

Authorized by
Extension Service and Agricultural
Experiment Station Personnel
NDSU



NORTH DAKOTA
STATE UNIVERSITY

JAN 12 1968

LIBRARY

Semidwarf Wheat Varieties

Semidwarf (short) wheat varieties are not new to plant breeders. They have been observed and studied since 1945 when Norin 10, a semidwarf white winter wheat, was first introduced from Japan. In recent years, breeders of all classes of wheat have incorporated semidwarfs in their breeding programs, including sources other than Norin 10.

The first semidwarf variety released was Gaines, developed for the Pacific Northwest by Washington State University and the USDA. It has the short, strong straw and yield capacity of its semidwarf parent Norin 10, but acquired many of its good agronomic characteristics from the locally adapted varieties of wheat used in its parentage.

Wheat breeders with the Rockefeller Foundation working on world wheat improvement in Mexico have incorporated Norin 10 in their spring wheat breeding program. They have developed and released 16 semidwarf varieties since 1962. Mexico grows these varieties and has become an exporter of wheat in recent years. Some of these varieties are currently being grown commercially in Pakistan and India as well as other countries where they offer the opportunity of making some of these countries self-sufficient in wheat production.

The early Mexican varieties were susceptible to rust and other diseases in the United States and very low in bread-making quality compared with our spring wheats. The more recent varieties have good stem and leaf rust resistance and have shown some improvement in quality. The Mexican Institute of Agriculture and Rockefeller Foundation is continuing its wheat improvement program by crossing with high quality spring wheats from our area such as Justin and Chris. They offer free exchange of breeding material and new varieties upon request of both public and private plant breeders anywhere in the world including North Dakota State University.

NDSU breeders made their first crosses using semidwarf wheat parents with hard red spring wheat and durum wheats in 1956. None of these crosses has materialized into a commercial variety. As the breeding program continues, these "shorty" wheats will likely become more and more prominent. Other states also

have worked with semidwarfs in their breeding programs. Texas released the variety Sturdy in 1966 and Arizona released a semidwarf variety called Maricopa in 1967. Both are intended for production under irrigation or high rainfall areas. As a result of the total breeding efforts, we may soon see semidwarf wheats released that are acceptable for commercial production in our spring wheat area.

Promising Mexican semidwarf red spring wheat lines have been evaluated in the North Dakota wheat improvement program since 1956, but none has been adapted to North Dakota growing conditions nor has had acceptable milling and baking quality. One named Mexican semidwarf variety released in 1966 was included in the regular variety tests at most North Dakota stations in 1967. This variety showed satisfactory field performance but unsatisfactory milling and baking characteristics.

The cooperative international spring wheat nursery crops grown at Fargo and Minot during the past three years have given NDSU breeders an opportunity to determine local performance of the best semidwarf, hard red spring and durum varieties available. The performance of semidwarf wheat varieties grown in Mexico also have been observed by NDSU wheat breeders while observing and harvesting NDSU spring wheat nurseries grown there during the winter months.

CHARACTERISTICS OF SEMIDWARF WHEATS

The term "semidwarf" is used to describe varieties that are considerably shorter in height than common varieties. Not all semidwarf varieties are alike. Some desirable agronomic characteristics of released varieties include:

1. They are 10 to 12 inches shorter than common varieties under favorable growing conditions but only 2 to 3 inches shorter under drought conditions.
2. Their general appearance, including the number of leaves, is the same as common varieties, but the stem, especially the peduncle (the stem portion just below the head and above the top joint), is considerably shorter which makes the plant short.

3. They have considerably stronger straw, which makes them especially desirable to produce under irrigation and heavy fertilizer application.
4. They may tiller well under highly productive conditions, but increased tillering may not occur with a short spring growing period in North Dakota. The increased tillering ability of semidwarf wheat is best realized by winter types which have a long period of development.
5. They resist shattering.
6. They tend to have a short coleoptile, which is not a major emergence factor unless they are seeded too deeply.
7. Many semidwarf wheats are insensitive to day length which means they will mature in about the same number of days regardless of day length. This reaction gives the varieties wide areas of adaptation in the world.
8. They express their greatest yield advantage under very favorable moisture and fertility levels.
9. Because they are short strawed, the foliage density of heavy stands will be greater resulting in a tendency to favor greater development of foliar diseases such as Septoria and other leaf spotting diseases.

SEMI-DWARF WHEATS AVAILABLE

Red River 68 wheat has recently been named and released by a private seed firm and seed of this variety is being offered for sale. The variety name was approved by the North Dakota State Seed Department in September, 1967. Red River 68 is accepted for certification by the North Dakota State Seed Department. Certification of any variety verifies its genetic purity but does not in itself mean the variety is recommended for commercial production in the state where it is certified.

Other semidwarf wheats without variety names have been sold by another private seed company and were grown in North Dakota in 1967. Seed of these is also being offered for 1968 sowing.

RED RIVER 68 AND OTHER SEMI-DWARFS NOT RECOMMENDED

It is recognized that Red River 68 has several desirable agronomic characteristics, but in view of the quality report Red River 68 cannot be recommended and should be discouraged for commercial wheat production in North Dakota.

Other semidwarf wheats that may be offered for sale have not been adequately evaluated but are apt to be lacking in both disease resistance and quality, and therefore cannot be recommended at this time.

RESULTS FROM THE NORTH DAKOTA AGRICULTURAL EXPERIMENT STATION

Red River 68 was included in nursery trials only for observation in 1966. In 1967, it was sown in nurseries for yield and observation at six locations. The results

are reported in Table 1. Yield or other data from one year's tests is not enough to draw valid conclusions. North Dakota crop environment in 1967 tended to favor early varieties of grain crops and did not contribute to the development of rusts or other foliage diseases

Table 1. Agronomic data on Red River 68 from North Dakota nursery plots 1967 crop 1/

Station	Variety or line	Heading date	Ht., in	Lodging 2/	Percent rust		Test wt.	Yield
					Leaf	Stem		
Casselton	Chris	7-11	43	3	0	0	58.0	40.4
	Justin	7-12	43	2	30	0	60.0	31.4
	Red River 68	7-8	34	2	0	0	61.0	46.3
Fargo	Chris	7-16	44	5	0	0	58.0	35.0
	Justin	7-15	46	2	1MR	Tr-R	60.0	40.8
	Red River 68	7-9	33	1	Tr-R	0	60.5	46.9
Langdon	Chris	7-18	37	0	0	0	62.0	40.7
	Justin	7-18	37	0	0	0	61.5	37.1
	Red River 68	7-15	32	0	0	0	63.0	39.5
Minot 3/	Manitou	7-6	32	0	0	0	61.0	33.1
	Justin	7-7	33	0	0	0	60.0	27.5
	Red River 68	7-1	26	0	0	0	61.0	43.5
Williston	Chris	7-4	22	0	0	0	57.1	17.8
	Justin	7-4	22	0	0	0	56.6	17.9
	Red River 68	6-28	20	0	0	0	60.0	19.5
Dickinson	Chris	7-8	27	0	0	0	58.8	21.1
	Justin	7-9	30	0	0	0	60.5	18.6
	Red River 68	6-30	26	0	0	0	60.0	22.0

1/ Grown in small replicated plots on fallow with normal fertilizer application

2/ 0=erect; 10=flat

3/ Note Manitou instead of Chris

From these 1967 results, it is obvious that Red River 68 has desirable agronomic characteristics. Compared with Chris, it matured from 3 to 7 days earlier, was 9 to 10 inches shorter at eastern and central stations and only about 2 inches shorter at western stations where drought was a greater factor, was considerably stronger strawed, had a higher test weight per bushel, had good stem and leaf rust resistance, and yielded higher especially at the eastern and central stations (except Langdon).

DISEASE REACTION

Red River 68 has good resistance to the common field races of stem rust as shown in Table 2 and is also resistant to leaf rust.

Table 2. Greenhouse Reaction of Three Wheat Varieties to Stem Rust 1/

Variety	Stem Rust Races			
	56	32B	15B-2	151
Chris	R	MS	R	MS
Manitou	R	MS	R	MS
Red River 68	R	MS	R	MS

R - resistant, MS - moderately susceptible

1/ Source: Federal Rust Laboratory, St. Paul, Minn.

N. D. Experiment Station, Fargo

The 1967 season was not favorable to the development of Septoria and other leaf diseases, so no field evaluation was possible. Preliminary greenhouse tests, however, tend to indicate that Red River 68 may be as susceptible to Septoria and other leaf diseases as are Chris and Manitou. Since it matures early it makes

most of its growth during the cooler, high humidity part of the season. When stands of short strawed crop are heavy, their thick ground cover is likely to be high in humidity, creating field conditions under which these diseases may be more damaging to Red River 68 than to other long-strawed varieties.

SEMIWARF DURUM PROGRESS

So far the only semidwarf durum variety released is Oviachic by Mexico in 1965. It and the more promising current breeding lines are insensitive to day length, a desirable characteristic, which resulted from early crosses made by North Dakota breeders. Oviachic has been included in the Cooperative International Durum Nursery at two locations in North Dakota. Results are reported in Table 3.

Table 3. Semidwarf Versus Langdon Durum in International Nursery, 1966

Variety	Yield (bu./A)		Test wt. per bu.	
	Minot	Carrington	Minot	Carrington
Langdon (durum)	45	45	61	60
Oviachic (durum)	47	16	58	47

This durum variety seems to have satisfactory yield capacity, but its susceptibility to diseases is expressed in the low yield and test weight produced at Carrington. These results support the statement of NDSU durum breeders that the satisfactory use of semidwarfism in durum is not as advanced as in hard red spring wheats. They also point out that fewer breeders conduct research on durum and some difficulty is encountered in transferring semidwarf genes from common wheat to durum. Shortening and strengthening of straw has, however, been partially accomplished in such new varieties as Leeds, Wells and Lakota.

QUALITY TEST RESULTS ON RED RIVER 68

The NDSU Cereal Chemistry and Technology Department's findings show that compared with check samples, Red River 68 has a higher test weight and a higher 1,000 kernel weight, and was free of kernel diseases. The variety did show lack of proper kernel size distribution, a higher wheat ash content than desirable and a slight tendency towards lower protein. While the total flour yield was higher, the high ash content decreased the patent flour yield by 10 to 20%. Patent flour is that refined portion used for bread baking.

The baking properties of Red River 68 indicate a long mixing tolerance. However, this is accompanied by an excessive mixing requirement which is about two to three times longer than usual for spring wheat flour. In addition, the flour prepared from Red River 68 tends to absorb water slowly and to form doughs which are wet and sticky. The net effect of slow water absorption and a long mixing requirement is to reduce substantially the number of loaves of bread that bakers can produce in a given period of time with current equipment. While acceptable loaves of bread were made from Red River 68 and from blends of Red River 68 with other spring and winter wheat flours, major adjustments in the normal baking procedure were necessary.

Figure 1 shows one of the quality differences in characteristics of doughs made from Chris and Red River 68 flours. Such curves are made on a scientific instrument which is designed to measure certain dough properties. The curve for Chris represents a normal dough pattern. The curve for Red River 68 indicates that much more force is required to extend the dough, and that it is less extensible, which illustrates an undesirable property that bakers call "buckyness".

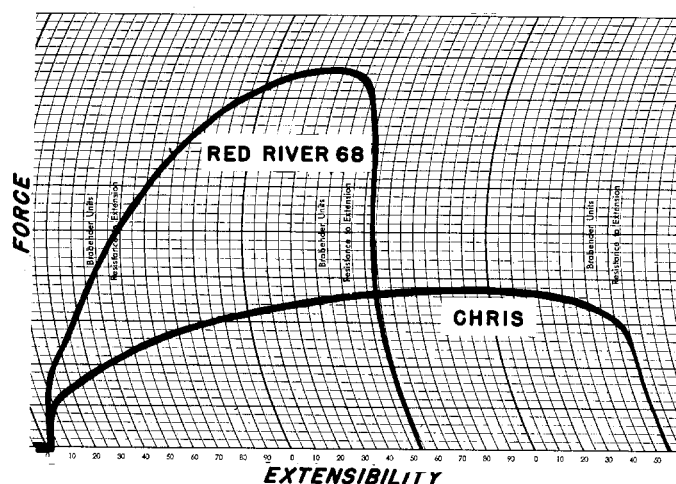


Figure 1. EXTENSOGAM SHOWING VARIETY DIFFERENCES IN DOUGH CHARACTERISTICS

Five samples of Red River 68 and standard varieties grown in 1967 on five different northern Red River Valley farms were carefully taken by a disinterested party. At four of the locations Chris was used as the check variety and at one location it was Manitou.

These wheats were milled separately at the USDA Hard Red Spring and Durum Wheat Laboratory at Fargo and the 10 flour samples were sent to 15 different milling industry, state and federal laboratories for independent tests and evaluation. Collaborating in these quality tests were the North Dakota State Mill and Elevator and other industry representatives, the NDSU Cereal Chemistry and Technology Department and the USDA Hard Red Spring and Durum Wheat Laboratory.

The conclusions reached unanimously by this group and reported by the Crop Quality Council in their behalf were that,

"Economically important problems encountered in the first year of broad scale industry tests, include a substantial reduction in the production of bakery flours from grain of Red River 68, and an excessively long mixing requirement for the new wheat which would slow bread production in modern baking plants. The ability of Red River 68 to be blended with other types of wheat was also substantially less acceptable than present-day upper midwest spring wheat varie-

ties. Based on evidence available from this first year of tests, we conclude that the processing qualities of Red River 68 are not acceptable. Recognizing the rapid trend toward the highly automated "continuous mix" baking process, those who conducted the test felt that bakers could not economically reduce production rates enough to make satisfactory bread from Red River 68. With the ready availability of alternate sources of wheat, widespread production of Red River 68 could result in a substantial shifting of grain purchases to other producing areas in order to obtain needed processing characteristics."

Industry representatives indicated that because of the processing problems of Red River 68, they would seek other sources of wheat for flour rather than make processing changes.

Quality requirements of our wheat market are geared largely to automated bread baking processes. Quality tests from laboratories, millers and bakers in far-off locations, unless they are made on the basis of our market requirements, are of little value because these concerns may not be buyers in our wheat market.

The North Dakota State Wheat Commission in a news release stated,

"Total exports of hard red spring wheats have increased dramatically from 75 million bushels during the 1964-65 marketing year to 120 million bushels during the year ending July 1, 1967, while domestic use hovered around 136 million bushels. We feel that our export market has grown because of a cooperative effort between plant breeders, cereal chemists, tradesmen and producers to provide both for-

eign and domestic buyers with acceptable, high quality spring wheats. Based on the continuing demand for high quality hard red spring wheat in both domestic and export markets, we are deeply concerned about the production of new varieties that might lower the overall quality profile of North Dakota spring wheats."

SUMMARY

1. Semidwarf wheats are not new. They were introduced from Japan about 20 years ago.
2. NDSU wheat breeders made their first semidwarf crosses with hard red spring wheat and durum varieties in 1956. They noted two major faults with these early crosses.
 - a. Susceptibility to disease
 - b. Low quality.
3. The first major breakthrough in the U.S. using semidwarf parentage was the white winter wheat variety Gaines in the Pacific Northwest. Gaines produces a low protein cake flour.
4. Wheat breeders of the Rockefeller Foundation in Mexico have used semidwarfs extensively in their hard red spring wheat and durum breeding programs. They have released many varieties, but so far none has been adapted to commercial production in our area.
5. Increasing amounts of semidwarf parentage are being used in the hard red spring wheat and durum wheat breeding programs at NDSU and in other spring wheat states.
6. No semidwarf wheat is currently available that can be recommended for commercial production in our area. The variety, Red River 68, is not recommended for commercial wheat production in North Dakota because it lacks the quality required by our wheat market.