L. P. Reitz

REPORT

of the

FOURTH HARD RED WINTER WHEAT IMPROVEMENT CONFERENCE

Manhattan, Kansas
March 24 and 25, 1938

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FOREWORD

This conference marked the fourth regional meeting of the hard red winter wheat research workers (i.e., the third since the inauguration of the coordinated program in 1930). The meeting was called for the primary purpose of discussing plans for the new hard red winter wheat quality laboratory being established at Manhattan, Kans. It was considered desirable to discuss not only problems of quality but also take stock of the progress being made with the breeding work.

The first day of the meeting, March 24, 1938, was spent in a round-table discussion of problems of wheat quality, with Dr. S. C. Salmon as chairman and Dr. Mark A. Barmore as secretary. The second day, March 25, was devoted to a discussion of the breeding work now under way.

Workers were present from Texas, Oklahoma, Kansas, Colorado, Nebraska, Minnesota, and Washington, D. C., representing both State and Federal cooperation. Directors or Vice-Directors of three of the State stations were present and took an active part in the discussions. Attendance at the meetings varied from twenty-five to thirty-five.

DISCUSSION OF QUALITY PROBLEMS
March 24, 1938

The following consists primarily of notes taken by Finney, McCluggage, and Barmore on points of interest as expressed by the various individuals present. No attempt was made to take notes on the more or less formal reports given. The ideas expressed by the representatives of each State have been grouped together with the idea that their opinions and points of view would be the more similar. The report is given as notes because it was thought that in this way the ideas would be distorted as little as possible. However, it must be emphasized that the following is our interpretation of the ideas expressed and is not the words used by the various individuals.

Dean L. E. Call (Kansas)

The goal of the laboratory should be to set up standards which may be used to evaluate the milling and baking quality of wheat. Poor quality from the point of view of the miller and baker will ultimately be reflected in prices paid to the farmer. We must not lose sight of the fact that the ultimate goal must be practical.

The laboratory might well expend some effort in attempting how best to use some of the varieties already well established that at present have desirable agronomic characteristics but undesirable milling or baking properties.

Prof. R. I. Throckmorton (Kansas)

We must have a clear, definite idea of what we mean by quality, how to measure it; and one that the trade will use and respect.

Dr. John H. Parker (Kansas)

We cannot expect to completely satisfy everybody and should rather attempt to have a maximum agreement among those in the trade. In a report of 15 labora tories on Chiefkan wheat three said they liked it and wanted all they could get, the rest w ere unanimous in the opinion that it was of poor quality and that they didn't want it. There are varieties which all millers agree are good, such as Marquis and Mindum durum, and others such as Humpback that are generally admitted to be poor.

Dr. C. O. Swanson (Kansas)

The laboratory has been merged with the regular laboratories of the department, which were already crowded. The agronomists should remember that the personnel consists of only three men, and since they are crowded it should be realized that there is a limit to the work that can be accomplished.

Certain varieties are used at present as standards and new varieties compared with these.

In order to run physical, chemical, and baking tests at least 2,000 grams of wheat must be on hand. Smaller amounts will limit the amount of testing.

Dr. L. S. Ellis (Oklahoma)

Dr. Ellis stated his interest to be mainly in the economic aspects of wheat improvement. The laboratory could best help by having in mind definite quality factors. Poor varieties should be eliminated at the source since any other way is very difficult and impractical.

Prof. C. B. Cross (Oklahoma)

Stress should be placed on uniform standards for testing varieties.

An Oklahoma Representative indicated that the agronomist wants to be told what w heats are good from the milling and baking standpoint and of the factors which the cereal chemists think are essential for good quality.

Mr. P. B. Dunkel (Denton, Texas)

Sometimes we fail to see the relation of the farmer and the miller. First of all the plant breeder needs to know the agronomic characteristics of a wheat but he needs to know also the milling and baking properties as well. He must not forget that the wheat has to be milled and baked as well as to be grown.

Texas Representative

The laboratory should as a result of tests be able to recommend or condemn a variety. The plant breeder wishes to be informed of such an opinion rather than the results of individual tests.

Dr. T. A. Kiesselbach (Nebraska)

Perhaps the laboratory should tell millers and bakers how to change their methods to handle a new variety rather than to tell the farmers what to grow.

Varieties that don't fill the bill for quality should be eliminated as early as possible so as to allow more time for further breeding work.

Dr. M. J. Blish (Nebraska)

In dealing with both old and new varieties of hard winter wheats our experience has consistently justified a belief that wheats found agronomically desirable will usually be found commercially acceptable when familiarity with their milling and baking characteristics is once established. When two flours of equal gluten content will produce equally good bread, the fact that they require different baking treatments does not warrant an assumption that one is superior to the other in "quality," unless the treatment needed for one wheat is significantly more inconvenient, more hazardous, or more difficult to control than the treatment required for the other.

With sound, untreated flour milled from mature, untreated wheat, inherent differences in "fermentation tolerance" are of no practical importance. Tolerance to fermentation alone, (in terms of time range for good bread production) is predominantly a matter of maintained sugar level in the dough, and not of inherent differences in structural properties of the gluten.

Defining "strength" as a flour's potentiality for producing a large "well-piled" loaf, it is quite generally the case that flours of equal protein content will produce equally large loaves when each flour receives its own proper treatment. Viewed in this manner, therefore, strength is largely a matter of protein content, and " protein quality" appears to be a much abused term. In evaluating the various baking properties for the purpose of treating each flour according to its inherent requirements, tolerance and response to oxidizing agents is usually found to be far more important than tolerance to mixing or to fermentation. Blackhull normally requires more oxidation than most hard winter varieties, while Tenmarq requires much less.

Dr. D. W. Robertson (Colorado)

Tests for quality early in the breeding program are important. If a variety is found to be unsuitable in any way for bread it could profitably be thrown out on that alone. The development of tests that could be run on small samples would be valuable because it would help to eliminate undesirable selection early.

Red color and high test weight are widely used at present as a measure of quality by farmers and millers. In some cases very inferior wheats, from a bread-making standpoint, are red and have a high test weight and therefore obtain an equal or better price than wheats of better quality. Therefore, one of the tasks of the laboratory should be to show that these factors are not necessarily measures of quality.

Prof. Alvin Kezer (Colorado)

The laboratory should determine the quality standards and keep them up to date.

General

Since it is necessary to have rather large samples for milling and baking tests requiring several years propagation, it was agreed that varieties should first be eliminated for undesirable agronomic characteristics.

There seemed to be two desires on the part of the plant breeders. One group wished to know the characteristics of the wheat from the milling and baking standpoint. This information was desired so that they would know whether a wheat was satisfactory from this standpoint but also to use these facts in breeding work much as agronomic characteristics are now used. The other group wished to know if a wheat could be recommended for distribution due to its milling and baking characteristics. This group generally seemed willing to disqualify a variety for a single undesirable characteristic, especially if it could be done early in the breeding program.

In summing up the day's conference it appeared that the concensus of opinion favored (1) the development of methods for characterizing and evaluating varieties as the most immediate important function of the laboratory, (2) cha racterize and evaluate the varieties now in uniform plot and nursery trials; also such new varieties a s are in commercial production or are likely soon to be distributed to farmers, and (3) develop methods for testing small quantities of grain for quality.

DISCUSSION OF BREEDING PROBLEMS
March 25, 1938

PROGRAM

Friday Morning - 9 A.M.

Report of work in progress at the various cooperating stations (10 minutes for each report)

Stem rust resistant winter wheats (20 min.)---------- Mr.C.O. Johnston

Hessian fly resistant wheats (20 min.)---------- Dr.R.H. Painter

Studies on straw strength (20 min.)---------- Mr. I. M. Atkins

Friday Afternoon - 1:30 P.M.

Crop testing nurseries (15 min.)---------- Dr. J. H. Parker

Special studies on cold resistance (20 min.)-------- Dr. E. Kneen

Controlled freezing studies on the varieties in the uniform winter-hardiness nursery (20 min.)-------- Mr. R. O. Weibel

Studies on drought and heat resistance of wheat ---- Dr. H. H. Laude (20 min.)

Pasturing winter wheat (25 min.)---------- Mr. A. F. Swanson

Discussion of wheats on the superior germ plasm list (30 min.)---------- Entire group

Discussion of varieties for plot and nursery tests-- Entire group (45 min.)

Following are brief summaries of the reports of work in progress at the various stations as reported by each representative present:

I. M. Atkins, Denton, Texas

The wheat breeding program for north-central and northwestern Texas has objectives designed to meet the needs of three distinct types of land and climatic conditions in the State. These regions are: (1) The north-central Texas blacklands with a rainfall of 30 to 40 inches; (2) the mid-western portion of the State from Wichita Falls to Chillicothe and south to Abilene, with lighter soils often verging into sandy types and rainfall of 24 to 30 inches; and (3) the Panhandle or High Plains, with a rainfall of 15 to 25 inches, and a climate similar to much of the western hard wheat belt.

In north-central Texas the most important problem in small grain production is the cereal rusts. We are now concentrating on the problem of producing one or more rust-resistant, high quality, soft winter wheats for this area. Varieties of wheat now grown on farms include Denton, Moditerranean, Fultz, Fulcaster, Red May, and Tenmarq. The earlier work of the Denton Substation had to do with pure-line selection within the native Mediterranean wheat. Some of our most leaf-rust-resistant strains have come from this work. However, most of these strains are especially susceptible to stem rust. Efforts to produce a high yielding leaf-and stem-rust resistant soft winter wheat by crossing Mediterranean and Hope have been rather disappointing because the more promising rust-resistant segregates have not been so productive as standard varieties at Denton. About 300 rust-resistant strains are now growing at Denton. These are the survivors from over 2,000 strains selected for winter-hardiness at Manhattan, Kansas, in 1936.

The more promising Mediterranean x Hope strains have been crossed with the commercial varieties Clarkan, Fulcaster, Harvest Queen, Fultz, Red May, Denton, and certain leaf-rust-resistant Mediterranean strains. We plan to give special attention to the Clarkan crosses as this variety has proved well adapted to our section. Special attention is being given to strength of stem in new strains for this region.

Loose smut also is an important disease in this region and we are now giving some attention to the breeding of new strains resistant to this disease. The loose-smut-resistant varieties, Valprize, Forward, Forward x Dietz selection, and Honor x Forward selection, were obtained from the Cornell (N. Y.) Experiment Station last year. These have been crossed upon the rust-resistant Mediterranean x Hope strains and upon commercial varieties.

As rapidly as possible we hope to incorporate into new strains for the hard wheat area earliness, resistance to shattering, resistance to lodging, resistance to bunt, and resistance to rust. Varieties now grown on farms include Early Blackhull, Blackhull, Tenmarq, and Turkey. Early Blackhull has increased in popularity in this region in the last few years. The more promising hybrids available are Kawvale x Tenmarq, Denton x Kanred, Kanred x Clarkan, Kanred x Hard Federation x Tenmarq or Kanred, Kanred x Oro, P1066 x Prelude x Kanred or Tenmarq, Tenmarq x Oro, Martin x Kanred, and Martin x Tenmarq. A large number of strains are now being tested in replicated nursery plots at the Chillicothe Substation. One new smut-resistant Martin x Tenmarq strain is being tested in field plots.

C. B. Cross, Stillwater, Okla.

At Stillwater, the work with wheat has been confined to material from other stations. There is need in Oklahoma for rust-resistant wheats for the eastern part of the wheat belt. There is also a need for varietal purification in much of this same area.

V. C. Hubbard, Woodward, Okla.

In the work at Woodward the development of short, stiff-strawed wheats by using Hard Federation and other similar types from the Pacific Northwest as a parent is being emphasized. Another desirable characteristic for wheats at this station is resistance to shattering.

Bunt resistance is being given considerable attention both as to inheritance and the development of resistant varieties. A Martin-Blackhull x Blackhull strain developed at this station is highly resistant to bunt. Such wheats as Oro, Turkey selections, and Ridit are being used as resistant parents. A large number of Blackhull x Cheyenne and Early Blackhull x Cheyenne lines are available, some of which look promising. Special studies include date of planting tests, clipping experiments, and root studies leading to evaluation of varieties for drought resistance.

John H. Parker, Manhattan, Kans.

In the breeding work at Manhattan, emphasis is being placed on earliness, high test weight, winter-hardiness, bunt resistance, hessian fly resistance, and rust resistance. A large number of hybrid combinations in various stages are being grown. A few of the most promising are:

Cheyenne x Tenmarq - For a more winter-hardy Tenmarq.
Early Blackhull x Tenmarq - Earliness and test weight.
Oro x Tenmarq - Bunt resistance, yield, and quality. Very promising.
Kawvale x Tenmarq - Hessian fly resistance, nonshattering.
Marquillo x Oro - Hessian fly and bunt resistance.
Kawvale x Currell and Fultz - To obtain a true soft kernel on Kawvale.

This list gives an idea of some of the combinations being studied. Many others are available. A plan is now in operation which calls for all hybrid material to pass through the disease gardens and the hessian fly nursery before being tested in the nursery for agronomic value. The idea is to eliminate all susceptible material as early as possible.

Much attention is being given to quality tests as early as possible in the history of the strain. The dough ball test is used rather extensively as a first measure of quality.

H. H. Laude, Manhattan, Kans.

About 30 varieties and strains of winter wheat are being studied in plots. Some of the most promising are Oro x Tenmarq and Kawvale x Tenmarq strains.

In a special study the yields of new varieties by 5-year periods have been compared with standards for the same periods. Among the varieties studied (Kanred, Blackhull, Tenmarq, Cheyenne) there has been a tendency for the new variety to outyield the standard at first but gradually to come down in yield until they equal the standard. This same condition was found to be true at Lincoln, Nebr., with Nebraska No. 60 and Cheyenne.

Considerable discussion followed this report. The general opinion seemed to be that the cause or causes for the decrease in comparative yield of new varieties should be studied.

C. O. Johnston, Manhattan, Kans.

Leaf rust:

Work on breeding for resistance to leaf rust has been in progress for many years and several hundred leaf-rust resistant segregates, representing more than 50 different crosses have been studied. High resistance in the field to leaf rust and resistance to pure physiologic races in the greenhouse have been obtained with ease, but most of the selections have some agronomic shortcoming such as lack of hardiness, weakness of straw, low yielding capacity, or poor grain quality. This probably is due to the necessity of obtaining resistance to leaf rust from soft red winter and spring wheats.

The program of breeding for rust resistance in winter wheat is now interwoven with the agronomic and entomologic wheat breeding programs into a single program of wheat improvement through controlled breeding. To prevent future duplications of effort the crosses to be made are decided upon in conference before they are made. The agronomists make the crosses in the greenhouse and the F_1 is grown in the greenhouse and given a preliminary rust test. All of the crosses pass through the rust nursery in F_2 and are subjected to heavy artificial infections of leaf and stem rusts. Resistant plants are saved and passed on to agronomists and entomologists for other tests. The most promising strains then are brought back to the rust nursery for final tests.

The best sources of leaf rust resistance among winter wheats are shown below. Kawvale, which is widely grown in eastern Kansas, was distributed largely because it was known to be highly resistant to leaf rust. The resistance of some of the Oro x Tenmarq selections is greater than that of either parent. Two selections of Oro x Tenmarq and two of Kawvale x Tenmarq were grown in plots at the agronomy farm in 1937 and proved to be high yielding as well as resistant to leaf rust.

In general there is more resistance to leaf rust among soft red winter wheats than among hard red winters. Kanred, P1066, and P1068 possessed considerable field resistance 20 years ago, but the introduction and increase of certain physiologic races has changed the picture, so that they seldom exhibit any resistance today. The best sources of resistance to leaf rust at present are as follows:

Varieties or named hybrids

Hard Red Winter - Kawvale (semihard), Quivira, Tenmarq, Malakof, Iowin, Hussar.

Soft Red Winter - Strains of Fultz, Fulcaster, Mediterranean, and Michigan Amber.

Soft White Winter - Democrat

Promising unnamed hybrids

Hard Red Winter - Some strains of the following crosses have shown a high degree of field resistance: Oro x Tenmarq, Kawvale x Tenmarq, P1066 x Prelude, Kanred x Marquis, Kanred x Hard Federation, Kanred x Fulcaster, Fulcaster x Tenmarq, Kanred x Kawvale, Hard Federation x Kawvale. Also selections from Hope and Marquillo crosses.

Soft Red Winter - Mediterranean x Hope, Harvest Queen x Kawvale, (Kanred x Fulcaster) x (Kanred x Hard Federation), Marquillo x Minturki.

The present trend in wheat breeding at the Kansas station is away from simple two-variety crossing and toward carefully planned compound crossing. Besides compound crossing a definite effort is being made toward combining resistance to leaf rust, stem rust, and bunt in a single cross.

Besides the breeding phases of the leaf rust work, studies are being made at Manhattan on the distribution and prevalence of physiologic races of leaf rust, the effect of leaf rust on the yield and quality of winter wheat, and the relation of leaf rust infection to transpiration in wheat.

Stem rust:

Until recently it was erroneously supposed that the hard red winter wheat growing area suffered severe losses from stem rust only about once in 10 years. The epidemics of 1935 and 1937 dispelled this myth. Each of these epidemics damaged the Kansas wheat crop alone about $10,000,000.

The knowledge that stem rust may overwinter in abundance in southern Texas, that the commercial wheats of north-central Texas are extremely susceptible varieties, and that the prevailing spring winds are from the south makes it reasonably certain that similar epidemics will occur in the future. Furthermore, unless resistant varieties are distributed and grown in Texas, an increase in the wheat acreage in that State, aside from the Panhandle, will increase the rust danger to the northward.

With these points in mind the common-sense thing to do would be to take stock of the wheats now being commercially grown in the area, as well as those available in experimental sowing, and plan a program of breeding for resistance accordingly.

The commercial varieties of hard red winter wheat are catalogued below according to their reactions to stem rust. It often has been said that the hard red winter wheats are, in general, more resistant to stem rust than the soft red winters. That statement is partly but not entirely true. Under conditions of an early-developing severe epidemic hard red winter varieties are as heavily infected as soft red winters. It is true, however, that the hard red winters seldom rust heavily early in the season and consequently usually are not so severely damaged as the soft red winters. This is due partly to the fact that some of the hard-seeded varieties have heritable late-rusting characteristics and partly to the fact that the hard red winter varieties are grown in the drier parts of the western Mississippi Valley, where stem rust develops later than it does farther east.

REACTION OF COMMERCIAL VARIETIES OF WINTER WHEAT TO STEM RUST

Resistant

Kanred - This variety is highly resistant to some physiologic races but frequently is heavily infected in the field by races to which it has no resistance.

Moderately Resistant or Tolerant

Blackhull - Under field conditions Blackhull frequently shows only light infections when other varieties are heavily infected. It also may exhibit heavy infection late in the season under epidemic conditions. Even when infections are heavy, Blackhull is not injured so severely as other varieties.

Chiefkan - This variety has practically the same behavior as Blackhull except that its resistance apparently is a little greater.

Kawvale - During the epidemics of 1935 and 1937 Kawvale made a remarkable record in eastern Kansas. It is characteristically a "late ruster," seldom showing anything but light infections until very late in the season. Stem rust pustules usually are small and not of the coalescing type. Kawvale also is a few days earlier than most hard winter wheats and has the faculty of maturing rapidly. Although it frequently is heavily infected, Kawvale possesses a distinct tolerance to rust and usually produces considerable grain.

Iobred - In northeastern Kansas and at Manhattan, Iobred has reacted much like Kawvale. It apparently has considerable resistance to some races of stem rust but in general its advantage lies in its late rusting tendency and its tolerance.

Iowin - This variety developed at the Iowa Agricultural Experiment Station has a reaction very similar to Kawvale. Except under severe epidemic conditions it seldom shows much stem rust infection. It is a tolerant late ruster.

Rust Escaping

Early Blackhull, Quivira - Both of these varieties are susceptible when sown late, but if sown at the normal time they usually escape infection through their early maturity. They nearly always mature ahead of heavy stem rust infection.

Susceptible

Turkey, Kharkof, Tenmarq, Cheyenne, Nebraska No. 60, Sibley selections, Penquite, Denton, Mediterranean types, Fulcaster, Fultz, Currell, Harvest Queen, Clarkan, Michigan Wonder, Cooperatorka, and Russian selections. In general, the soft wheats are more susceptible than the hard red winters. The latter frequently rust rather late and the infections are characterized by smaller pustules than those on soft-seeded varieties.

The epidemics of 1935 and 1937 proved beyond question that none of the varieties of hard red winter wheat possess as high a degree of field resistance as desired. The most resistant winter wheats available for use in a breeding program are certain selections of the crosses listed in the table below. These proved to be highly resistant to stem rust in the Manhattan rust nursery in 1935 and 1937.

WINTER WHEAT HYBRID SELECTIONS HAVING STRONG RESISTANCE TO STEM RUST

Cross	Source	Generation	Number of selections	Grain texture
Hope x Hussar	Washington	Advanced	Few	± Hard
Mediterranean x Hope	Texas	F_9	Many	Hard + Soft
Hope x Cheyenne	Nebraska	F_7	Many	Hard
Hope x Turkey (C.I.10016)	do	F_7	Many	Hard
Hope x Kawvale	Kansas	F_8	Many	Hard + Soft
Marquillo x Tenmarq	do	F_6	Many	Hard
Kawvale x Marquillo	do	F_6	Many	± Hard
Marquillo x Minturki	do	F_6	Many	Mostly soft
Marquillo x Oro	do	F_6	Many	Hard
(Kanred x Hard Federation) x Marquillo	do	F_6	Few	Hard
Hope-Minturki x Minturki	Minnesota	Various	Many	± Soft
H-44-Minhardi x Minturki	do	do	Many	Soft

It will be noted that the two principal sources of resistance in these crosses are Hope and Marquillo - both spring wheats. As a consequence, many of the selections are seriously lacking in winter hardiness even though they have the winter habit of growth.

The selections of Hope x Hussar have combined resistance to leaf rust, stem rust, and bunt but are all tall and late maturing. Many of the Mediterranean x Hope selections also have resistance to leaf rust, stem rust, and bunt but most of them proved to be very weak strawed and low yielding at Manhattan. Many of them also show evidence of susceptibility to heat, drought, and blackchaff. The Hope x Cheyenne and Hope x Turkey (C.I.10016) selections show promising resistance to leaf and stem rusts and some selections of the latter cross should have bunt resistance. Many selections have grain with excellent dark hard appearance and there is more cold resistance in these selections than among the Mediterranean x Hope lines. However, there are many nonhardy lines and some of the selections from both crosses have poor head types.

The Hope x Kawvale cross was made in the leaf rust project at Manhattan and many of the selections have proved to be highly resistant to both of the rusts. Some selections also have resistance to bunt. Many of them are early and apparently have strong straw, but the cross does not seem to possess yielding capacity and many selections are nonhardy. The grain of many selections also appears to be of poor quality.

There are many selections among the crosses involving Marquillo that show considerable resistance to both leaf and stem rust. In general, however, the stem rust resistance of these selections is not so great as that shown by the Hope hybrids. Many of the Marquillo x Oro and Marquillo x Minturki selections have shown a high degree of resistance to bunt and some of them also have resistance to one or both rusts.

The two Minturki back crosses from Minnesota contain many selections with combined resistance to leaf rust, stem rust, and bunt. Nearly all lines are very tall and late maturing but the straw seems to have remarkable strength for its height.

While none of these selections may be satisfactory for distribution as they now stand, they are valuable parental material. In them the resistance to stem and leaf rust has been combined with winter habit. Some of these selections are being used as parents in crosses made at Manhattan rather than to depend entirely on spring wheats as sources of stem rust resistance. Considerable use also is being made of the stem-rust-resistant spring wheats Apex, Ceres x Hope-Florence, Renown, and Thatcher.

Hurley Fellows, Manhattan, Kans.

Foot-rots are probably of more importance than usually considered. Work on the take-all foot-rot with respect to resistant varieties has been difficult and discouraging. There are very few if any varieties of wheat that are really resistant to take-all.

A few varieties have been found somewhat resistant to the dry-land foot-rot. These are Wisconsin selection 21.25, Cheyenne, Oro, certain Turkey selections, and wheat x rye (C. I. 11403). There seems to be an association between resistance to winter injury (and perhaps drought) and resistance to the dry-land foot-rot. Some extensive testing of the reaction of varieties to the disease is now under way at Akron, Colo.

At present the best method for controlling the dry-land foot-rot seems to be delayed date of seeding. Seeding on the date recommended by the agricultural experiment stations is generally late enough for satisfactory control.

There is a desire for more varieties and strains for testing.

A. F. Swanson, Hays, Kans.

The work with wheat at Hays consists mostly of testing strains developed elsewhere. Extensive plot tests are carried on both fallow and cropped land. A large nursery is also grown.

Some of the Oro x Tenmarq strains from Manhattan appear promising. Several early strains, probably field hybrids with Blackhull or Early Blackhull, are being watched closely.

One breeding problem under way is a study of the cross Cooperatorka x P1066-Burbank. Each parent has some desirable qualities and the question is whether, by crossing two wheats neither of which is outstanding, anything of merit can be developed.

Extensive work is being done on pasturing tests. This work is reported later in this summary.

D. W. Robertson, Fort Collins, Colo.

Considerable effort is being placed on multiple crosses. An example is the attempt to combine stiff straw (Akron No. 7), quality (Kanred), bunt resistance (Turkey selection), and rust resistance (Mediterranean-Hope). F_1 hybrids combining all these characters are being grown this year and seed will be available for distribution to various stations in the fall of 1938.

Fort Collins is a good place to study the ability of varieties to yield.

Studies are being conducted on dates of seeding winter wheat, irrigation after seeding, and vernalization, also to determine whether wheat will head if the seed swells in the ground in the fall but does not emerge until spring.

J. J. Curtis, Fort Collins, Colo. (Reporting on the work at Akron, Colo.)

At Akron, hybrid strains are studied for winter-hardiness, drought resistance, and general adaptability under dry-land conditions. The plan now followed is to make the crosses and grow the early generations at Fort Collins and test the selections at Akron. Drought resistance is considered very important.

A variety test in plots is grown on both fallow and cropped land. A rather extensive date-of-seeding test is also being continued.

K. S. Quisenberry, Lincoln, Nebr.

Turkey selection Nebr. No. 1063 (C. I. 10094) continues to give good yields. In the fall of 1937, 70 bushels of this variety were seeded by selected farmers and at the Station.

In a so-called advanced nursery, a few of the most promising lines are seeded at three different dates to study their reaction to time of seeding. It has been found that varieties do react differently to different dates of seeding.

Lines of Hope x Cheyenne and Hope x Turkey selection (Nebr. 1069) now in F_7 are being watched very closely. It is known that these lines are rust resistant, but most of them seem to lack hardiness. Some of the better lines are being back-crossed to Cheyenne.

About 70 lines of Cheyenne x Blackhull are now in F_7. This material should give interesting material for dough ball studies since the parents differ widely in their reactions to this test.

Considerable emphasis is being placed on bunt studies. A large number of resistant selections are available and some inheritance work is under way. Part of the bunt work is carried on at North Platte under irrigation.

Rust studies are carried on at Lincoln under artificial epidemics, the chief object being to test the Hope x Cheyenne and Hope x Turkey selection (Nebr. 1069) material and any other material of promise. Results from last year indicate that susceptible varieties may differ in tolerance to rust.

During the winter extensive freezing studies are carried on, especially with respect to the relation of various environmental conditions to winter-killing. Artificial freezing is also used to select hardy hybrid material.

E. R. Ausemus, St. Paul, Minn.

Winter wheat in Minnesota is increasing and Minturki is still the best variety on farms.

Some of the objectives are as follows: (1) Cold resistance, by using Minturki, Minhardi, Lutescens, and Yogo as parents; (2) quality, by the use of spring wheats as a source of good quality; and (3) disease resistance. In this case the back-cross method is being used rather extensively. Lines of Hope x Minhardi or Minturki that are disease resistant are back-crossed to the commercial parent.

Some promising Minturki x Marquis lines are making good records in various tests.

An attempt is being made to produce a winter-hardy, good soft wheat. The cross is Minhardi-Marquis x Fulhio. The F_3 is being grown in the nurseries at St. Paul and Lincoln as well as being frozen under controlled conditions. There seems to be no relation between cold resistance and texture of seed.

Reginald H. Painter, Manhattan, Kans.

In the coordinated wheat improvement program for resistance to hessian fly two separate nurseries (Manhattan, Kans., and Springfield, Mo.) are grown. At Manhattan the infestation is maintained by sowing susceptible wheat near the nursery and by bringing in infested stubble from the hard wheat belt in the fall. In recent years, the drought has prevented these methods from being as successful as might be wished. On two occasions, when fly infestation was too light to be significant in the spring, Mr. C. O. Johnston inoculated plants in the nursery with leaf and stem rust and secured infections. The information thus gained was used in addition to fly infestation data in making selections. The Manhattan fly nursery has been largely used as a source of seed stocks for the following years' seeding.

In the Springfield nursery, fly infestation is natural and is maintained by sowing susceptible wheat about the test plots. Heavy infestations have been obtained and excellent information for selection of strains has been secured. This nursery is basically a duplicate of the one at Manhattan. Kawvale and some of the other winter wheats are resistant to the hessian fly that commonly occurs at Manhattan and at certain other points in Kansas and Nebraska. One of the problems has been to transfer their resistance to typical soft and hard winter wheats. Segregating generations of crosses of Kawvale with Tenmarq, Oro, Kanred x Hard Federation, Clarkan, Harvest Queen, and other wheats have been studied. Some of these hybrids are now in advanced generations and are being tested for yield and other characteristics in the agronomy nursery.

At Springfield, and at certain other localities in the soft wheat belt, no winter wheat resistant to hessian fly has been found. The explanation of this difference in results in different localities appears to lie principally in the presence of biological races within the various population of hessian fly. There have been found, however, several varieties of spring wheat that have been resistant to the fly wherever tested thus far. The more important of these are Marquillo, Ill. No. 1 W38, Marvel, Renacimiento, two other Uruguay varieties, and several durum wheats. Yaroslav and some other varieties of emmer are resistant but Hope and H_{44} are not. Survey nurseries are being planted and other sources of fly resistance are being located, mostly in unnamed wheat introductions.

Marquillo, a cross between Marquis and Iumillo durum wheat, was the first common wheat found that has been resistant to hessian fly thus far, wherever it has been tried. The importance of its use in breeding for resistance is evident. Crosses were first made between Marquillo and certain winter wheats at the Kansas station in the spring of 1931. At that time and later, successful crosses were made with Tenmarq, Minturki, Oro, Kawvale, Kanred x Hard Federation, Illini Chief selection (223415), and Michigan Wonder. Crosses have also been made with Fulhard, Clarkan, Fultz, Honor, and Shepherd, but the F_1 plants died after reaching the three or four leaf stage, indicating the presence of a lethal factor or combination. Compound crosses between a fly-resistant strain of Marquillo x Minturki and Kawvale x Clarkan and Harvest Queen x Kawvale have also given F_1 plants which died in the early stages, indicating that this lethal condition is inherited.

Back-crosses and compound crosses have been made between fly-resistant F_3 Marquillo hybrids and promising winter wheats. The F_1 plants of the compound crosses have been nearly as heavily infested as the susceptible parents, when tested in the greenhouse, indicating that susceptibility to hessian fly tends to be inherited as a dominant character. Tests of direct F_1 hybrids between Marquillo and winter wheats gave similar results. It is not known whether this susceptibility of the F_1 plants concerns high oviposition and high larval survival or only the latter character.

Infestation counts were made on the F_2 Marquillo hybrids with winter wheats at Manhattan in the fall of 1933 and on the F_2 plants of the compound crosses and back-crosses at Manhattan in the fall of 1936 and at Springfield, Mo., in the fall of 1936 and the spring of 1937. All four counts are similar in that the F_2 population had an infestation about one-third as heavy as the susceptible parent. This type of "reversal of dominance" when the infestation of the F_1 plants and F_2 populations from these F_1 plants are compared may be due to the fact that the studies of the former were conducted in the greenhouse and of the latter in the field. More probably it indicates a fairly complex genetic combination of factors for resistance.

In the F_2 and succeeding generations, the more susceptible plants and strains were discarded, as were lines that lacked desirable agronomic characters. During these generations natural selection for winter hardiness also occurred. No evidence was secured of the factorial basis of fly resistance. By the F_5 generation, however, following continued selection for fly resistance, the infestation of more than 70 percent of the hybrids at one of the nurseries lay within the range of the resistant Marquillo parental rows while one or two of the 326 hybrids were grown which approached the susceptibility of the winter wheat parents. All of these hybrid segregates had the winter habit of growth and some approached the winter hardiness of their parents, but it is not known whether any are as hardy as Turkey and Kanred.

In the F_4 generation at Springfield, Mo., an infestation occurred in which as many as 270 larvae were removed from a plant having but a single tiller. Under these conditions the winter parents were completely infested and in most cases were killed by the infestation. The winter wheat with the best survival was a row of Kawvale in which 21 percent of the plants survived the infestation. Under these conditions and with an average infestation of 44 percent of the plants infested for Marquillo, some of the hybrids had as low as 32 percent of the plants infested and 85 percent of the rows had a higher survival after the fly infestation than did any row of a winter parent. In many cases there was no close relationship between the percentage of plants infested by fly and the percentage of plants surviving the infestation. This fact, as well as other data, seems to indicate that the genetic factors for low larval survival (resistance) and for ability to survive fly infestation (tolerance) are not the same and perhaps not even genetically linked. In a fully susceptible variety it has generally been assumed that the number of plants killed by fly would be proportional to the intensity of the infestation. In this population of Marquillo hybrids which were undergoing some segregation for resistance to the hessian fly there are some segregates that have both a high fly infestation and a high ability to withstand injury by the fly. There are other segregates in which a low fly infestation has not been accompanied by a high ability to withstand injury. In a number of the segregates, however, factors for low infestation and for ability to survive the infestation have gone together. In part this is due to the normal association between intensity of infestation and amount of killing by fly which is mentioned as being characteristic of a fully susceptible variety; in part, it appears to be merely chance association of more or less independent genetic factors. The fact that Marquillo and apparently some of its hybrids carry genetic factors for low oviposition rate would further complicate this relationship between plant survival and infestation. In other words, it appears that at least three mechanisms are responsible for the difference between winter wheats and the winter type Marquillo hybrids under fly infestation. These are (1) low oviposition rate, (2) low larval survival, and (3) high ability of the plants to survive infestation. There is evidence that these three characters are governed by different genetic complexes but, on the other hand, a re interrelated in their effects so far as final infestation and survival of infested plants are concerned. A little evidence has been secured which indicates that some lines among the resistant Marquillo hybrids are still segregating for fly reaction at a low level of resistance.

Nearly all the lines selected have passed through the disease nurseries and carry more resistance to stem rust than do the ordinary winter wheats such as Turkey, Kanred, Blackhull, Tenmarq, and Cheyenne. Many of them carry resistance to leaf rust equal to that of the better winter wheats and some of the crosses between Marquillo and Oro or Minturki also carry resistance to bunt. Both hard and soft kernels are represented among the Marquillo hybrids. Forty-six of the most promising segregates with hard kernels were recently submitted for the Pelshenke wheat-meal-time fermentation test and nearly all gave a satisfactory long "time" in this test of gluten quality.

Last fall more than 600 F_6 hybrid strains believed to be largely homozygous for fly resistance were transferred to the agronomy department for yield and other agronomic tests.

Studies of F_1 Hybrids

The object of the studies with first generation hybrids has been to ascertain the dominance or recessiveness of fly resistance in various resistant sorts, and particularly the number of distinct genetic complexes involved. The study of these hybrids involves two difficulties: (1) The number of plants available for study is usually small; and (2) plants must be grown to maturity in order to be sure that actual hybrids have been used. Six different hessian-fly-resistant spring wheats and four susceptible winter wheats have been used in the study. About 150 F_1 hybrid plants were grown in the greenhouse this year and used for these studies.

In the crosses studied, Marquillo resistance tends to be recessive, while the resistance of Ill. No. 1 W38 tends to be dominant. In crosses involving Marvel and some of the Uruguay selections there is still some question concerning the dominance or recessiveness of the character for fly resistance since some of the plants tested have not matured and may not be actual hybrids. However, it appears probable that at least two factors or groups of genetic factors are involved. The importance of this discovery is that it presents the possibility of accumulating additional resistance from several groups of factors and a possible defense against biological strains should they develop on separate resistant varieties.

STRENGTH OF STRAW AND LODGING STUDIES

I. M. Atkins

An extensive survey of varietal sources of strength of straw in winter wheat varieties has been made during the period from 1932 to 1936 at Denton, Texas. Morphologic characters associated with strength of stem and lodging have been studied in more than 130 varieties 1/.

1/ I. M. Atkins. Relation of certain plant characters to strength of straw and lodging in winter wheat. Jour. Agr. Research 56 (2): 99-120. 1938.

Morphologic characters found to be associated with strength of stem were height of plant, weight of grain, diameter of culm, and weight per unit length of culm at the base of the plant. Weight per unit length was found to be correlated very closely with strength of stem (3-year average $r = +0.945$) and this measure is suggested as a quicker, more accurate measure of lodging resistance than breaking strength. A cutter has been devised for cutting sections from the culm for this purpose. Considerable data are available to support the conclusion that weight per unit length or breaking strength are correlated with field lodging of varieties.

In a preliminary study of the inheritance of strength of straw in crosses of Kanred x Clarkan and Kanred x Coppei, strength of stem was found not to be correlated with either head type, awn classification, or pubescence of glume. Fourth-generation lines from the above cross, tested for strength of straw in 1937, support the conclusion that strength of straw or weight per unit length tests can be used to test early segregates of a cross for resistance to lodging.

CROP TESTING NURSERIES

John H. Parker

Since 1930 there has been a crop testing plan in operation in Canada under the direction of Dr. L. H. Newman, Dominion Cerealist, and Major G. H. L. Strange. The plan calls for the grain elevator agents, who are cooperating, to take a sample of the crop sold them by each farmer. These samples are then registered and planted in small plots. As the wheat matures each sample is rated "A," "B," or "C." "A" ratings are given to varieties of good milling and baking quality that are adapted to the area and are pure. Wheat that is fair as to quality of variety, purity, and adaptation is given a B. Wheats poor in quality, lacking in adaptation, and badly mixed are graded C.

A field day is held and the wheats are observed. The farmer may compare his wheat with the rest. Those having C grade are encouraged to obtain seed of A or B for the next crop. In this way it is hoped to encourage the raising of better and purer varieties.

This plan was started at Junction City, Kans., in the fall of 1936, in cooperation with the Hogan Milling Co., Geary County Farm Bureau, and the Kansas State College. At the field day held in June 1937, much interest was shown in the plan.

At present the Southwest Wheat Improvement Association is backing the plan and 25 nurseries are planted in central and eastern Kansas. Each nursery consists of samples from about 100 farmers in the county. At harvest each row will be graded A, B, or C and at the Field Day each farmer will know just how his wheat ranks, although the identity of the rows will not be made public. Each farmer will be informed as to the identity of his own sample. At Junction City, a master nursery of over 3,000 rows is being grown for careful study. It is the hope that these nurseries will encourage farmers to grow better varieties.

A COMPARISON OF CONTROLLED LOW TEMPERATURE WITH FIELD RESULTS AS A MEASURE OF THE COLD RESISTANCE OF WINTER WHEATS

R. O. Weibel, Lincoln, Nebraska

Thirty varieties of winter wheat were subjected to low temperature over a period of two years and the percentage survivals were compared to the cold resistance of these varieties, as shown by data from the uniform winter-hardiness nurseries based on from 10 to 290 station years.

A correlation coefficient of +0.8095 was obtained between the percentage survivals from the two methods, indicating a very close agreement between controlled freezing and field reaction.

Four freezing periods from November to January were used, all material being replicated three times in each period. In this manner it was hoped to obtain data concerning the relative hardiness of the varieties as well as the rate at which it was attained. The agreement between percent survivals of varieties for the freezing periods was good as was shown by correlation coefficients ranging from +0.6719 to 0.8815 over the two years. While all varieties did not react the same, there was an increase in cold resistance from November to January as shown by higher percent survivals with progressively lower exposure temperature.

An attempt was made to study dehardening of the varieties, but because of insufficient material the data obtained were not reliable.

SPECIAL STUDIES ON COLD RESISTANCE

Eric Kheen, Lincoln, Nebraska

Two methods of approach are being used to study the specific problem of winter-hardiness of cereal crops. By differential nutrition the attempt is to either increase or decrease the ability of a plant to acquire cold resistance. On the other hand, investigations on the hardening process in normally grown plants are in progress.

From a nutritional standpoint, the results of both sand culture and soil experiments demonstrate the harmful effects of a too abundant supply of nitrates. In like manner, the beneficial role of phosphate is indicated.

A study of the "hardening" and "dehardening" process in wheat and barley plants permits some definite conclusions: (1) Field behavior may be duplicated in essentials by controlled greenhouse low temperature hardening; (2) carbohydrate metabolism is of prime significance in hardening and dehardening against low temperatures; (3) light intensity plays a prominent role in hardening; (4) the quantity of sugar in the crown of a hardening plant at any stage of hardening apparently is an index of its cold resistance at that time; (5) six varieties of winter wheat have been arranged in order of their field-exhibited winter-hardiness by determining their ability to accumulate sugar under controlled low-temperature hardening conditions and retain this sugar against dehardening influences; (6) plants may be "artificially hardened" to some extent by feeding them on sugar in sand cultures.

RESEARCH IN RESISTANCE OF CROP PLANTS TO HEAT

H. H. Laude, Manhattan, Kansas

The term "drought" usually refers to a condition resulting from the combination of a moisture deficit and high temperature. Whether injury to plants is caused by only one of these factors or by both is not known. Probably the stress on plants due to either factor is intensified by the coincidence of the other factor, e.g., moisture deficit is probably more serious when accompanied by high temperature, and heat injury is greater when accompanied by moisture deficit. If this is the case, resistance to either factor is synonymous with resistance to drought, i.e., to the combination of the two.

In cases of drought injury it may be assumed that three phases or factors are involved, namely, (a) temperature, (b) humidity of the air, and (c) soil moisture. In the study of drought resistance in artificially controlled conditions it may be desirable to measure the influence of each of these phases separately. In the work here it seemed advisable to study first the effect of high temperature when atmospheric humidity was

constant and moderately low and soil moisture was adequate. Results obtained in that way would be primarily a measure of heat resistance. Later it is planned to investigate the influence of varying atmospheric humidity in relation to temperature and finally to vary soil moisture.

Early in the work it was found that marked differences in high temperature resistance among plants could be detected by subjecting them to short stress periods. Five hours exposure to a high temperature is sufficient time to clearly indicate differential resistance. In the case of corn it was found that resistance to heat in the seedling stage corresponded with drought resistance of the plants when grown to maturity in the field. Whether similar agreement between the response of seedings in artificial tests and plants grown in the field exists in other crops is not yet known. However, it is evident that among the crops tested large differences in heat resistance prevail in the seedling stage.

A short stress test with seedlings, if specifically related to field results, will be important in crop research because large numbers can be tested in a short time at little expense. The material for a complete experiment can perhaps be grown and tested within a month.

As in other controlled physiological tests it is possible to adjust the severity of the stress so as to clearly differentiate among different degrees of heat resistance. A limitation of field experiments lies in the fact that often the stress is not at such a level as to cause differential injury. Furthermore, several factors are involved and the relationships among these are likely to change during the period of observation. Also the length of time involved is so great that secondary conditions or results may develop and thus confuse the study.

Resistance of varieties of wheat to high temperature - average 8 experiments. Tested at about 122° F. and 20 percent relative humidity for 5 hours.

Variety	Average injury (Pct.)
Hope	64
Marquis	61
Kubanka	58
Ceres	54
Hope x Ceres 2642	50
Fulcaster	44
Tenmarq	41
Kanred	40
Kawvale	40
Turkey	35

DIURNAL CYCLE OF HEAT RESISTANCE

It was discovered that plants can withstand more heat at midday than early in the morning. The resistance increases rapidly to a maximum and decreases slowly reaching a minimum during the night. Apparently there is a diurnal cycle of heat resistance in plants.

This cycle has been found in all the plants studied. It appears to be definitely associated with light. In some cases only a short exposure to light is required to cause a significant increase in resistance. In artificial light the plants tend to retain resistance.

Plants lose resistance in darkness slower than they gain it in light. In limited experiments it appears that the gain in one hour is about as much as is lost in four hours. The cause for such resistance is not known. However, tests have shown that water content is lower in the morning than at midday or late afternoon, e.g., in wheat seedlings the dry matter has been found to increase from 10.8 percent at 7 a.m. to 12.5 percent at 1 p.m.

The transpiration rate as measured in wheat was relatively low in the morning, increased to early afternoon, and then decreased.

The solid content (refractometer) was lower in the morning than at midday or late afternoon, e.g., Turkey wheat seedlings at 7 a.m. = 27.5 (scale reading) and at 1 p.m. = 35.4 Comparable Turkey plants tested at 122° F. and 23 percent relative humidity were injured 78 percent when tested in the morning and 18 percent in the afternoon.

PASTURING WINTER WHEAT

A. F. Swanson, Hays, Kansas

Livestock gains on good wheat pasture have been produced at the Fort Hays station at costs from $2.00 to $2.50 per hundred weight; compared with more than $7.00 for sorghum silage plus a supplement. The dry feed consumption on good wheat pasture has been reduced from 75 to 80 percent. Adequate growth of winter wheat for grazing in the semi-arid region can best be assured when the crop is grown on fallowed land.

Successful grazing of winter wheat without injury to the grain yield depends on a number of factors. The two most important appear to be (1) a high stored moisture content in the seedbed at seeding time, and (2) an abundance of available nitrates in the soil for quick spring recovery. When winter wheat is to be grazed the rate of seeding should be from 25 to 50 percent higher than when the crop is intended for grain only. The date of seeding should be somewhat earlier than is customary for a cash crop alone. Grazing should begin in late November or early December and continue until late March or early April, depending on the advance of the season and the locality. The mark of a well-grazed field of wheat when the cattle are removed in the spring is to have it so uniformly grazed that it has the appearance of having been cut with a lawn mower. If the livestock is removed at the proper time, recovery of the plants is rapid.

Continuous grazing and tramping of the animals from early winter to April 1 is more desirable than intermittent grazing during this period, provided dry feeds and shelter are available for inclement weather. During periods of extremely muddy weather it is desirable to remove the animals from the field. However, after the initial firming of the seedbed by the tramping of the animals has been completed, the puddling is usually not a serious factor in regions where the winters are mild and open.

Injury to the yield of wheat is most likely to occur when the initial grazing is started with the advance of spring.

The firming of the seedbed and the leveling of the drill ridges by the livestock tends to submerge the crowns of the wheat plants more deeply, seemingly resulting in protection against winter-killing. The firming of the soil around the crowns of the plants also tends to conserve the moisture. Plants in a moist surrounding are less susceptible to injury from low temperatures than when surrounded by a loose, dry soil. On the other hand, grazing causes some mortality when plants are pulled up by the animals or deeply tramped into the ground before the seedbed has been firmed.

SUPERIOR GERM PLASM

After a very thorough discussion the following wheats were listed as having superior germ plasm and suitable for use as parents of crosses:

List of Wheats Containing Superior Germ Plasm

Character and Variety	C. I. No.	State or Hybrid No.	Remarks
Winter-hardiness			
Minhardi	5149	---	
Lutescens	8896	---	
Yogo	8033	---	Resistant to most races of bunt
Minturki	6155	---	
Minard x Minhardi	11502	Minn. No. 2614	
Earliness			
Early Blackhull	8856	---	
Quivira	8886	---	Resistant to leaf rust
Tenmarq	6936	---	
Missouri Early Premium	11858	---	
Kanred x Hard Federation	10092	---	
Turkey selection 159	10100	---	Colorado
Quivira x (Kanred-Hard Fed.)		Kans. selection no. 373963	
Prelude x Kanred	11591	---	
Test Weight			
Blackhull	6251	---	
Early Blackhull	8856	---	
Chiefkan	11754	---	
Clarkan	8858	---	
Hessian Fly Resistance			
Illinois No. 1, W-38	.....	Kans. 37FN25	Spring
Marvel	8876	---	Spring
Marquillo x Tenmarq	---	Kans. 37FN529	Winter habit resistant to stem rust
Kawvale x Marquillo	---	Kans. 37FN748	Resistant to stem rust
Kawvale	8180		Good yielded
Drought Resistance		(Very little definite information available)	
Turkey ?	3689	So. Dak. 144	
Kharkof ?	1442	---	
Turkey ?	1558	---	General value
Baart	1697	---	White spring
Yielding Ability			
Quivira	8886	---	For southern district
Tenmarq	6936	---	For southern district
Cheyenne	8885	---	
Yogo	8033	---	For northern district
Turkey sel.	10094	Nebr. No. 1063	For central district
Kawvale x Tenmarq	11750	---	
Kanred x Marquis	11589	---	
Leaf Rust Resistance			
Mediterranean	3332	---	
Kawvale	8180	---	Hessian fly resistant
Hope x Hussar	11835	Kans. sel. G2343A-3-38	Stem rust and bunt resistant
Hope x Kawvale	---	Kans. J361606	
Medit. 3015-63 x Hope	---	Tex. 41-17-3	
Mediterranean sel.	---	Texas 3015-63	

List of Wheats Containing Superior Germ Plasm (Continued)

Character and Variety	C. I. No.	State or Hybrid No.	Remarks
Stem Rust Resistance			
Hope x Hussar	11835	--	Leaf rust resistant
Marquillo x Oro	--	FN787-3	
Hope	8178	--	Spring wheat
Mediterranean 3015-63 x Hope	--	Texas 41-17-3	
Hope x Turkey 1069	--	Nebr. 363401	
Ceres x Hope-Florence	11712	--	Spring
Bunt Resistance			
Hope x Hussar	11835	--	Stem and leaf rust resistance
Wheat x Rye (Meister)	11403	--	
Turkey sel.	10016	Nebr. 1069	Early, hardy. Questionable quality
Turkey sel.	10094	Nebr. 1063	High yielder
Ridit	6703	---	
Oro	8220	---	
Turkey sel.	11530	---	Resistant to forms attacking Oro
Martin x Tenmarq3	11804	Texas 50-33-23	
Oro x Tenmarq	11673	---	
Oro - Turkey - Florence Composite No. 2	1/		
Hussar - Hohenheimer	10068-1	1/	
Stiff Straw			
Akron sel. No. 7	11660	---	Different quality
Clarkan	8858	---	
Cheyenne	8885	---	
Non Shattering			
Blackhull	6251		
Mildew Resistant			
T. timopheevi F.P.I.94760		---	
Loose Smut			
Forward	6691		
Valprize	11539		
Perennial Wheats			
Agropyron hybrids	--	---	Mostly sterile

1/ These appear to be resistant to all known races including the dwarf smut.

VARIETIES IN PLOTS AND NURSERY

It was decided to take no action on the varieties to be included in the uniform plots and nursery until after the 1938 harvest. These are as listed below :

Varieties of Winter Wheat in Uniform Plot Tests 1937-38

South			Central		
Name	C. I. No.	Years tested	Name	C. I. No.	Years tested
Kharkof	1442	7	Kharkof	1442	7
Tenmarq	6936	7	Tenmarq	6936	7
Blackhull	6251	7	Blackhull	6251	7
Quivira	8886	7	Oro	8220	7
Early Blackhull	8856	4	Cheyenne	8885	7
Chiefkan	11754	New	Chiefkan	11754	New
Oro x Tenmarq	11673	New	Oro x Tenmarq	11673	New
Kawvale x Tenmarq	11669	New	Kawvale x Tenmarq	11669	New
Soft Red Winter			Kanred	5146	7
Denton	8265	7	Turkey selection	10094	3
Kawvale	8180	7			

North		
Name	C. I. No.	Years tested
Kharkof	1442	7
Minturki	6155	7
Yogo	8033	7
Karmont	6700	7
Minturki x Marquis	11502	2
Minard x Minhardi	8888	2
Turkey selection	10094	1

Varieties of Winter Wheat in the Uniform Yield Nursery, 1937-38

Variety	C. I. No.	State No.	Years grown	Yield record	Quality note	Remarks
Kharkof	1442	--	6	Fair	Good, 1934	
Blackhull	6251	--	6	Good	Good, 1934	Checks
Nebraska No.60	6250	--	6	Low	Good, 1934	
Early Blackhull	8856	--	6	Good	Good, 1935	Very early
Turkey selection	10083	Oklahoma No. 1	6	Good	Good, 1934	Weak straw
Turkey selection	10016	Nebr. 1069	6	Good		Early, hardy, bunt resistant
Turkey selection	10094	Nebr. 1063	6	Good	Poor, 1934, Needs long mix, yellow crumb	
Sibley No. 62	11523	Okla.	4	Fair		Weak straw
Kanred x Marquis	11589	Kans. No. 2690	4	Good	Needs long mix	
Turkey selection	11576	Nebr. No. 1082	4	Fair	Good, 1934, 1935, 1936	Bunt and fly resistant
Turkey selection	11577	Nebr. No. 1081	3	Good	Good, 1935, 1936; needs long mix	Bunt and fly resistant
Oro x Fulhard	11579	Nebr. No. 1083	3	Fair	Needs long mix	Bunt resistant
Kawvale x Tenmarq	11669	Nebr. No. 1086	3	V.good	Good, 1935, 1936	Early, promising
Akron selection	11660	Akron sel. No. 7	3	Good	Good, 1935	Stiff straw
Penquite selection	11745	Okla.	2	Poor	Yellow crumb	Soft wheat
Minturki x Blackhull	11671	Nebr. No. 1089	2	Poor	Yellow crumb	
Cheyenne selection	11666	Nebr. No. 1087	2	Fair	Needs long mix; yellow crumb	Hardy, bunt resistant
Kanred x Marquis	11746	Akron sel. No. 46	2	Poor	Fair plus	
Turkey x Marquis	11747	Akron sel. No. 49	2	Poor	Fair	
Oro x Tenmarq	11672	Kans. No. 2728	1	Fair		Bunt resistant, tender
Oro x Tenmarq	11673	Kans. No. 2729	1	Good		Bunt resistant, tender
Kawvale x Tenmarq	11750	Kans. No. 2727	1	V.good		Res.to leaf rust, promising
Blackhull selection	11737	Nebr. No. 1093	1	Good		Hardy selection
Tenmarq x Minturki	11580	Nebr. No. 1094	1	Good		
Kanred x (Hope-Hard Fed.)	11843	Akron No. 537				Rust resistant
Early Blackhull Hybrid	11846	H. C. No. 366				Early
Tenmarq x Nebr. No. 28	11847	Woodward 1094				Early
Turkey selection	11734	Nebr. No. 1095				
Kanred x Blackhull	11844	Nebr. No. 1098				
Minturki x Blackhull	11815	Nebr. No. 1099				

The following varieties in the yield nursery were listed as possible discards:

	Variety	C. I. No.
1.	Nebraska No. 60	6250
2.	Turkey selection	10083
3.	Turkey selection	10016
4.	Sibley No. 62	11523
5.	Minturki x Blackhull	11673 ? 11671
6.	Kanred x Marquis	11746
7.	Turkey x Marquis	11747