



Dr. Richard Frohberg compares Olaf, at right, with the conventional hard red spring wheat, Waldron.

OLAF . . . A Short-Strawed, High Yielding Hard Red Spring Wheat Variety

R. C. Frohberg, L. D. Sibbitt, R. H. Busch and J. D. Miller

Olaf is a new semidwarf variety of hard red spring wheat released March 1, 1973 by the North Dakota Agricultural Experiment Station. The United States Department of Agriculture has participated in evaluation and testing of Olaf. This bearded, short-strawed variety is higher yielding and larger

Dr. Frohberg and Dr. Busch are associate professors, Department of Agronomy; Sibbitt is associate professor, Department of Cereal Chemistry and Technology; and Dr. Miller is plant pathologist, Agricultural Research Service, U.S. Department of Agriculture, NDSU.

in kernel size when compared to the hard red spring wheat varieties Chris, Waldron and World Seeds 1809. Olaf is heavier in test weight and less susceptible to ergot than Waldron. The new variety displays good field resistance to the prevalent races of stem and leaf rust.

Olaf wheat is named in recognition of Olaf M. Gronaas who was a technician for 50 years with the hard red spring wheat breeding project of the North Dakota Agricultural Experiment Station.

Table 1. Yield performance (bushels per acre) of five hard red spring wheat varieties grown at North Dakota Stations, 1970-72.

Variety	Dickinson 1970-72	Williston ¹ 1972	Minot ² 1970-71	Carrington ²		Langdon 1971-72	Fargo 1970-72
				Dryland 1970-71	Irrigated 1970-71		
Olaf	22.9	40.3	44.4	55.0	63.6	69.6	55.4
Chris	23.6	33.4	40.9	45.3	52.4	53.8	46.1
Waldron	22.7	37.0	36.4	46.2	56.6	49.8	53.1
Era	29.9	39.3	52.0	57.0	66.4	69.7	56.7
World Seeds 1809	18.7	35.4	42.7	54.8	64.3	67.9	53.7

¹Hail damage in 1971.

²Hail damage in 1972.

Table 2. Summary of agronomic performance of Olaf, Chris, Waldron, Era and World Seeds 1809 grown at North Dakota Stations, 1970-72.

Variety	Date headed (17) ^a	Ht. in. (16)	Lodging score ¹ (9)	% Rust		Leaf score ² (4)	Test wt. lbs/bu (18)	Yield bu/A (15)
				Leaf (10)	Stem (6)			
Olaf	7-5	30	1.3	tMR	0	3.9	60.6	48.2
Chris	7-6	37	4.4	15MS	0	3.0	61.1	41.3
Waldron	7-3	34	1.4	tMR	0	3.9	59.8	42.3
Era	7-8	29	1.8	5MS	0	3.0	61.4	51.1
World Seeds 1809	6-29	26	1.7	5MS	0	4.4	60.7	46.3

¹1 is erect; 9 is completely lodged.

²Leaf spotting diseases - visual rating 1, no infection; 6 severe infection.

³Number of tests.

Agronomic Performance

Early generation evaluation and preliminary yield trials indicated the potential agronomic desirability of the experimental line now named Olaf. Since 1970 Olaf has been tested as ND497 for three years in field plot trials and for two years each in the Uniform Regional Hard Red Spring Wheat Nursery and the Crop Quality Council commercial quality tests.

Yield data from the individual North Dakota Agricultural Experiment Stations show that Olaf has yielded more than Chris and Waldron at all locations except the Dickinson Station (Table 1). Compared with two other semidwarf varieties, Olaf generally has yielded 2-4 bu/A more than World Seeds 1809, but less than Era. Olaf and World Seeds 1809 have yielded similarly at the Carrington Station while at the Langdon Station, Era and Olaf have the same average grain yield.

Comparative agronomic and disease data from the North Dakota Stations (Table 2) indicate that Olaf has averaged two days later in maturity, about three-fourths of a pound heavier in test weight and 15 per cent higher in yield than Waldron. It has ranked equal to Waldron in lodging resistance and superior to Chris. Incidence of leaf spotting diseases for Waldron and Olaf has averaged higher than

Chris. Olaf is earlier in maturity than Era and later than World Seeds 1809. The three semidwarf varieties have similar lodging resistance; however, Olaf exceeded Era and World Seeds 1809 in plant height by 1 and 4 inches, respectively. The test weight of Olaf was similar to World Seeds 1809 and less than Era. In the three years of tests Olaf averaged 4 per cent higher in yield than World Seeds 1809 but 6 per cent less than Era.

Agronomic data from the regional nursery tests in the United States and Canada (Table 3) indicate that Olaf should be a well adapted variety to the Upper Midwest spring wheat production area. Information from the regional nursery was similar to and supported the data from North Dakota Stations.

Resistance to Stem Rust

Olaf has been resistant or moderately resistant to the prevalent and non-prevalent virulent North American stem rust races in greenhouse seedling tests (Table 4). It was moderately resistant to 15B-2 and 15B-6, the prevalent subraces of race 15B in North Dakota, and to non-prevalent virulent races 32, 113 and 151. With most races, Olaf's reactions were similar to those of Waldron. Olaf has shown good greenhouse adult plant resistance to a composite of races 17, 29, 32, 38, 87 and 151, except

Table 3. Summary of agronomic performance of Olaf, Chris, Waldron and Era grown in uniform regional trials in North Dakota, South Dakota, Minnesota, Montana, Manitoba and Saskatchewan, 1971-72.

Variety	Days to head (25) ^a	Ht. in. (27)	Lodging score ¹ (20)	% Rust		Leaf score ² (6)	Test wt. lbs/bu (29)	Yield bu/A (25)
				Leaf (13)	Stem (11)			
Olaf	63	32	1.7	tR	0	3.3	60.5	52.9
Chris	63	38	4.7	10MS	tR	3.0	60.5	43.1
Waldron	61	36	2.2	tMR	tR	3.9	59.8	47.1
Era	65	30	2.0	tMS	0	2.9	61.0	56.2

¹1 is erect; 9 is completely lodged.

²Leaf spotting diseases - visual rating 1, no infection; 6, severe infection.

³Number of tests.

Table 4. Seedling reactions of six bread wheat varieties to 11 races and subraces of the stem rust fungus, *Puccinia graminis f. sp. tritici*.

Variety	Race and Varietal Reaction ¹										
	11	15B-2	15B-6	17	29	32	28	56	87	113	151
Olaf	R	MR	MR	R	MR	MR	MR	MR	MR	MR	MR
Waldron	R	R	MR	R	MR	MR	MR	R	R	MR	MR
Chris	R	R	S	R	R	MS	S	R	R	MS	S
Era	R	R	R	R	MS	MR	MR	R	R	R	MR
World Seeds 1809	R	R	S	R	R	R	MR	R	R	MS	S
Marquis	MS	MS	S	MS	MS	S	MR	MS	S	MS	MR

¹R - resistant, MR - moderately resistant, MS - moderately susceptible and S - susceptible.

for a trace of a moderately susceptible reaction. Also a trace of a moderately susceptible reaction to race 87 was noted in tests of seedling plants. In the field, adult plants showed resistance to race 15B and to races 15B-6, 32 and 151 in Puerto Rico rust nurseries. Olaf was resistant in the 1971 and 1972 uniform regional trials grown in North Dakota, Minnesota, Nebraska and Manitoba.

Milling and Baking Quality

The overall quality of Olaf is more or less typical of semidwarf hard red spring wheats grown and tested to date in North Dakota. None of the semidwarfs evaluated for quality by the Department of Cereal Chemistry and Technology are equal or superior to any of the hard red spring conventional height varieties currently in production.

Tables 5 and 6 show comparable average quality data for Olaf, Chris, Waldron, Era and World Seeds 1809. These tables represent 18 samples grown over a three-year period at Fargo and other branch stations throughout North Dakota.

On the basis of these data, Olaf is higher in test weight than either Chris or Waldron, some-

what similar to World Seeds 1809, but 1.1 lbs. per bushel lower than Era. Test weight is important from both the standpoint of the grower and the miller. Plump, heavy wheat usually is higher in grade and hence the price per bushel to the producer is higher. Plump wheat usually yields more flour and this is important to the commercial miller. Percentage of vitreous kernels is also important as it is a major grading factor. In this respect, Olaf is quite similar to Chris and Waldron but higher than the other two semidwarfs, Era and World Seeds 1809, in this comparison.

Spring wheat varieties high in wheat and flour protein contents are very desirable, not only from a nutritional standpoint, but possibly more importantly these factors are usually associated with good baking properties. In these factors Olaf is higher in wheat and flour protein content than Era but about the same as World Seeds 1809. It is, however, not equal to either Chris or Waldron. Possibly of more importance is the drop in protein from wheat to flour for Olaf. The normal difference for spring wheats is a drop of from 0.6 to 0.8 per cent. Olaf has a drop of 1.1 per cent. Thus, to obtain a flour protein content comparable to the level as shown in

Table 5. Summary of average (3 years) quality data for Olaf, Chris, Waldron, Era and World Seeds 1809 grown comparably at North Dakota stations (1970-71-72 crops).

Variety	Test Weight	Vitreous Kernels	Wheat Protein ¹	Flour Protein ¹	Protein Difference from Wheat to Flour ¹	Flour Yield	Flour Ash ¹
	lbs/bu	%	%	%	%	%	%
Olaf	61.4	85	14.4	13.3	-1.1	67.5	0.39
Chris	60.8	86	14.6	14.0	-0.6	67.5	0.41
Waldron	60.6	86	14.9	14.1	-0.8	67.7	0.43
Era	62.5	74	13.1	12.2	-0.9	70.6	0.44
World Seeds 1809	61.9	81	14.3	13.4	-0.9	68.6	0.39

¹Expressed on a 14.0% moisture basis.

these data for Chris, the wheat protein content for Olaf would have to be about 15.0 per cent. The other two semidwarfs in the comparison show similar tendencies, but the drop is not as great as that shown for Olaf. This deficiency in Olaf can be considered as a major fault.

The experimentally milled flour yield of Olaf is at an acceptable level; this is coupled with a relatively low flour ash which is very desirable. High flour yields with low ash contents appear to be a characteristic of most of the semidwarfs tested in this laboratory.

Possibly the best criterion for wheat quality is the baking test when performed under specific controlled conditions in which all variables, except the flours being evaluated, are kept as constant as possible. Absorption, an important characteristic, is of great interest and concern to the commercial baker. A flour that is high in absorption will produce more pounds of bread per sack of flour than one with low requirements. The absorption of Olaf is lower than Chris, about the same as Waldron but considerably better than either Era or World Seeds 1809.

The loaf volume of Olaf is the second lowest in this comparison and can be considered as a major fault. Large loaves are desirable, provided other factors such as the general shape of the loaf (symmetry) and the color of the loaf crust are satisfactory. In these two factors Olaf is not equal to any of the other varieties shown in Table 6. The internal characteristics of the loaf are ascertained routinely and provide information concerning the grain and texture and color of the crumb. The grain and texture of a desirable loaf should contain relatively small elongated thin-walled cells of uniform size. In addition, the texture should have a "silky sheen" to the surface. The desirable color of the loaf crumb made from unbleached flour should be bright and only slightly creamy. The crumb grain and texture of Olaf is better than World Seeds 1809, equal to Waldron, but not quite as good as Chris or Era. The crumb color of Olaf is not equal to Chris, but is

slightly better than Waldron, somewhat better than World Seeds 1809 and considerably better than Era.

Although data is not presented here, physical dough tests were performed on all of the varieties listed in the tables. Physical dough properties are relatively difficult to define. Possibly the simplest explanation could be termed the "elastic properties" of a flour-water dough.

One of the most widely used instruments for physical dough testing is the Brabender Farinograph. The Farinograph is a recording dough instrument that measures plasticity and mobility of dough subjected to prolonged, relatively gentle mixing action at a constant temperature. Resistance offered by the dough to the mixing blades is transmitted through a dynamometer (a device which measures mechanical energy) to a pen that traces a curve on a kymograph chart. This chart, which is commonly called a farinogram, provides information about the mixing time, the mixing tolerance, and the absorption (or water-binding capacity) of the flour being tested.

Farinograms obtained for Olaf have been quite variable showing a range of curve characteristics which are weaker than Chris or Waldron to excessively "tough", "abnormal" types which, in some instances, require more than 30 minutes to reach the optimum mixing time.

Briefly, mixing time is the time required to mix a dough composed of flour, yeast, sugar, salt, water and other baking ingredients to its optimum gluten development. A "normal" mixing time is similar to the values shown for Chris, Waldron, Era, and World Seeds 1809. Actual mixing times will vary with the type of commercial mixers used but the relative positions usually do not change. The dough mixing time for Olaf as shown in Table 6 is about 30 per cent longer than any of the other varieties in this comparison. Additional tests performed on Olaf also revealed extremely strong mixing requirements when determined by the continuous baking process. Tests reported elsewhere show that Olaf had mixing requirements six times longer than the

Table 6. Summary of average (3 years) quality data for Olaf, Chris, Waldron, Era and World Seeds 1809 grown comparably at North Dakota stations (1970-71-72 crops).

Variety	Absorption	Mixing Time	Loaf Volume	Grain & Texture	Crumb Color	Crust Color	Symmetry
	%	min.	cc.				
Olaf	65.3	8.1	825	7.9	7.9	3.8	4.3
Chris	65.9	6.4	900	8.0	8.3	4.0	4.5
Waldron	65.3	6.3	887	7.9	7.8	4.0	4.5
Era	62.0	6.2	814	8.0	7.2	3.9	4.4
World Seeds 1809	63.6	6.1	872	7.3	7.6	4.0	4.4

check varieties. These abnormal and inconsistent curve patterns and excessive mixing requirements are also considered as major faults.

Independent tests of Olaf from other sources substantiate more or less the conclusions formulated from these data.

Botanical Description

Olaf is a hard red spring wheat variety, *Triticum aestivum* L., with the following botanical description:

Growth habit: typical spring, daylength sensitive.

Stem: mid-short, strong, white.

Spike: awned, fusiform, middense, erect.

Glume: glabrous, white, midlong, midwide; shoulders narrow to midwide, oblique; beaks wide acuminate, 6-8 mm long.

Awn: White, 4 to 9 cm long.

Kernel: red, midlong, hard, ovate; germ midsized; crease midwide, middeep; cheeks angular to rounded; brush midlong.

Breeding History

Olaf, C.I.15930, is a selection from the cross Justin*2/3/ND259/Conley//Conley/ND122/4/Justin/5/Waldron made in the greenhouse in 1965 by Glenn S. Smith. The awned breeding line used as the maternal parent in this cross came from Smith's program to combine the semidwarf character of ND259 (Mayo 54//Norin 10/Brevor), the stem rust resistance and excellent quality of Justin and Conley, and the high grain yield of ND122. Waldron, the paternal parent, contributed strong straw, good yield and rust resistance to the cross.

The early segregating generations of the cross were grown in North Dakota and the final selection (single F₄ plant) was made in the 1967-68 winter nursery at Ciudad Obregon, Sonora, Mexico. Agronomic, disease and quality tests have been conducted in North Dakota since 1968 and regional tests beginning in 1971.

Increase and Allocation of Seed

The first increase of Olaf was produced from a block of rows in the 1969-70 Mexico winter nursery. Part of the seed produced was used for seeding 1970 field plot trials and the remainder was used to seed one-eighth of an acre under irrigation at the Carrington Station. Seventy bushels of seed were produced in 1971 at the Agronomy Seed Farm, Casselton, N. D. and five acres were seeded near Yuma, Arizona in 1971-72. Three hundred eighty-two bushels were returned and seeded in North Dakota in 1972. Foundation seed available from these increases will be allocated in North

Dakota to County Crop Improvement Associations and the Seed Division of the North Dakota Agricultural Association for seed increase in 1973. Allocations also will be made to other states in compliance with the policy of mutual sharing of new variety seed stocks.

The North Dakota Agricultural Experiment Station will maintain purified Breeders seed of Olaf hard red spring wheat for foundation seed growers so long as the variety is commercially in demand.

Summary

Olaf, a new semidwarf hard red spring wheat variety, has been released by the North Dakota Agricultural Experiment Station. It is higher yielding than the HRS wheat varieties Chris, Waldron and World Seeds 1809 but less than Era in North Dakota. Olaf is taller in height than Era and World Seeds 1809 and is equal to Waldron in lodging resistance. It is similar to Waldron in reaction to most stem rust races and in resistance to leaf rust.

The quality of Olaf is somewhat typical of all semidwarf wheats grown and tested to date in North Dakota. Olaf has a tendency for low wheat and flour protein contents. Olaf's major quality faults are the drop in protein from wheat to flour, low loaf volume of the bread, and long mixing time which is sometimes excessively long. Farinogram patterns have been variable, showing a number of "abnormal" type curves. Olaf has on the average good test weight, acceptable experimentally milled flour yield, ash content, absorption, bread crumb color, and crumb grain and texture. However, despite these acceptable quality factors, some of the major faults may play an important role in determining the usefulness of this wheat in the domestic and export markets.

Acknowledgments

The development, selection and testing of this new variety was a cooperative effort of the Departments of Agronomy, Cereal Chemistry and Technology and Plant Pathology, North Dakota State University, and the NDSU Branch Experiment Stations throughout the state. Scientists of the ARS-USDA also have participated in the evaluation and testing. The extra winter generations at CIANO (Experiment Station), Ciudad Obregon, Sonora, Mexico expedited the development and increase of the variety through cooperation of the Crop Quality Council, Minneapolis, Minn., the Rockefeller Foundation, and the Mexican Ministry of Agriculture. The NDSU Seed Stocks Project organized and supervised the large increase phases in North Dakota and at Yuma, Arizona.