1R, PENTOSANS, AND BAKING QUALITY

Merle Shogren

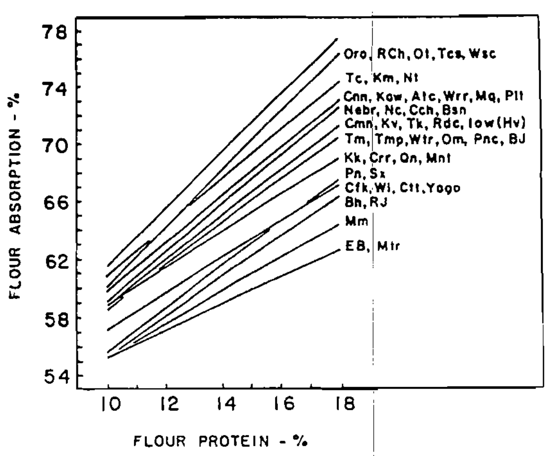
SLIDE 1

FUNCTIONAL PROPERTIES

MILLING	BAKING
Bolting	Flour Protein
Break Flour	Mix Req. & Tol.
Midds Flour	Dough Handling
Total Flour	Water Req.
Hardness	Oxidation Req.
Flour Ash	Loaf Volume
W- to F- Protein	Crumb G & C

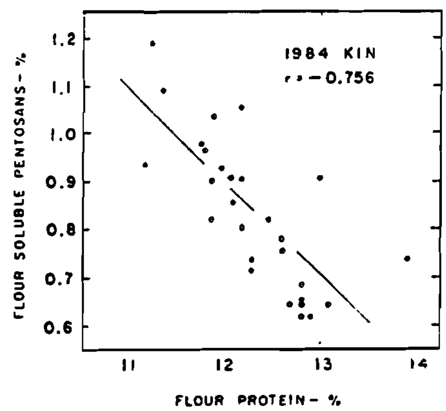
I'm going to start with baking quality and sort of wander around to pentosans and 1A/1R rye translocations. I will comment on the 1B/1R rye translocations and finally share some experiences with you. Flour or baking quality includes several considerations. One that is not emphasized very much or perhaps not enough is baking absorption. I will address that aspect of quality and touch a little bit on mixing and dough handling properties. Most all of these, one way or another, have revolved around protein content.

SLIDE 2



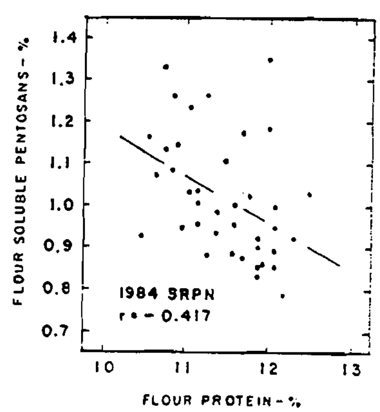
This is some of Karl Finney's early work in which he established absorption versus flour protein content regression curves for a number of cultivars. Since each cultivar curve was established on the basis of many samples, this pretty well states that bake absorption is a heritable trait. The differences in the levels of absorption at a given protein level have largely been attributed to protein quality although it is not new that other factors such as starch damage and pentosan content can be contributing factors. So, when we developed a method for estimating pentosans in grain, it soon became apparent that we had a tool with which to study further the factors affecting bake absorption.

SLIDE 3



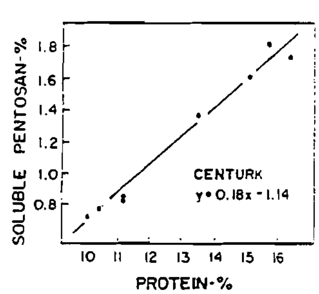
We looked at many grains and grain products. One of the first was the 1984 Kansas Intrastate Nursery (KIN). We have come to relate many of the baking quality parameters to flour protein content but it came as a surprise that the relationship of pentosan to protein content was negative. Note that these are different cultivars.

SLIDE 4



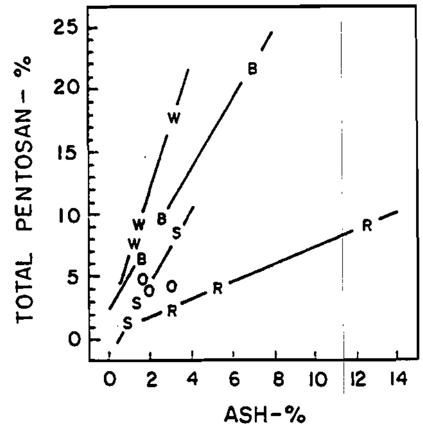
This is the 1984 Southern Regional Performance Nursery (SRPN). The poorer correlation here than with the KIN I would guess is due, in part, to more diversified growing conditions in the SRPN. From that point on though, in general, we found positive relations with pentosan and protein contents. Some examples:

SLIDE 5



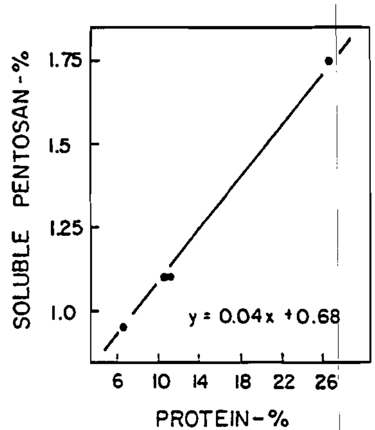
The milling streams of Centurk were combined to give a range of protein contents which resulted in a significant and positive relationship between pentosan and protein contents.

SLIDE 6



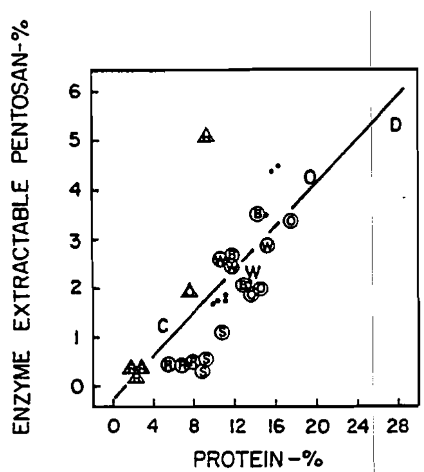
This happens to be total pentosan versus ash contents but the same exists for soluble or enzyme extractable and protein contents. In general, as ash increases, protein content also increases. These are the pearlings, pearled, and unpearled wheat, barley, sorghum, oats, and rice.

SLIDE 7



Here the flour has been fractionated according to particle size by air classification into a range of protein contents. Again we found a positive and good relationship between pentosan and protein contents.

SLIDE 8

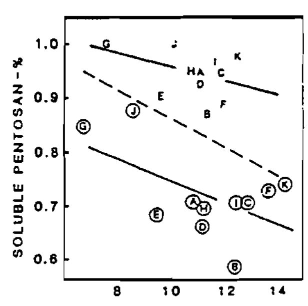


This is an intriguing plot. Pentosans seem to be ubiquitous in cereal grains and the good correlation exhibited here surprised me. The plot includes: whole grains and abraded grains; pearlings of wheat, barley, oats, rice, and sorghum; milling streams of centurk; the commercial milling by-products wheat bran, brewers spent grain, and oat and corn bran; and oat, rice, and soy bean hulls.

Now I am going to back peddle a little to the early 1980's. Somewhere along there we evaluated two cultivars which stand out in my memory, not because they were so good but because they kept appearing in subsequent crosses. One was Amigo with its 1A/1R rye translocation and the grand daddy of that line of cultivars. It was developed to impart biotype C greenbug resistance to winter wheat by the late Emil Sebesta, an ARS cyctogeneticist located at Oklahoma State University. The other was Aurora with its 1B/1R rye translocation and the grand daddy of that line of cultivars. I can't give you any of its history. What stood out about each was that Aurora had very poor baking qualities. Amigo wasn't good but it wasn't as bad as Aurora, if memory serves me correctly. With our office being dismantled and later moved and reassembled, I have been unable to find any original data on the two. The plus I saw in Amigo and its derivatives was their high baking absorption. At the time I didn't know the history of Amigo but when I later did, I made a mental association of the high pentosan content and baking absorption of rye with that of Amigo.

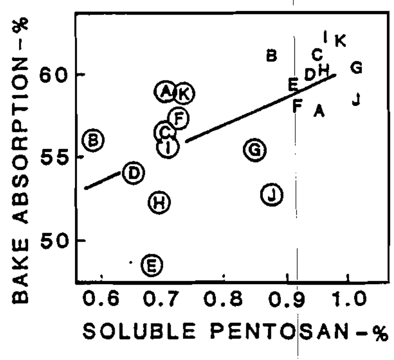
Therefore, I set out to (1) demonstrate that some of the cultivar differences in bake absorption at the same protein content were due to pentosan content, (2) that pentosan content is a heritable trait, and (3) that the genetic information to produce higher pentosan content was also transferred from rye to hard winter wheat.

SLIDE 9



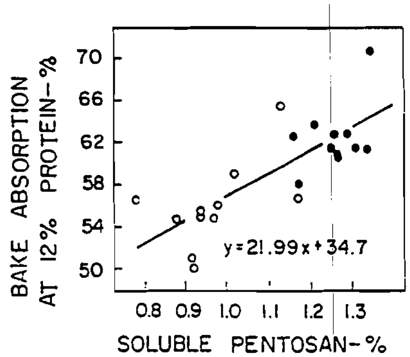
Here we have TAM-107 (uncircled) and TAM-108 (circled) from 1984. Letters represent locations. Kenny Porter was kind enough to supply these samples. With TAM-107 being so high and TAM-108 on the low side (bake absorption) they were naturals for comparison. As you can see, I needed to look at pairs from the same location. If I compared this 107 (B) with this 108 ((J)), I might conclude that they are of the same pentosan content. TAM-107 genetically certainly is higher than TAM-108. Note that TAM-108 has lower protein at the lower protein locations and higher protein contents at the higher protein locations.

SLIDE 10



This plot shows the basic relationship for baking absorption versus soluble pentosan for TAM-107 (uncircled) and TAM-108 (circled).

SLIDE 11



Here I have corrected bake absorption to a constant protein level and thus demonstrate an improved relationship between the two parameters.

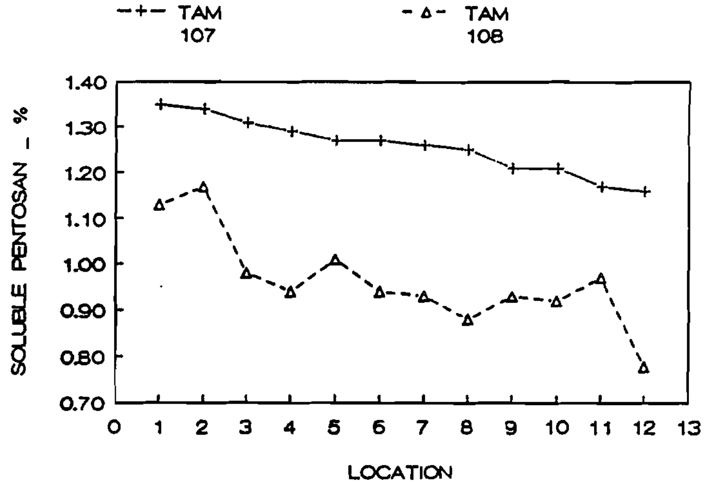
SLIDE 12

Simple and Partial Correlation Coefficients for Baking Absorption vs. Pentosans

	KIN	SRPN
Soluble	0.31	0.46
Soluble·Protein	0.71	0.61

Going back to the earlier slides of the 1984 KIN and SRPN, simple and partial correlation coefficients tell the same story. However, pentosan and protein contents still don't take into account everything contributing to baking absorption. For the time being we can assign protein quality and, perhaps, pentosan quality to most of the remaining baking absorption.

SLIDE 13



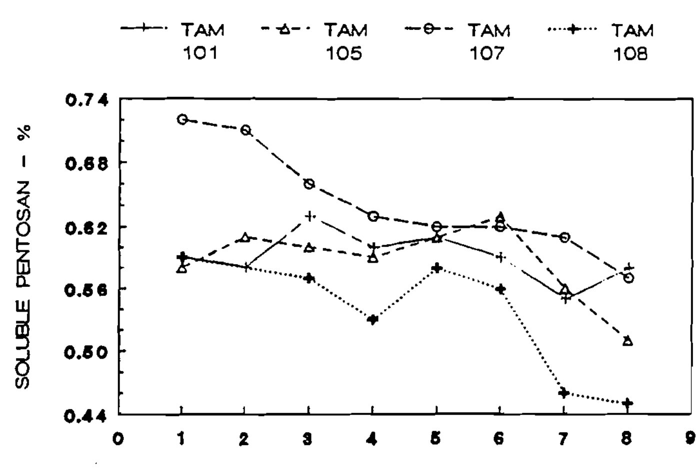
Looking at it yet another was. I have arranged TAM-107 by decreasing pentosan content. I'm convinced that pentosan content is a heritable trait.

SLIDE 14

Cultivar	Pentosan Soluble	Pentosan Total
	%	%
Amigo	1.18	2.04
Payne	0.78	1.77
Payne/Amigo	0.99	2.18
TAM-101	1.04	1.95
TAM-101/Amigo	1.34	2.08
TAM-105	1.05	1.77
TAM-107	1.06	1.86

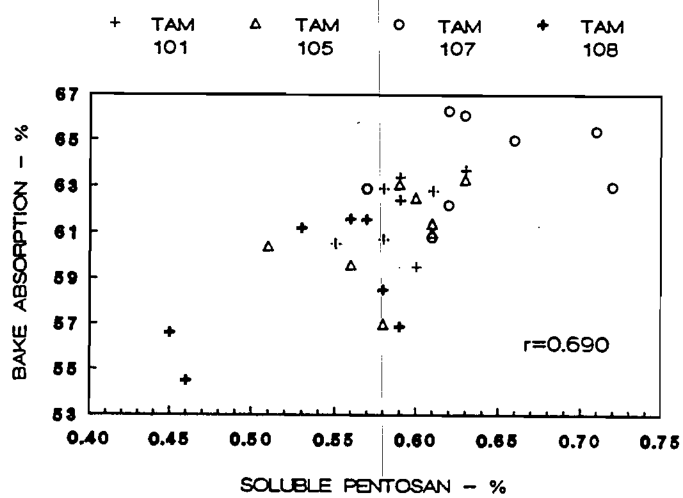
Dr. Sebesta sent me these samples to answer the last question, was genetic information to produce higher levels of pentosans also transferred from rye. Since I already knew TAM-107 to be so high in both pentosan content and baking absorption, I was disappointed in the poor showing in the case of TAM-105 and TAM-107 (TAM-105/Amigo). Therefore I set out to demonstrate that TAM-107 in fact is higher in both.

SLIDE 15



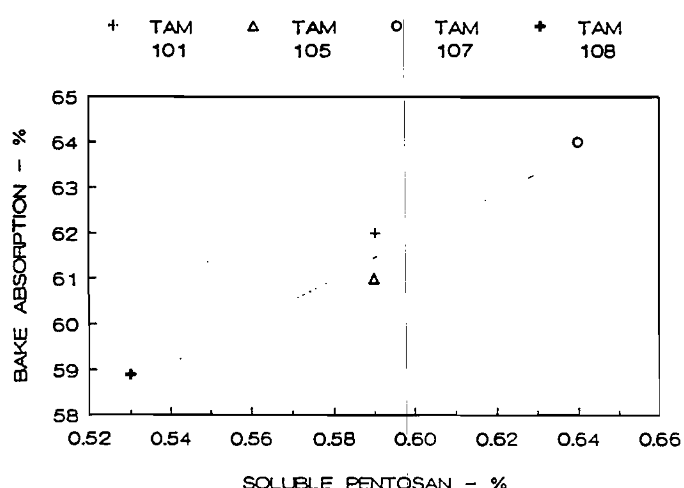
Again Kenny Porter helped me with these four cultivars from locations in Texas in 1985. With two exceptions, TAM-107 is highest in soluble pentosan content.

SLIDE 16



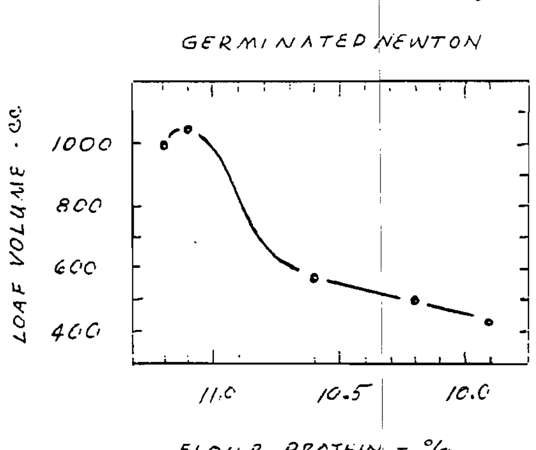
When these were compared in their relationship of bake absorption versus soluble pentosan content I arrived at about the usual correlation. There is some overlapping but otherwise TAM-107 ranks highest and certainly if we were to compare those from the same locations there would be no question.

SLIDE 17



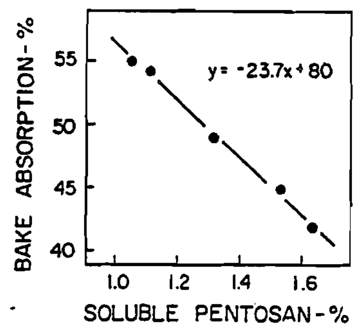
Means of the last slide tell the story.

SLIDE 18



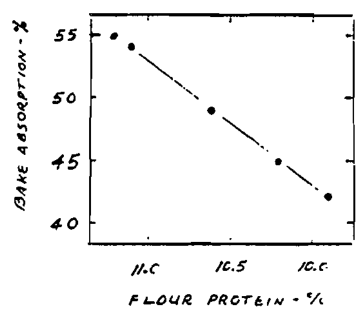
I also germinated Newton wheat for 1, 2, 3, and 4 days. Some interesting results emerged. Although 100 % germination occurred, baking quality improved materially after 1-day germination. I suspect not all wheat would so improve so I don't recommend germination as a means of improving baking quality.

SLIDE 19



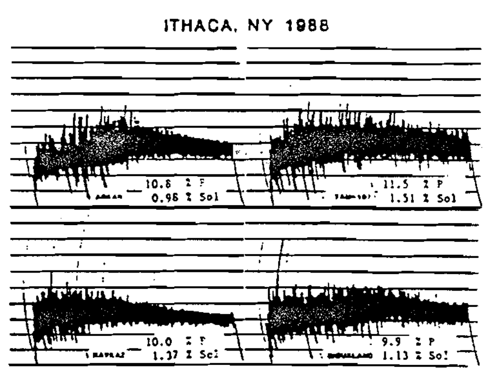
This is a lesson in statistics as well. There can't be much doubt that as insoluble pentosans are converted enzymatically to soluble pentosans during germination, baking absorption decreases. The correlation is very nearly 1.0.

SLIDE 20



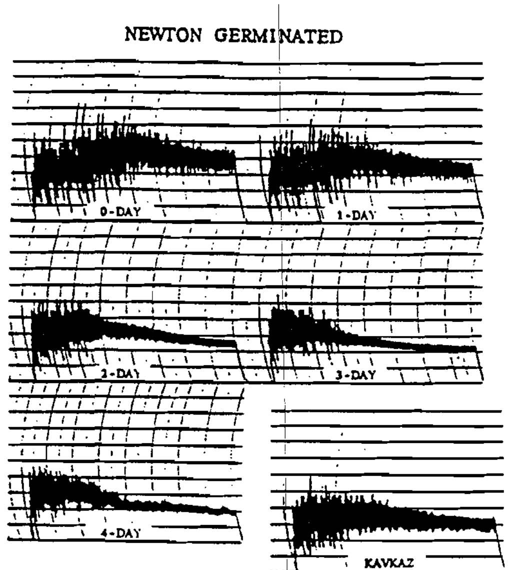
However, the same high correlation exists for the decrease in baking absorption as protein content was decreased during germination. I thought I would throw that in just for kicks. Statistics can work for you!

SLIDE 21



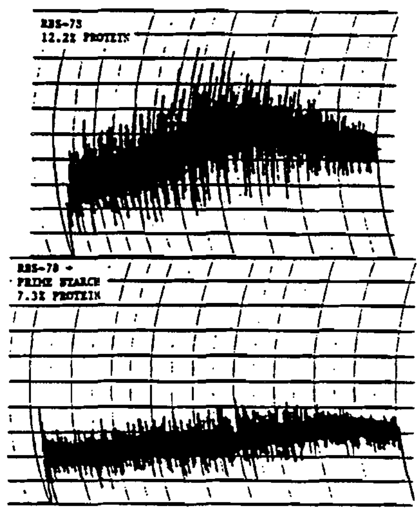
Now for a couple of comments on the 1B/1R translocation. As you have seen, for sound comparisons I needed cultivars from the same environment. In that way I have been a little hampered. From Mark Sorrell's nursery in Ithaca, New York I have representatives of the 1A/1R, 1B/1R, and Arkan with neither. There's TAM-107 on top with 1.51 % soluble pentosan content. Its followed closely by Kavkaz and then Siouxland and Arkan. I want to make a point that TAM-107 is the only cultivar whose mixogram I can recognize and call by name. With higher protein content and among modern cultivars Arkan comes in a close second with its usually sharp peak which is in contrast to TAM-107 with hardly any peak. The TAM-107 physical dough properties strike me as being just the opposite of Aurora and its derivatives. Of course, this Siouxland curve contradicts that idea. But then it had only 9.9 % protein content, the usual consequence of which is a flat curve.

SLIDE 22



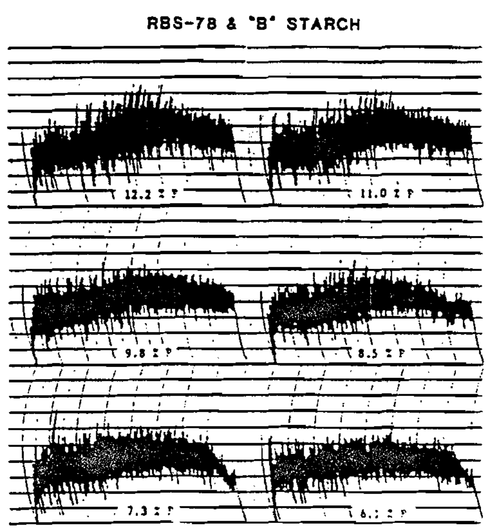
I Include this for a couple of reasons. Its pretty "far out" but I see a similarity between Kavkaz and Newton after two days of germination or perhaps about 1.5 days. Could the sticky dough problem be one of over active enzyme systems? Or, it almost suggests an incomplete synthesis in the endosperm. I have lamented the fact that "sticky doughs" has not been a part of our vocabulary - until this year. The KIN was divided into two parts: Eastern and Western Kansas and this year included a couple of possible 1B/1R translocations so it was a complete surprise to find virtually all the eastern samples to be sticky. It was an unusual year in that harvest was very early due to early hot weather. We are seeing protein contents as high as 18 %. We are seeing a lot of color and unheard of bake mixing times (as long as 15 minutes). I point out also the squiggly tail of the 4-day germinated Newton. When that happens, dough hangs up on the bowl sides, then gets picked up by the bulk of the dough. The process repeats itself.

SLIDE 23

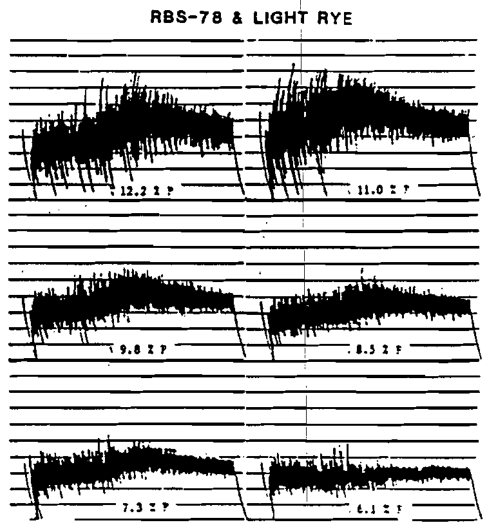


Here is a blend of hard winter wheats which I have diluted with prime starch. Thats the almost pure large starch granule. The diluted flour produced a curve typical of a low protein flour. The same curve resulted when diluted with rice flour.

SLIDE 24

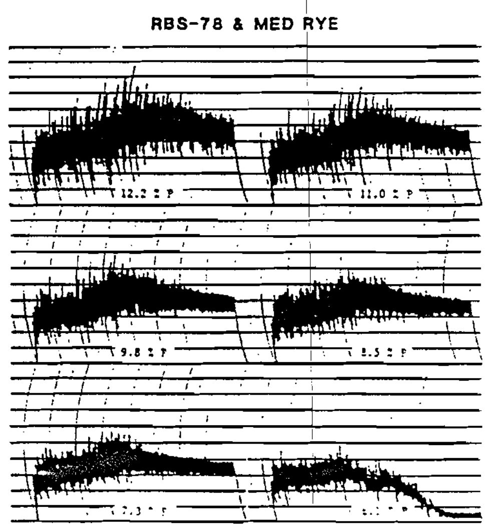


Here the flour has been diluted with starch "B", the small and damaged starch granules. You see the squiggly tail at the greater dilutions. I see a similarity between some of these curves and those of TAM-107 i.e. no sharp peaks but flat.



SLIDE 25

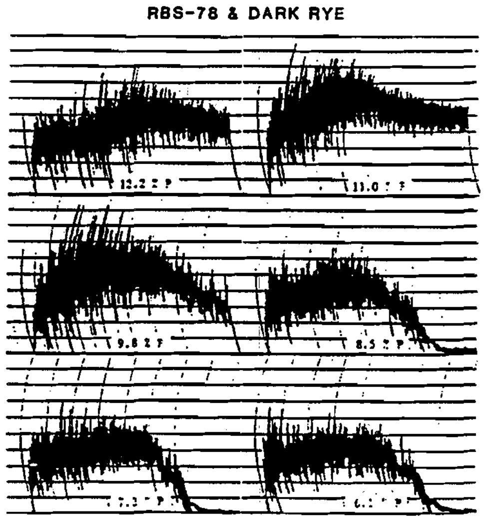
Here the flour has been diluted with light rye flour. The common ingredient causing the squiggly tail is pentosan content.



SLIDE 26

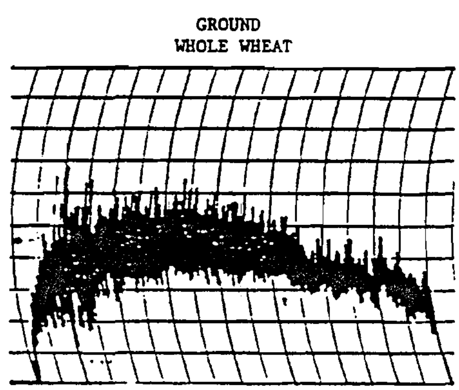
Here the flour has been diluted with medium rye flour. The squiggly tail is more pronounced than before.

SLIDE 27



- Dilution has been with dark rye flour. From light to dark rye means greater extraction during milling which, in turn, means higher pentosan content. The higher the pentosan content, the more squiggly the mixogram tail. I think that it will occur with lesser amounts of pentosan containing material the lower the flour protein content.

SLIDE 26



Finally, this is fairly typical of a whole ground wheat mixogram. And, of course, the bran is high in pentosan content. Since the sticky dough seems to me to be associated with absorption, or rate of absorption, I am thinking out loud if there might be a connection. So far I can't resolve it but perhaps it might give someone some idea.

APPARENT CAUSE OF DOUGH STICKINESS
PRELIMINARY REPORT

D. E. ROGERS AND R. C. HOSENEY

During the last few years there has been much discussion about the fact that many wheats having a 1B/1R translocation produce breed doughs that are sticky. Preliminary work in our laboratory has shown that not all samples of lines having the translocation are sticky. With samples of the cultivar Siouxland, we have found about half show the sticky character an the other half do not. Additional preliminary work appears to agree with the results reported from Germany that a small carbohydrate appeared to be involved in the sticky character.

A major factor slowing the work, in addition to a lack of funding, is the lack of a definitive method to measure stickiness. Any method that depends upon a subjective determination can always be debated. Also, it is difficult to mark progress if a number cannot be assigned to the results. Therefore, our first priority is to develop a method to measure stickiness. We are using the Instron Universal Testing Machine, and several different attachments. The method(s) developed will be used to confirm our preliminary work with the carbohydrates.

Our ultimate goal is to determine what causes stickiness. It is our assumption that if we understand what causes stickiness, we will then be able to either suggest a technique to stop the stickiness or to be able to develop a test to identify those lines that are subject to producing sticky doughs.

THE IMPORTANCE OF DOUGH RHEOLOGY AND 1B1R TO THE MODERN COMMERCIAL BAKERY

MARK STEARNS

The sponge and dough process takes about seven to eight hours from the mixing of the sponge to slicing and wrapping of the bread. A modern commercial bakery can easily have over 60,000 potential loaves of bread in the baking process before the first loaf is completed and wrapped. Dough rheology plays a very important role in almost every phase of the baking process. The commercial bakery is designed and reliant on having consistent rheological dough properties each time bread is produced. Unexpected rheological problems reduce production efficiency, consumer acceptance, and profits for the commercial baker. The commercial baker is concerned with reports of varieties with the 1B1R translocation producing unmanageable sticky and weak doughs. More information on the extent of the problem, the cause of the problem, and rheological methodology for screening is needed. This germplasm is already finding its way to the marketplace. We must all work together to resolve our questions about 1B1R and formulate a workable response to minimize any problems.

A STUDY ON SIOUXLAND QUALITY CHARACTERISTICS

P. J. MATTERN

Siouxland, PI 483469, a 'Warrior'*5/'Agent'//'Kavkaz' to Warrior *5/Agent line was named and released jointly in 1984 by the Nebraska and Texas Agricultural Experiment Station and the USDA-ARS. Kavkaz provided a 1B/1R translocation which gave excellent disease protection.

About this same time Australia withdrew a cultivar for release which contained the 1B/1R translocation because so called "sticky doughs" developed with overmixing. Siouxland with a moderately long mixing time would be expected to have improved mixing tolerance over the shorter mixing Australian cultivar.

Kavkaz and a sister line Aurora were tested in the 1975 International Winter Wheat Performance Nursery (IWWPN). These lines, as well as Siouxland, have a reduced mixing tolerance as evaluated by mixograms. The baking performance is only average and usually below that of typical HRWW grown in the Great Plains areas. Russian authors (1) reported that Kavkaz and Aurora exhibited more quality variation than other Russian cultivars.

Examination of mixing curves of Siouxland from Texas and Nebraska, over several years, indicated wide variation, but there was no statistical comparison against check cultivars. Baking results of Nebraska grown Siouxland also appeared to be more variable than check varieties, but again no statistical measures were used. An unusual environmental effect was a strong "over-oxidized" characteristic with a straight dough although no oxidizing agents were used.

In a recent Australian paper (2) Dhaliwal, et al., reported that 1B/1R lines had more water-soluble protein due to the presence of the rye secalin proteins, which are more water soluble than their wheat gliadin counterparts.

To test the Dhaliwal report, samples of a number of Kavkaz-Agent derived lines and controls were extracted with 0.5M NaCl solution at a 1-10 (flour-salt water) concentration for one hour. Samples were centrifuged 15 minutes at 5000 X g and the proteins in the supernatants were determined by a biuret procedure which was standardized against the Kjeldahl method. Samples were originally weighed to contain 65 mg of protein at 14% M.B. Table 1 reports the 0.5M NaCl soluble protein data in comparison to certain quality factors. The soluble protein is given as a percentage of total flour protein. Samples of Siouxland and those with less mixing tolerance had higher salt soluble proteins. One exception was Lancota. A partial explanation is that higher protein samples have less mixing tolerance when evaluated with the mixograph.

Loaf volumes were not always adversely affected when the salt-solubles were high. However, this quick test may prove to be useful to identify lines which have a potential to produce sticky doughs.

A 12% protein (14% M.B.) flour from Siouxland wheat milled on the KSU mill was distributed to bakery and mill laboratories requesting it. One bakery laboratory found no problem, others generally complained of weak and sticky doughs.

Table 1. 0.5M NaCl flour solubles vs quality data for Kavkaz-Agent derivatives and checks.

Selection	Flour protein %	NaCl sol. protein %	Mixing Time min.	Mixing Tol.	Loaf volume cc
Redland	12.7	14.1	5.5	4-	915
Siouxland	12.0	17.3	4.3	3-	955
Lancota	14.5	11.2	3.3	2+	900
NE86494	10.7	14.2	4.7	4-	945
NE86527	11.2	16.8	3.3	2	875
NE83498	11.8	13.9	5.7	4+	870
NE85707	13.3	16.0	5.7	2+	850
OK83396	11.0	17.5	3.7	2	940
NE86487	11.0	17.5	4.0	3-	905
NE86488	10.7	16.3	4.3	3-	885

References

1. Prutskova, M. G. and Ukhanova, O. I. 1972. New varieties of winter wheat. Kolos Publishing Co., Moscow. Translated by USDA-ARS and republished 1976 by the Amerind Publishing Co., New Delhi, India.

2. Dhaliwal, A. S., Mares, D. J., Marshall, D. R., and Skerritt, J. H. 1988. Protein composition and pentosan content in relation to dough stickiness of 1B/1R translocation wheats. Cereal Chem. 65(2):143-149.

RELATIONSHIPS BETWEEN PROTEIN SOLUBILITY PARAMETERS, 1B/1R, AND BAKING QUALITY

ROBERT GRAYBOSCH, VERN HANSEN AND C. JAMES PETERSON

Wheat varieties carrying 1B/1R translocations have been reported to be deficient in baking quality characteristics. Dhaliwal et al. (1988) found that 1B/1R lines had a higher proportion of water soluble proteins than isochromosomic lines that lacked 1B/1R. It was suggested that the greater water solubility of rye secalins (seed storage proteins) encoded by genes on 1RS might be related to the phenomenon of dough "stickiness" associated with 1B/1R-containing lines. The objectives of this study were as follows: 1) Do water soluble protein concentrations correlate with dough stickiness (as estimated from mixing tolerance scores) or other baking quality parameters? 2) Can lines containing 1B/1R be identified by the level of water soluble proteins? and 3) Can mixing and baking properties of high protein germplasm be related to variability in classes of proteins.

The wheat lines selected for study consisted of 27 lines from the 1987 Nebraska High Protein Nursery (HPN) and 44 lines from the 1987 Lincoln Elite Nursery (LEN). Entries in the HPN previously had been selected on the basis of protein content and baking quality, and had a low probability of containing 1B/1R (based on pedigrees). The lines in the LEN had been selected only on the basis of grain protein content with no selection for optimal baking quality attributes. Also, entries in the LEN had a higher probability of containing 1B/1R. Proteins were fractionated into three solubility classes by sequential extractions of 100 mg samples of ground wheat with 0.04 M NaCl, 70% ethanol, and 0.1% KOH. The NaCl fraction in this study is considered to be equivalent to the sum of the water and salt soluble classes of Dhaliwal et al. (1988). Protein content of each fraction was determined by use of the bicinchoninic acid (BCA) reaction. Protein in each fraction was expressed as percentages of total protein extracted. We have found that 1B/1R lines can be identified by the presence of a 40 kD protein that is soluble in 0.4 M NaCl. At the time of this presentation, 20 lines in the LEN had been screened for the presence or absence of this protein (and 1B/1R) by SDS-PAGE analysis and silver staining of proteins.

The two nurseries both were grown at Lincoln, Nebraska in 1987-88. However, the entries in each nursery were quite different in both baking quality (Table 1) and protein solubility (Table 2) parameters. The percentages of proteins solubilized by 0.4 M NaCl were much higher in the HPN, even though few of these lines contained 1B/1R. Correlations between baking quality parameters and protein solubilities are given in Table 3. In the HPN, there were no significant correlations between the solubility in 0.04 M NaCl and any of the measured quality parameters. However, in the LEN, the amount of protein in the NaCl fraction was negatively correlated with mixograph times and tolerances, farinograph absorption and peak, and positively correlated with farinograph tolerance. In both nurseries, the amount of protein soluble in 70% ethanol was positively correlated with flour protein and absorption. The KOH fraction was positively correlated with loaf volume in both nurseries, and positively correlated with mixing times and tolerances in the LEN. The differences in the correlations between baking quality parameters and the amount of protein soluble in 0.04 M NaCl in these two nurseries might be due to either a higher frequency of 1B/1R-containing lines in the LEN, or, to lower variability for both baking quality and protein solubility parameters in the HPN.

Twenty entries in the LEN were screened for the presence of the 40 kD secalin present in 0.04 M NaCl extracts. This protein is found in the 1B/1R-containing varieties Kavkaz and Siouxland, and is absent from lines in which 1B/1R does not occur (Brule, Plainsman V, Lancota). Results are given in Table 5, along with the percentage of protein extracted by 0.04 M NaCl, and mixograph results. From the table it is seen that high levels of NaCl-soluble proteins do not necessarily indicate the presence of 1B/1R. However, within segregating populations, or in comparisons of sister lines, it may. For example, the lines 86L085, 86L090 and 86L096 are sister lines. 86L085 lacks 1B/1R and has significantly lower amounts on NaCl soluble proteins than its sister lines, both of which contain 1B/1R. It should also be noted that two lines with good mixing tolerance scores contain 1B/1R. However, data from a previous study has indicated that the mixing tolerances of these lines are variable and in some cases, poorer than those achieved in the 1987 LEN.

Thus, we conclude that high levels of salt soluble proteins are not correlated with diminished dough handling properties across all varieties, nor are high levels of salt soluble proteins indicative of 1B/1R over all varieties. In populations segregating for 1B/1R, high levels of proteins soluble in 0.04 M NaCl likely correlate with the presence of 1B/1R. The variation in protein solubilities identified shows some relationships to quality parameters. However, it is likely that the quality of the protein within each fraction is more important than the quantity. Future plans are to complete the screening of all 71 lines for the presence of 1B/1R in order to substantiate the possible link between the 40 kD secalin and diminished mixing tolerances.

Reference

Dhaliwal, A. S., D. J. Mares, D. R. Marshall, and J. H. Skerritt. 1988. Protein composition and pentosan content in relation to dough stickiness of 1B/1R translocation wheats. Cereal Chemistry 65: 143-149.

Table 1. Ranges in baking quality parameters in the 1987 High Protein Nursery (87 HPN) and in the 1987 Lincoln Elite Nursery.

	87 HPN		87 Elite	
	Mean	Range	Mean	Range
Wheat Protein %	17.0	13.9 - 19.1	15.5	12.6 - 17.5
Flour Protein %	15.0	12.3 - 16.9	13.6	11.2 - 16.1
Hardness (NIR)	78.6	43.5 - 95.6	63.5	44.8 - 83.1
Mixing Time (min)	5.3	2.3 - 10.7	3.8	0.7 - 7.0
Mix Tolerance (min)	3.2	1.0 - 4.8	3.3	0.0 - 5.5
Absorption %	64.1	57.1 - 67.8	58.8	51.6 - 63.7
Loaf Volume (cc)	831	734 - 1059	892	492 - 1062
Farinograph Peak (min)	11.6	5.0 - 23.0	8.7	1.5 - 19.0
Farinograph MTI	22.8	10.0 - 50.0	44.5	10.0 - 170.

Table 2. Protein solubility characteristics of lines entered in the 1987 HPN and 1987 LEN. Values are given as percentages of total extracted protein.

	87 HPN		87 Elite	
Extraction	Mean	Range	Mean	Range
NaCl	34.7	27.7 - 40.9	27.7	18.6 - 40.5
Ethanol	22.1	12.4 - 28.0	23.2	13.6 - 35.3
KOH	43.2	37.6 - 54.3	49.5	40.7 - 59.7

Table 3. Correlations between protein solubility parameters and baking quality characteristics in the 1987 HPN and 1987 LEN.

1987 HIGH PROTEIN NURSERY

Extraction (% Protein)	Flour Protein	Mix Time	Mix Tol.	Loaf Vol.	Absorption	Farinogr. Peak	Farinogr. MTI
NaCl	-0.27	0.08	0.07	0.14	-0.34	0.05	0.16
Ethanol	0.59**	0.11	-0.02	-0.60**	0.50**	0.23	0.11
KOH	-0.25	-0.17	-0.04	0.47**	-0.20	-0.26	-0.23
NaCl/KOH	0.04	0.14	0.07	-0.21	-0.08	0.17	0.24
Ethanol/KOH	0.58**	0.14	-0.01	-0.12	0.47**	0.26	0.17

1987 LINCOLN ELITE NURSERY

Extraction (% Protein)	Flour Protein	Mix Time	Mix Tol.	Loaf Vol.	Absorption	Farinogr. Peak	Farinogr. MTI
NaCl	-0.35	-0.39**	-0.35*	-0.09	-0.33*	-0.62**	0.38*
Ethanol	0.52**	0.05	-0.02	-0.26	0.42**	0.41*	-0.11
KOH	-0.24	0.36*	0.41**	0.40**	-0.14	0.19	-0.29
NaCl/KOH	-0.21	-0.45**	-0.44**	-0.21	-0.23	-0.57**	0.42**
Ethanol/KOH	-0.47**	-0.08	-0.15	-0.31*	-0.35*	0.26	0.01

Table 4. Protein solubility characteristics, mixograph scores, and presence/absence of 1B/1R in 20 lines from the 1987 LEN.

Selection	NaCl Sol. Protein	Mixing Time	Mixing Tol.	1B/1R
	%	-- min --		
Redland	26.8	4.33	3.75	-
Colt	25.6	2.75	3.5	-
Siouxland	35.0	3.67	2.75	+
N86L011	51.5	1.75	2.0	-
N86L016	32.6	1.75	1.5	-
N86L021	32.7	2.5	3.0	-
N86L022	28.7	5.25	3.5	-
N86L023	33.5	2.33	3.0	-
N86L031	33.9	4.5	3.5	+
N86L040	32.7	3.5	4.0	+
N86L044	24.7	3.5	3.75	-
N86L050	31.8	3.67	4.0	-
N86L053	32.6	6.0	4.75	-
N86L075	28.2	2.75	3.0	-
N86L076	24.3	3.75	3.5	-
N86L085	27.8	3.5	4.5	-
N86L090	37.3	0.67	0.0	+
N86L096	37.0	3.0	2.5	+
N86L165	27.4	3.75	3.75	-
N86L177	21.3	7.0	4.75	-

MARKET CLASSIFICATION OF HARD WHITE WHEAT

ROBERT K. BEQUETTE

Classification of Hard White Wheat breaks down into 3 subjects which relate to FGIS Standards for White Wheat and which will influence breeding procedures:

1. FGIS White Wheat classification system.
2. Hardness testing procedures adopted by FGIS.
3. Determination of kernel color.

FGIS White Wheat Classification System.

There is no provision for true hard endosperm white wheat in the current U.S. Grain Standards. Presently, Hard White and Soft White are subclasses of the class White Wheat. If a sample has less than 74% vitreous (not chalky) kernels, it is classed Soft White. Samples having 75% or more vitreous kernels are classed Hard White.

Apparently, the subclass Hard White was originally established to identify soft endosperm white wheats which had a high percentage of vitreous kernels, and consequently might have higher protein content or be suitable for special applications such as puffed breakfast cereal.

Vitreous soft endosperm wheats appear to be hard but have the functional milling and flour properties of soft wheat and are not suitable for most hard wheat applications.

Most of you know that weathered hard wheats, or hard wheats with yellowberry (chalky) kernels, are sometimes graded Soft but still retain hard wheat milling and flour properties which make them unsuitable for most soft wheat uses.

The staff of the KSU Grain Science Dept. served as consultants to the Kansas Wheat Commission and the Hard White Wheat Classification Subcommittee of U.S. Wheat Associates. This subcommittee developed a proposal for revising the White Wheat classification system. This proposal was presented to the administrative staff of the Federal Grain Inspection Service on December 1, 1988.

Briefly, we proposed that FGIS:

1. Define Hard White and Soft White as separate market classes instead of subclasses.

2. Define Soft White, White Club and Western White as subclasses of the class Soft White.

3. Distinguish between Hard White and Soft White on the basis of NIR and/or single kernel hardness tests they adopt for red wheats: or by distinct external varietal kernel features.

4. Treat all other wheats as Contrasting Classes when mixed with Hard White wheat.

5. Treat Hard White as a Contrasting Class when mixed with Soft White.

6. Maintain Grade determinations for White Wheat as presently given in the FGIS Grain Inspection Handbook.

FGIS has made two minor changes in our proposal. They would like to use the subclass name Common White instead of Soft White. This makes sense. Because FGIS has not finalized hardness testing equipment and procedures, and because only a few Hard White varieties are being produced or considered for release, they will use visible kernel features to distinguish the Hard White varieties.

FGIS plans to publish proposed revisions of the White Wheat standards in the Federal Register in early February. They will then accept public comment for 60 days. They hope to adopt the revised standards by early May 1989. Normally there is a one year waiting period between adoption and implementation of revised standards. FGIS expected California interests to press for speeding up the process, or for implementation of "interim" or temporary procedures.

<u>Hardness Testing</u>

Reliable single kernel and bulk hardness tests will be essential if Hard White wheat is grown in areas where Soft White wheat is produced, or if Hard White is moved through an area where Soft White is produced or marketed.

Substantial quantities of wheat produced in Northwest Kansas, the Nebraska Panhandle and Colorado is now exported from the port at Portland, Oregon. If Hard White wheat becomes a significant crop in Northwest Kansas, the Nebraska Panhandle or Colorado, there will be many opportunities for accidental or intentional mixing of Hard White and Soft White at Portland terminals and port facilities.

Data I have seen for the FGIS hardness studies indicate that Pacific Northwest Soft White wheat is harder than Soft Red Winter wheat. The Norris acoustic single kernel hardness test shows Soft White as being much harder than Soft Red Winter and having a greater overlap with Hard Red Winter.

Regardless of the hardness testing procedures finally adopted by FGIS, it seems advisable for Hard White breeders to discard lines which have hardness values below the average for Hard Red Winter varieties. I would suggest hardness in the Newton - Eagle range is about right for Hard White varieties.

Lines softer than Newton could often be difficult to distinguish from Soft White on the basis of hardness tests. The Triumph - Chisholm hardness level is definitely too soft for Hard White varieties.

I hasten to remind you that excessive hardness will result in milling and flour performance problems.

The hardness ranges I have suggested for Hard White are equally applicable to Hard Red Winter wheat.

A narrow range of hardness within and between varieties will be important in all classes of wheat when FGIS implements hardness testing as a part of wheat classification (see references).

Kernel Color

Breeders must select white wheats which are truly white. I am not an expert on evaluating kernel color but I am sure that growing conditions, weathering, disease and other factors influence bran color. An Australian publication on variety identification states that "the distinction in bran colour can be difficult when it is masked by differences in endosperm texture."

Vitreous white wheat - regardless of actual hardness - is amber like good durum wheat. Non-vitreous or chalky white wheat has an opaque white color.

It appears that bran color is like many other factors breeders measure. Data for several locations and years is needed for an accurate characterization.

You should avoid white wheats which normally have a reddish or pinkish tint or tend to be "brown". Omar, an old PNW White Club variety, usually had a pink tint and many people called it red.

There are staining tests to distinguish red and white wheats. However, if you normally need a staining test to show that your line is white (or red), then it does not have a distinct color and probably will cause marketing problems.

Staining Test to Differentiate Red and White Wheat

This procedure visually differentiates White Wheats from Red Wheats in 5 minutes. It is not an official FGIS test, but should be useful to plant breeders, grain elevators and farmers.

This test is a slight modification of the FGIS Sorghum Germ Damage Test. The S/J Systems Co. mixer used in the Sorghum test should not be used for wheat because it peels bran from the wheat kernels causing red wheats to appear white.

Chemicals and Equipment Required

1. Potassium hydroxide (KOH) pellets (Lab supply company or pharmacy).
2. Clorox or other liquid household bleach containing 5.25% sodium hypochlorite by weight.
3. 250 ml glass beakers or wide mouth 1/2 pint jars.
4. Strainer with handle (grocery or variety store).
5. Glass or plastic rod or spoon for stirring.
6. Balance or 1-teaspoon plastic measure for KOH pellets.
7. Balance or 1-tablespoon plastic measure for grain.
8. 50 ml graduated cylinder or 1/4 cup plastic measure with handle to measure bleach.

Procedure

1. Place 15 grams (1 tablespoon) grain in beaker or jar.

2. Add 15 grams (2 heaping teaspoons) KOH pellets.

3. Add 40 ml (1/4 cup) bleach.

4. Stir to dissolve KOH pellets and thoroughly wet kernels.

5. Allow to stand for 5 minutes with occasional stirring.

   Caution: Reaction rate decreases rapidly as temperature decreases. Room, grain and equipment should be 70°F or warmer.

6. Hold strainer over sink or waster receptacle, swirl beaker containing grain and pour grain into strainer.

7. Rinse grain with warm tap water.

8. Spread grain on paper towels for examination.

   White wheat will appear light straw color.
   Red wheat will be dark red (brick red, brown).

Cautions: Fusarium (scab) will cause white wheat kernels to stain dark red like red wheat. Differentiation is reduced when air dried tests samples are stored.

Selected References

American Association of Cereal Chemists. Approved methods. Wheat hardness as determined by near-infrared reflectance (NIR). Method 39-70 revised 11-4-87. Bulk-sample procedure being considered by FGIS. Calibration samples available from FGIS, USDA, P. O. Box 20285, Kansas City, MO 64195.

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REGIONAL BUSINESS MEETING

Hard Red Winter Wheat Improvement Committee
February 2, 1989
Dallas, Texas

MINUTES

The meeting was called to order by Chairman Sears at 8:30 a.m. Committee member in attendance were:

R. Bruns, NAPB, CO
*A. Guthrie, Cargill, CO
D. Johnston, Cargill, CO
*S. Perry, Cargill, CO
J. S. Quick, CO
*J. Baker, Pioneer, KS
S. Cox, ARS, KS
J. R. Erickson, HybriTech, KS
R. G. Sears, KS
G. A. Taylor, MT
*R. A. Graybosch, ARS, NE
P. J. Mattern, NE
C. J. Peterson, ARS, NE
F. J. Gough, ARS, OK
*R. M. Hunger, OK
E. L. Smith, OK
*J. A. Webster, ARS, OK
J. L. Gellner, SD
E. C. Gilmore, TX
D. S. Marshall, TX
*P. Sebesta, TX
N. A. Tuleen, TX
*R. Ward, Pioneer, TX
W. D. Worrall, TX

Committee members not present:

*B. Cooper, NAPB, CO
J. W. Echols, CO
J. P. Hill, CO
J. A. Morgan, CO
J. F. Shanahan, CO
R. E. Atkins, IA
*M. Iwig, Pioneer, IA
L. E. Browder, ARS, KS
B. S. Gill, KS
J. H. Hatchett, ARS, KS
C. Hayward, Pioneer, KS
W. J. Hoover, KS
S. L. Kuhr, HybriTech, KS
T. J. Martin, KS
G. M. Paulsen, KS
D. Seifers, KS
A. L. Scharen, ARS, MT
E. L. Sharp, MT
V. R. Stewart, MT
*P. S. Baenziger, NE
*R. French, ARS, NE
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J. E. Watkins, NE
N. Christensen, NM
D. J. Cox, ND
*B. Carver, OK
*A. Guenzi, OK
*R. L. Westerman, OK
*B. Jordan, Pioneer, TX
J. Michels, TX
H. Nguyen, TX
K. B. Porter, TX
R. W. Toler, TX
*J. Krall, WY

* New members

Members voted to approve minutes of the last meeting held at Manhattan, KS on February 24-28, 1986 and dispense with reading of the minutes. The minutes are printed in the Proceedings of the Seventeenth Hard Red Winter Wheat Workers Conference, February 24-28, 1986, Manhattan, KS.

W. D. Worrall was elected Chairman of the Hard Red Winter Wheat Improvement Committee. Rob Bruns and Stan Cox were elected representatives to the National Wheat Improvement Committee. They, together with the Chairman and Secretary, will represent the Hard Red Winter Wheat Region on the National Committee.

Regional Nurseries

SRPN -- A motion to replace the check variety TAM-105 with TAM-107 and retain check varieties Kharkof and Scout 66 was passed. Maximum number of entries will remain at 45.

NRPN -- Maximum number of entries (45) and check varieties Kharkof, Roughrider, and Colt to remain the same.

UWHN -- (Southern and Northern Sections) -- Check varieties will remain and maximum number of entries for each section will remain at 300. Warrior, Scout 66, and Vona are currently used as checks in the Southern Section and Warrior, Centurk 78, and Norstar in the Northern Section.

Soil borne Mosaic Nursery -- Check varieties Pawnee, Bison, and Concho will remain and maximum entries remain at 200.

Cooperating states and companies are not limited to a specified maximum number of entries in the SRPN or NRPN; rather they are instructed to prioritize candidate entries to provide guidance to the regional coordinator in the event that the total number of candidate varieties exceeds the nursery limit.

Seed requirements for the regional nurseries are currently 15 lb/entry in the SRPN; 11 lb/entry in NRPN; 120 gm/entry in UWHN; and 80 gm/entry in the Soilborne Mosaic Nursery. Seed is to be untreated. Seed of check varieties are increased and distributed with new entries each year from Lincoln, NE. The current format of the Regional Report is to be retained.

Quality Analyses of Regional Nursery Entries

A motion was passed to begin using samples from the SRPN to serve as composites for small scale mill and bake testing by the Wheat Quality Council. Cooperators will provide as much seed as possible of all first and second year entries from the SRPN trials which are potential candidates for testing by the Wheat Quality Council. Seed of first year entries will be composited and stored at the USDA-ARS Grain Market Research Laboratory, Manhattan, KS, then composited with seed from the second years tests prior to analyses. Entries that have completed two years of SRPN testing will be eligible for entry into the Quality Council tests. SRPN entries will be forwarded to the Quality Council tests only at the request of the originating breeder. The plan is to obtain approximately 2 bushels of seed for quality testing. Nursery cooperators are to determine if seed from a particular location is of adequate quality (i.e. adequate test weight and soundness) to submit for quality evaluations. The regional coordinator will provide appropriate lists to cooperators to identify potential candidates for small scale milling and baking and request seed for shipment to the Grain Marketing Research Laboratory.

A motion was passed to exclude samples of Kharkof from the Quality Council tests and to replace TAM-105 with TAM-107 as a check in the SRPN to cover needed check comparisons both in terms of performance and quality.

Quality testing of the SRPN entries by the USDA-ARS Grain Marketing Laboratory will continue as in the past on one lb samples of all nursery entries from each location. Breeders that do not wish to participate in

Quality Council testing of SRPN entries may submit two bushel samples of experimental cultivars and checks to the Council for evaluation as in the past.

Germplasm Exchanges with the CIMMYT Winter Wheat Program

As regional coordinator, C. J. Peterson has been helping to coordinate germplasm exchanges with the cooperative winter wheat research programs of CIMMYT and the National Wheat Improvement Program of Turkey. Each year, entries in the SRPN and NRPN are shipped from Lincoln, NE to the CIMMYT program in Ankara, Turkey with prior approval of the originating breeders. In exchange, seed of the International Winter Wheat Screening Nursery (IWWSN) from Turkey is provided to Dr. Peterson. The IWWSN is grown in Yuma, AZ under quarantine increase then distributed from Lincoln, NE the following summer to interested breeding programs. It was the consensus of the committee that the exchanges were of significant mutual benefit and should be continued in this manner until such time that quarantine restrictions are lifted on materials originating from Turkey. It was also considered appropriate and useful to have Dr. Peterson obtain data and summarize results of the U.S. IWWSN trials for distribution to U.S. programs and CIMMYT. Members of the committee also expressed interest in obtaining seed of lines entered in the CIMMYT International Spring Wheat Yield Nursery (ISWYN) originating from Mexico. Dr. Peterson will proceed with attempts to obtain seed of the ISWYN for quarantine increase in Arizona and subsequent distribution to U.S. programs. Funds may need to be solicited to cover costs of the increases depending on size of the respective nurseries.

Russian Wheat Aphid Evaluations

J. S. Quick reported on an evening discussion of wheat researchers working on evaluation of Russian Wheat Aphid damage in cereals. The group agreed on a common rating scale for evaluation of Russian Wheat Aphid feeding damage on seedlings. A two factor scale will be employed. A 0-9 rating scale is to be used for measuring leaf chlorosis or streaking with a 9 indicative of seedling death. A 1-3 scale is to be used for measuring leaf rolling with 1 = flat, 2 = folded, and 3 = rolled. The group agreed to put together a uniform seedling screening nursery of 24 entries to be tested by all researchers currently working on seedling screening. The objective is to compare and standardize testing methodologies and determine possible biotype variation in the Russian Wheat Aphid across the country.

Site of Next Wheat Breeders Field Day

An invitation from E. L. Smith to hold the 1989 Wheat Breeders Field Day at Stillwater, OK sometime in late May was accepted.

Site of Next Regional Conference

An invitation to hold the 1992 Regional Conference at Bozeman, MT was tentatively accepted. A motion was passed to hold the next conference sometime in February as has been done in the past. Chairman Worrall will proceed with discussions concerning the next conference location and dates.

C. J. Peterson
Secretary

Resolutions

The following four resolutions were unanimously adopted:

No. 1. Whereas, the free exchange and use of wheat germplasm has been an essential ingredient in improvement of hard wheat varieties in the Great Plains; and

Whereas, recent events and discussions concerning variety release policies, royalties, utility patents, and protection of germplasm has led to concern by many groups, including the Hard Red Winter Wheat Improvement Committee, that free exchange of germplasm could be restricted in the future; and

Whereas, varieties released by public or private institutions are not sole inventions or creations by individual plant breeders. Germplasm utilized in plant breeding programs is the result of a compilation of efforts from institutions, states, regions, and countries. Free exchange of germplasm and cooperation is the principal component that has led to the successful development of new varieties in the United States;

Therefore be it resolved, the Hard Red Winter Wheat Improvement Committee wants to emphasize our strong desire that any group considering changes in release procedures carefully consider the impact of those changes on germplasm use and exchange.

Furthermore, the Hard Red Winter Wheat Improvement Committee would like to reinforce the philosophy and spirit of the Wheat Workers Code of Ethics.

No. 2. Whereas, Dr. Rollie Sears has provided superior and active leadership to the Hard Red Winter Wheat Improvement Committee; and

Whereas, Drs. James Quick and David Worrall, along with Dr. Sears, have served as excellent and conscientious representatives of the Hard Red Winter Wheat Improvement Committee to the National Wheat Improvement Committee;

Be it therefore resolved, that the Hard Red Winter Wheat Improvement Committee expresses its sincere appreciation to past-Chairman Sears, Drs. Quick and Worrall for their efforts and superior contributions on behalf of the committee.

No. 3. Whereas, the Hard Red Winter Wheat Improvement Committee recognized the long and distinguished contributions of Dr. Kenneth Porter to wheat and wheat improvement on regional and national levels; and

Whereas, Dr. Porter has provided superior support, guidance, and leadership to the Hard Red Winter Wheat Improvement Committee throughout his distinguished career;

Be it therefore resolved, that the Hard Red Winter Wheat Improvement Committee commends the efforts and contributions of Dr. Porter and expresses its sincere appreciation to him for his many contributions to wheat improvement.

No. 4. Whereas, the 18th Hard Red Winter Wheat Workers Conference has been an excellent and informative meeting and our hosts have expended much time and effort to ensure the success of the conference;

Be it therefore resolved, the Hard Red Winter Wheat Workers express their sincere appreciation to Dr. Neville Clarke, Director of the Texas Agricultural Experiment Station, and David Marshall for serving as hosts in this conference; to Dr. David Marshall for directing local arrangements; to Dr. Rollie Sears for program arrangements; and to Celsa Garcia, Tariq Mahmood, and Russell Sutton for their aid in local arrangements;

Be it further resolved, the Hard Red Winter Wheat Workers express their sincere appreciation for financial support of the conference from the Texas Wheat producers Board; Texas Seed Trade Association; Campbell Taggert; Cargill Hybrid Seeds; HybriTech Seeds Inc.; Nickerson American Plant Breeders; Pioneer Hi-Bred Inc.; and Trio Research, Inc.

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