Comparative Yields and Quality Data for Five Hard Red Spring Wheat Varieties as Affected by Growth Location

by

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Introduction

The wheat improvement program in North Dakota is made up of various experimental phases, one of which is the cooperative wheat nursery. Ten varieties have been grown in different localities for a number of years according to a definite plan. The majority of the growers have been practical farmers. This experiment is unique among others in the state in providing the most varied set of growing conditions for the varieties since the locations are distributed over the entire state. The wheats are grown comparably in randomized single rows one foot apart and replicated four times to make a total of 40 yield rows in each experiment. The separate varietal yields from each rod row are composited to secure a sample for technological tests. Randomized replications are used to obviate the influence of variations in soil properties upon yield and quality. In the 1944 experiments five of the ten wheats consisted of named varieties and only these will be discussed since they are of greatest general interest.

Experimental Methods

Methods for assessing the milling and baking quality of small samples of wheat have been developed, and these render it possible to estimate the commercial value of wheats grown in rod row trials. The wheats produced in the nursery at Fargo have been tested by these methods for a number of years since the Experiment Station installed suitable equipment. Their value lies in the use of wheat samples weighing one-half pound or less for evaluation instead of the usual four pound samples. The time elapsing between making the original cross and the accumulation of a sample large enough for testing is reduced two or more years. Rival and Mida were tested for quality in their early history by using small samples, and many unnamed varieties are continually being evaluated by micro methods. The early elimination of undesirable selections is also rendered possible with an economy in time, effort and expense. The principal factors used in the evaluation of the quality of nursery samples are test weight, wheat protein content, flour yield, volume, or size of loaf and color of the loaf crumb.

Results and Discussion

Differences Among Varieties: In Table 1 are shown varietal averages of the comparative quality

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Table 1
Comparative Varietal Averages Secured From the Five Wheat Varieties Grown at Eighteen Localities in 1944

(Arranged in order of decreasing loaf volume.)

Variety	Test weight	Wheat protein content	Flour yield	Loaf volume	Crumb color	Ratio of loaf vol. to protein content	Yield
	lbs/bu	%	%	cc			b.p.a.
Newthatch	55.4	14.8	72.4	189	7.1	12.8	22.7
Thatcher	56.0	14.2	70.5	176	7.0	12.4	23.5
Mida	58.8	13.9	73.7	174	8.0	12.5	29.6
Rival	57.3	13.9	73.4	168	7.4	12.1	27.0
Pilot	56.4	13.8	69.0	162	7.2	11.7	27.5
Average	56.8	14.1	71.8	174	7.3	12.3	26.1
Sig. dif.	0.6	0.3	0.7	11			1.0

data obtained from the five wheats with overall averages for the various quality factors. Yields per acre are also given. The values needed to indicate significant differences among the several factors are included.

There are very important differences in yield among the five varieties. For example, there are approximately six bushels between the yields of Mida and Thatcher and since a difference of one bushel in yield shows a noteworthy difference in the field performance of two varieties, variations of six bushels are relatively very important. Judged by this reasoning, the yield of Mida is outstanding in these experiments. The yield values for Thatcher and Newthatch may have been reduced somewhat by intervarietal competition when grown immediately adjacent to the three other varieties since they have done better in field plot tests.

The technologic results point to important variations in the quality of the five wheats. Test weight varies from 55.4 to 58.8 pounds per bushel, a difference of 3.4 pounds, while a difference of 0.6 pounds denotes a real variation in this factor. Mida is thus higher in test weight than the four other wheats. For wheat protein, the varietal variation ranges from 13.8 to 14.8 percent, or 1.0 percent, with Newthatch being the highest. Here a significant difference is 0.3 percent. Mida and Rival are highest in flour yield, and this indicates that the miller should be able to produce more flour per bushel of wheat from them. In size of loaf, Newthatch was first; loaf volume is the most important single factor in quality evaluation and this result increases confidence in the quality performance of this new variety. In crumb color Mida is much the best, and this result is in very good agreement with findings from larger field plot experiments. The ratio, loaf volume to protein content, is an index of the relative ability of the wheat protein to produce large loaves. The larger the index the better the protein quality. These values rank the varieties in essentially the same order as loaf volume.

The results secured from field plot experiments conducted at Langdon, Dickinson, Williston and Edgeley in 1944 were in essential agreement with data presented here. In test weight Mida was first and Newthatch lowest. Newthatch was highest in wheat protein content and loaf volume and Pilot was again lowest. These milling and baking data were obtained by use of the Allis Chalmers experimental mill and the 100-gram baking technique, which are in common use in wheat testing laboratories.

Table 2

Average Quality and Yield Data of Five Wheats for Eighteen Growth Locations

(Arranged in order of decreasing loaf volume.)

Growth location	Test Wt.	Wheat protein content	Flour yield	Loaf volume	Crumb color	Ratio of loaf volume to protein content	Yield
	lbs/bu	%	%	cc			b.p.a.
Grafton	52.6	16.2	70.4	209	7.1	12.9	18.5
Wyndmere	53.3	16.1	70.2	205	7.0	12.7	15.9
Napoleon	59.6	15.9	71.1	190	7.4	11.9	26.6
Grand Forks	58.3	15.6	71.7	189	7.2	12.1	28.2
Douglas	58.5	12.7	71.6	188	7.8	14.8	20.3
Adams	56.2	13.5	71.6	179	7.1	13.3	17.7
Marion	57.9	16.5	70.2	178	7.6	10.8	24.9
Park River	58.1	14.0	73.6	177	7.4	12.6	39.1
Velva	58.2	13.8	72.2	175	8.1	12.7	38.1
Williston	59.8	13.6	71.7	167	8.0	12.3	39.5
Hettinger	58.3	13.1	72.8	167	7.7	12.7	26.1
Hunter	51.5	14.9	71.4	163	7.2	10.9	26.2
Lisbon	56.0	13.9	72.3	162	7.0	11.7	30.2
Kindred	57.9	13.7	73.8	162	7.2	11.8	26.4
Binford	56.6	13.0	71.2	158	7.5	12.2	13.3
Alice	52.0	13.2	71.9	156	6.8	11.8	33.5
Keene	59.5	12.9	73.4	156	7.2	12.1	28.1
Bottineau	57.6	11.5	71.3	147	6.8	12.8	13.5
Average	56.8	14.1	71.8	174	7.3	12.3	25.9
Sig. dif.	1.1	0.6	1.4	21			1.4

Differences Among Growth Locations: The data arranged to show differences caused by locations of growth are presented in Table 2. The differences are much more marked than those between varieties, and are in general agreement with results obtained from rather similar experiments conducted on hard wheats. Sandstedt and Fortmann (1944) reported results from six varieties of hard red winter wheat grown at 14 locations in Nebraska. Yield per acre varied from 13.6 to 38.3 bushels. Protein content, absorption, flour handling properties, mixing requirements and loaf volume of the varieties all varied with the environment. Varieties with low loaf volume potentiality gave the least response in loaf volume to changes in environment, while varieties with high loaf volume potentiality gave the greatest response. Also the localities which produced the largest loaf volumes showed the greatest differences between loaf volume. A somewhat similar study made by Harris, Sibbitt, and Scott (1945) on eight North Dakota wheats grown at seven locations in 1943, showed very significant differences in flour yield, flour protein content and loaf volume between varieties and environment, with the latter factor apparently exerting the major influence.

In the present study, yield per acre varies from 13.3 to 39.5 bushels, a difference of 26.2 bushels. Average yields for the five varieties were less than two bushels higher for the western part of the state. In particular, Thatcher and Newthatch yielded better in the west than in the east, probably due to the greater amount of leaf

rust on these two varieties in the east. This difference in yield is estimated at approximately 14 percent. Test weight per bushel varied from 51.5 to 59.8 pounds per bushel, a spread of 8.3 pounds, and wheat protein varied from 11.5 to 16.5 percent, a range of 5.0 percent. Relatively large differences are also shown in loaf volume. The values for the ratio of loaf volume to protein content, while showing some variation, do not indicate consistent differences among various areas of the state.

A correlation between wheat protein content and loaf volume appears to be indicated by the data, and this was substantiated by statistical analysis of the results. A correlation coefficient of $r=+0.74$ was obtained between localities for the wheat protein-loaf volume relationship, and a coefficient of +0.57 for the total, or overall, correlation between the two variables.

Table 3 is an analysis of variance of the more important results.

Very important differences were found in four quality factors between wheat varieties and locations of growth, and the analysis based upon mathematical procedure, supports the following conclusions: The environment during seasonal growth appears to have more effect than heredity, as denoted by wheat variety, in respect to protein content of wheat, while the contrary seemed to be true for flour yield. Little difference is evident between the comparative effect of location and variety upon test weight and loaf volume.

Summary

The data presented, founded on tests from five wheat varieties grown at 18 North Dakota localities in 1944, indicate that variety and location of growth both had a significant influence on yield per acre and wheat quality. Both of these factors, yield and quality, must of necessity be taken into consideration, in wheat improvement work, since a wheat must possess good yield potentialities to be of interest to the grower, while it must also be satisfactory in quality to the miller and baker. These conditions are kept well in mind in the Station wheat testing program.

The authors wish to acknowledge the excellent cooperation of farmers, students and others who assisted in the experiment.

Table 3
Analysis of Variance of the Test Weight, Wheat Protein, Flour Yield, and Loaf Volume Data

Source of variation	Degrees of freedom	Variances			
		Test weight	Wheat protein	Flour yield	Loaf volume
		lbs/bu	%	%	cc
Between locations	17	35.38**	10.34**	5.85**	1486.2**
Between varieties	4	30.30**	3.11**	71.63**	1912.9**
Error	68	0.79	0.25	1.19	272.03

**Denotes significance exceeding 1% point.

Literature Cited

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