

This instrument (Brabender Farinograph) produces the curves for each individual variety to be compared with the standard farinograms found in Figure 2, page 12. Farinogram classifications for the varieties under test are in the Tables.

Effect of Fertilizer Nitrogen Rate on The Quality of Six Hard Red Spring Wheats

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INTRODUCTION

Because of interest in new semidwarf wheat varieties and the lack of information about their response to so-called high fertility levels, a study was recently undertaken at the North Dakota Branch Experiment Station at Carrington. Results pertaining primarily to the agronomic characteristics were reported in a paper entitled "Effect of Fertilizer Nitrogen Rate on Yield of Six Spring Wheats" (1). The article presented here is a companion paper and deals with the quality aspects of the samples used and discussed in the first paper.

MATERIALS AND METHODS

In addition to the agronomic characteristics, new wheat varieties must be satisfactory for commercial utilization. The wheat must be relatively high in test weight, possess a good kernel appearance, mill satisfactorily on equipment in general use by commercial mills and have a relatively high protein content.

The flour should be of a high yield, possess a bright color and be low in ash (mineral content).

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The flour protein content should be relatively high with good gluten strength. The mixing characteristics and absorption properties must also be at suitable levels.

The quality of the baked bread is of great importance and is evaluated according to the following: loaf volume, crust color, general shape of the loaf, internal loaf characteristics, dough handling properties, fermentation tolerance and oxidation requirements. In addition, the number of loaves of bread obtained from a given unit of flour is of considerable importance to the commercial baker.

RESULTS AND DISCUSSION

As it would be almost impossible to include all of the quality determinations made, only the characteristics that are of the most importance are shown in the tables.

It was found that although some specific quality differences occurred between the irrigated and dryland plots, these differences were minimal. Therefore, for brevity, only the dryland plots are reported and discussed.

To assist in a more thorough interpretation of the quality data as it relates to yield of bushels per

acre, Figure 1 depicts graphically the average yields obtained.

Table 1 lists data for Waldron and the five semidwarf varieties combined with zero nitrogen fertilizer application.

In the control test plot with the zero nitrogen treatment the test weights of the semidwarfs were all higher than the check variety, Waldron. The highest wheat protein content of the semidwarfs was Ciano 67, which was 1.7 per cent below Waldron. On the average, the five semidwarfs were 2.8 per cent lower in protein than Waldron. In absorption, World Seeds 1812 was 1.8 per cent lower than Waldron, Bonanza 5.1 per cent lower, with the other semidwarfs in between these two varieties. The dough handling properties for Red River 68 and Inia 66 were unsatisfactory. Loaf volumes of all the semidwarfs were considerably lower than the check variety. Crumb grain and texture of the loaves from the semidwarfs also were inferior to the check variety. The mixing times for World Seeds 1812 and Bonanza were undesirably short and Red River 68 was extremely long. The mixing tolerance as depicted by the farinograms were at satisfactory levels for Waldron, Ciano 67, Bonanza and Inia 66. However, the farinograms of both Ciano 67 and Bonanza produced curves which were slightly "abnormal". World Seeds 1812 showed very little mixing tolerance. Red River 68 was very long and exhibited characteristics of a "tough" abnormal type of gluten.

The yield of bushels per acre varied from a low of 32 for Ciano 67 to a high of 38 for Bonanza. Waldron produced 35 bushels per acre under the same conditions.

Table 2 presents data for Waldron and the five semidwarf varieties from the plots treated with 50 pounds of nitrogen.

In general, test weights decreased and protein contents increased for all varieties; however, the degree of change was not uniform between varieties. For example, the test weight of Waldron was reduced 0.4 pounds per bushel while Bonanza was reduced 2.1 pounds per bushel. Although the protein content was increased on all of the varieties, none of the semidwarfs reached the level obtained by the check variety. The increases in absorption for all varieties were in line with the increases shown for wheat protein content. The dough handling properties of Red River 68 and Inia 66 were unsatisfactory. With the exception of Bonanza, none of the semidwarfs produced loaves equal in size to the Waldron check. Crumb grain and textures of the semidwarfs were inferior to Waldron with the exception of Ciano 67 and Bonanza. The mixing time of World Seeds 1812 was short, with Red River 68 being extremely long. The others were at acceptable levels. The mixing tolerance for World Seeds 1812 was very short, while a long mixing tolerance was displayed for Red River 68 and Bonanza. Ciano 67 and Inia 66 were satisfactory in mixing tolerance; however, all of the semidwarfs, with the exception of World Seeds 1812, produced "abnormal" farinogram curves.

The bushel yields obtained ranged from a low of 44 for Waldron to 52 for Ciano 67. When compared with Waldron, Red River 68 was 4 bushels (9 per cent) more per acre, World Seeds 1812, 3 bushels (7 per cent) more, Bonanza, 7 bushels (16 per cent) and Inia 66, 2 bushels (4 per cent) more.

Table 1
PERTINENT QUALITY DATA FOR WALDRON AND FIVE SEMIDWARF VARIETIES
(Zero Nitrogen Application)

Variety	Yield b.p.a.	Test Wt. lbs./bu.	Protein ¹		Absorp- tion %	Dough ²	Loaf Volume cc.	Crumb Grain & Texture ³	Mix- Time min.	Farino- graph ⁴ classif.
			Wheat %	Flour %						
Dryland Plots										
Waldron	35	62.2	15.0	14.1	65.7	4	845	8.5	7.5	6
Ciano 67	32	64.4	13.3	12.8	62.9	4	740	7.5	8.0	6 ⁵
Red River 68	33	63.4	11.7	11.4	63.4	3	580	5.5	13.0	8 ⁵
World Seeds 1812	37	63.9	11.7	11.3	63.9	4	700	6.0	5.5	3
Bonanza	38	63.5	11.7	11.3	60.6	4	730	7.5	5.0	7 ⁵
Inia 66	35	64.1	12.9	12.4	62.4	3	705	6.5	7.5	6
Ave-Semidwarfs	35	63.9	12.3	11.8	62.6	3.6	691	6.6	7.8	6.0

¹Expressed on 14.0% moisture basis.

²Dough handling properties, 4 - good; 3 - fair; 2 - poor; 1 - very poor.

³Bread crumb grain and texture, 9.0 to 10.0 - excellent; 8.0 to 8.5 - good; 7.0 to 7.5 - fair; 6.0 to 6.5 - poor.

⁴See Figure 2 for reference farinograms.

⁵Abnormal curve type.

Carrington Dryland Plots

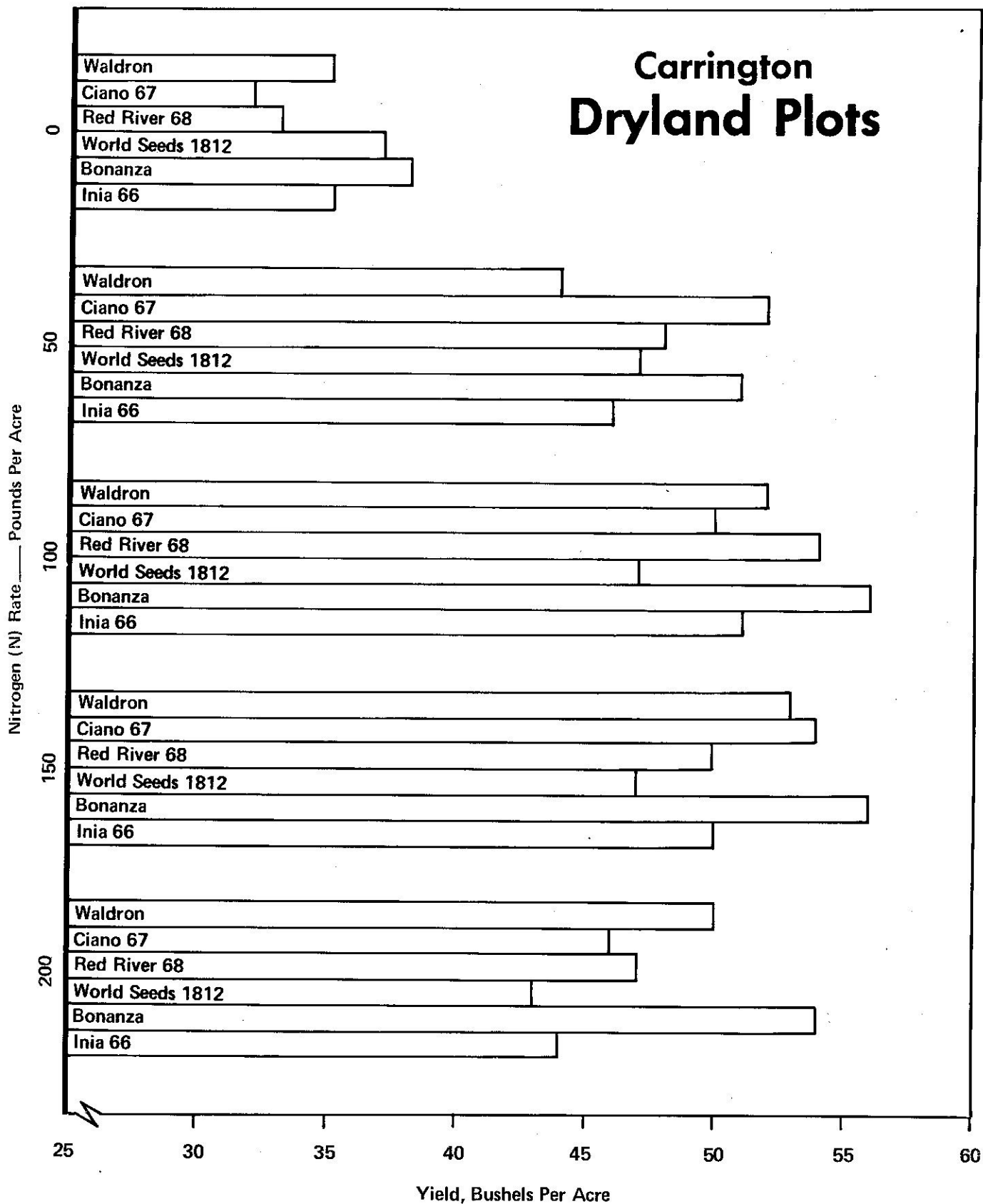


FIGURE 1. YIELD OF BUSHELS PER ACRE, DRYLAND PLOTS WITH VARIOUS LEVELS OF APPLIED NITROGEN FERTILIZER.

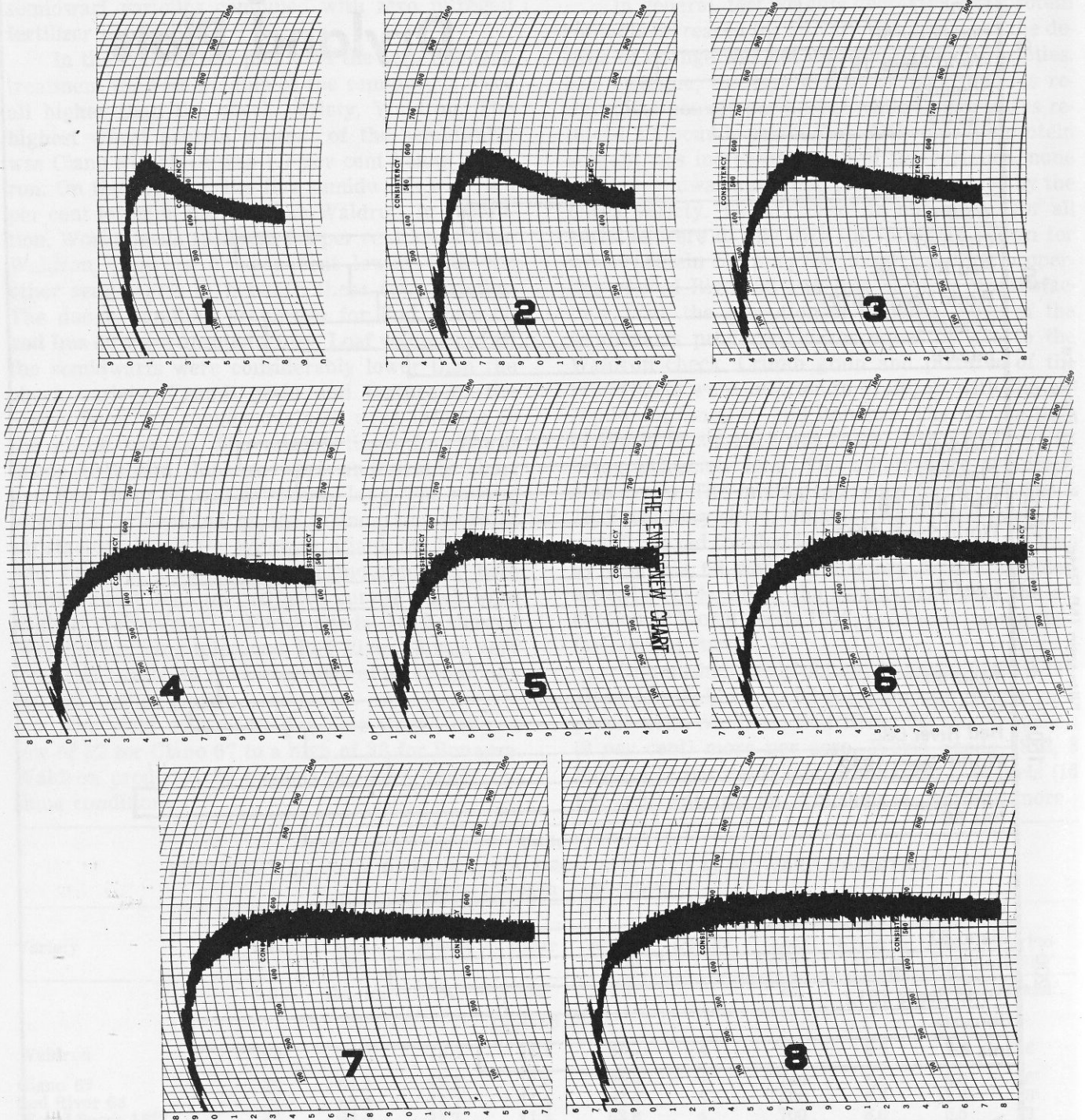


FIGURE 2. REFERENCE FARINOGRAMS — HARD RED SPRING WHEAT

Table 2
PERTINENT QUALITY DATA FOR WALDRON AND FIVE SEMIDWARF VARIETIES
(50 Pounds Nitrogen Application)

Variety	Yield b.p.a.	Test Wt. lbs./bu.	Protein ¹		Absorp- tion %	Dough ²	Loaf Volume cc.	Crumb Grain & Texture ³	Mix Time min.	Farino- graph ⁴ classif.
			Wheat %	Flour %						
Dryland Plots										
Waldron	44	61.8	15.8	15.2	67.3	4	840	8.5	6.5	6
Ciano 67	52	63.6	14.5	13.8	63.3	4	755	9.0	7.5	6 ⁵
Red River 68	48	63.1	13.1	12.3	66.6	2	625	5.5	14.0	8 ⁵
World Seeds 1812	47	63.7	12.2	11.8	64.1	4	710	7.5	5.5	2
Bonanza	51	61.4	13.6	13.0	61.6	4	820	8.5	7.0	8 ⁵
Inia 66	46	64.3	12.9	12.1	62.3	3	720	6.0	8.0	6 ⁵
Ave-Semidwarfs	49	63.2	13.3	12.6	63.6	3.4	726	7.3	8.4	6.0

¹Expressed on 14.0% moisture basis.

²Dough handling properties, 4 - good; 3 - fair; 2 - poor; 1 - very poor.

³Bread crumb grain and texture, 9.0 to 10.0 - excellent; 8.0 to 8.5 - good; 7.0 to 7.5 - fair; 6.0 to 6.5 - poor.

⁴See Figure 2 for reference farinograms.

⁵Abnormal curve type.

Data for Waldron and the five semidwarfs, in conjunction with 100 pounds of nitrogen per acre applied to the plots, is shown in Table 3.

Not all of the varieties increased in wheat and flour protein contents when twice the amount of nitrogen was applied. Also, only some of the varieties were reduced in test weight with the higher nitrogen application.

As shown in Table 3, the test weights were all higher than the check variety Waldron, with the exception of Bonanza. In this instance, it is one pound lower than the comparably grown check. Wheat and flour protein contents of the semidwarfs were all lower than the check. The range was from 0.8 per cent to 3.1 per cent for Ciano 67 and Red River 68, respectively, all being lower than Waldron.

Absorptions of the semidwarfs were all lower than the check variety. Red River 68 was 1.2 per cent and Bonanza 6.4 per cent lower than Waldron. World Seeds 1812 was 3.9 per cent lower, Ciano 67, 5.2 per cent lower and Inia 66, 5.7 per cent lower than Waldron. Dough handling properties for Red River 68 and Inia 66 again were unsatisfactory. Loaf volumes of the semidwarfs were all lower than the check. All the semidwarfs were inferior to Waldron in crumb grain and texture with the exception of Bonanza. The mixing times of the wheats again showed Red River 68 to be extremely long, with Bonanza and Inia 66 being classed as long. The others were acceptable. The mixing tolerance as depicted by the farinograms showed a very long tolerance for Red River 68 and Bonanza while World Seeds 1812 was again, very short. The others

Table 3
PERTINENT QUALITY DATA FOR WALDRON AND FIVE SEMIDWARF VARIETIES
(100 Pounds Nitrogen Application)

Variety	Yield b.p.a.	Test Wt. lbs./bu.	Protein ¹		Absorp- tion %	Dough ²	Loaf Volume cc.	Crumb Grain & Texture ³	Mix Time min.	Farino- graph ⁴ classif.
			Wheat %	Flour %						
Dryland Plots										
Waldron	52	61.6	15.5	15.1	67.7	4	930	8.5	6.5	5
Ciano 67	50	63.8	14.7	14.1	62.5	4	860	7.5	7.0	6 ⁵
Red River 68	54	63.9	12.4	12.0	66.5	2	625	5.5	12.5	8 ⁵
World Seeds 1812	47	62.7	13.2	12.3	63.8	4	685	6.0	6.5	3
Bonanza	56	60.6	13.8	13.4	61.3	4	800	8.5	8.0	8 ⁵
Inia 66	51	63.6	13.5	12.3	62.0	3	745	7.5	8.0	6 ⁵
Ave-Semidwarfs	52	62.9	13.5	12.8	63.2	3.4	743	7.0	8.4	6.2

¹Expressed on 14.0% moisture basis.

²Dough handling properties, 4 - good; 3 - fair; 2 - poor; 1 - very poor.

³Bread crumb grain and texture, 9.0 to 10.0 - excellent; 8.0 to 8.5 - good; 7.0 to 7.5 - fair; 6.0 to 6.5 - poor.

⁴See Figure 2 for reference farinograms.

⁵Abnormal curve type.

were at acceptable levels. All of the varieties with the exception of Waldron and World Seeds 1812 produced "abnormal" farinograms.

The yield per acre of the variety plots treated with 100 pounds of nitrogen showed a range of 9 bushels. When compared with Waldron, Ciano 67 was four per cent lower, Red River 68, four per cent higher, World Seeds 1812, ten per cent lower, Bonanza, eight per cent higher and Inia 66, two per cent lower.

Table 4 shows the pertinent quality data accumulated from the plots treated with 150 pounds of nitrogen. Comparing the 100 pound nitrogen treated plots with the plots having 150 pounds of nitrogen applied, it was found that the test weights, on the average, decreased 1.2 pounds per bushel with a corresponding increase of 0.8 per cent in wheat protein content, coupled with an increase in mixing time.

These data also show that the test weight of Bonanza was 2.2 pounds per bushel below the corresponding conventional height variety, Waldron. Red River 68 and World Seeds 1812 showed about the same test weight as the check, with Ciano 67 and Inia 66 being 1.1 and 1.9 pounds higher, respectively. Wheat protein content of Ciano 67 was about the same as Waldron. All of the other semidwarfs were significantly below the check variety. Absorption of the semidwarfs were all well below Waldron.

The dough handling properties were "tough" for Red River 68 and Inia 66, the others were satisfactory. Crumb grain and texture of the semidwarfs were all below the check with the exception of Bonanza. Mixing times of Red River 68 and Bo-

nanza were excessively long. The other varieties, with the exception of World Seeds 1812, required long mixing times. Mixing tolerance of Red River 68 and Bonanza were long. All doughs with the exception of Waldron and World Seeds 1812 exhibited "tough" gluten properties.

In these plots, Ciano 67 and Bonanza produced 2 and 6 per cent, respectively, more wheat per acre than the check variety Waldron. The others all showed lower yields of wheat than Waldron.

Table 5 shows data for the plots treated with 200 pounds of nitrogen.

When some of the pertinent data presented in Table 5 is compared with Table 4, it appears that on the average test weight has decreased 0.3 pounds per bushel, wheat protein has increased 0.3 per cent and mixing times have again been increased.

The data presented in Table 5 shows Red River 68 and World Seeds 1812 to be equal to Waldron in test weight. Ciano 67 and Inia 66 are higher than Waldron and Bonanza is lower. The protein content response of the varieties due to the increased amount (50 pounds) of nitrogen applied, showed a range of +0.7 per cent for Waldron to +0.1 per cent for Red River 68 and Inia 66. Again, all of the semidwarf varieties were below the check variety Waldron in wheat and flour protein contents. Absorptions were all below Waldron and ranged from 2.9 per cent for Red River 68 to 7.0 per cent lower for Inia 66. Again, dough handling properties of Red River 68 and Inia 66 were unsatisfactory. Loaf volumes of the semidwarfs were all below the Waldron check, but Ciano 67 and Bonanza produced loaves with acceptable volumes.

Table 4
PERTINENT QUALITY DATA FOR WALDRON AND FIVE SEMIDWARF VARIETIES
(150 Pounds Nitrogen Application)

Variety	Yield b.p.a.	Test Wt. lbs./bu.	Protein ¹		Absorp- tion %	Dough ²	Loaf Volume cc.	Crumb Grain & Texture ³	Mix Time min.	Farino- graph ⁴ classif.
			Wheat %	Flour %						
Dryland Plots										
Waldron	53	61.4	15.5	15.2	68.1	4	935	8.5	8.0	7
Ciano 67	54	62.5	15.6	15.0	63.5	4	840	7.5	7.5	6 ⁵
Red River 68	50	61.5	14.1	13.4	66.0	3	690	5.5	15.0	8 ⁵
World Seeds 1812	47	61.3	13.7	12.8	64.4	4	755	7.5	7.0	6
Bonanza	56	59.2	14.6	14.1	61.7	4	850	8.5	10.0	8 ⁵
Inia 66	50	63.3	14.0	12.8	62.9	3	710	7.5	8.0	6 ⁵
Ave-Semidwarfs	51	61.6	14.4	13.6	63.7	3.6	769	7.3	9.5	6.8

¹Expressed on 14.0% moisture basis.

²Dough handling properties, 4 - good; 3 - fair; 2 - poor; 1 - very poor.

³Bread crumb grain and texture, 9.0 to 10.0 - excellent; 8.0 to 8.5 - good; 7.0 to 7.5 - fair; 6.0 to 6.5 - poor.

⁴See Figure 2 for reference farinograms.

⁵Abnormal curve type.

Table 5
PERTINENT QUALITY DATA FOR WALDRON AND FIVE SEMIDWARF VARIETIES
(200 Pounds Nitrogen Application)

Variety	Yield	Test Wt.	Protein ¹		Absorption	Dough ²	Loaf Volume	Crumb Grain & Texture ³	Mix Time	Farinograph ⁴
			Wheat	Flour						
	b.p.a.	lbs./bu.	%	%	%		cc.		min.	classif.
Dryland Plots										
Waldron	50	61.1	16.2	15.4	68.9	4	985	8.5	9.5	7
Ciano 67	46	62.3	15.8	15.3	64.2	4	895	8.5	8.5	7 ⁵
Red River 68	47	61.1	14.2	13.7	66.0	2	660	6.0	15.0	8 ⁵
World Seeds 1812	43	61.1	14.1	13.1	64.4	4	745	9.0	7.5	6
Bonanza	54	58.7	14.9	14.2	62.0	4	875	8.5	9.0	8 ⁵
Inia 66	44	62.8	14.1	13.4	61.9	3	745	7.0	8.5	7 ⁵
Ave-Semidwarfs	47	61.2	14.6	13.9	63.7	3.4	784	7.8	9.7	7.2

¹Expressed on 14.0% moisture basis.

²Dough handling properties, 4 - good; 3 - fair; 2 - poor; 1 - very poor.

³Bread crumb grain and texture, 9.0 to 10.0 - excellent; 8.0 to 8.5 - good; 7.0 to 7.5 - fair; 6.0 to 6.5 - poor.

⁴See Figure 2 for reference farinograms.

⁵Abnormal curve type.

Red River 68 and Inia 66 produced loaves that possessed unsatisfactory crumb grain and textures. Mixing times were excessively long for all the varieties except World Seeds 1812. "Tough" gluten properties were displayed by all the wheats with the exception of Waldron and World Seeds 1812.

Bonanza produced 4 bushels (8 per cent) more per acre than Waldron. All of the other varieties did not equal Waldron in yield of bushels per acre.

SUMMARY

Based on these limited data for one year it appears that, generally, all of the variety test weights changed more or less inversely with increasing amounts of nitrogen fertilizer. Wheat and flour protein contents for all of the varieties usually increased with increasing amounts of nitrogen, but the amount of increase was not consistent for all. Regardless of the amount of nitrogen fertilizer used, the protein contents of the semidwarfs in all but one instance never reached the level of the comparably grown check variety, Waldron. Flour-water absorptions for the semidwarfs in comparably grown plots were always considerably lower than the conventional height variety, Waldron. These differences ranged from 0.7 per cent to as much as 7.0 per cent. Loaf volumes at all levels of fertilizer treatment were consistently below the comparably grown check variety, Waldron. In some other instances, although lower in volume than the check, acceptable volumes were obtained. Red River 68 and Inia 66 consistently displayed unsatisfactory dough handling properties. In most instances, the crumb grain and texture of the loaves from the semidwarfs were not equal to the check, however,

in certain limited cases, they were equal or superior to the check. Mixing characteristics ranged from very short to extremely long and these characteristics increased with increasing protein levels. Farinogram patterns had a tendency to increase numerically with increasing nitrogen treatments. In some instances, the addition of even small amounts of fertilizer when applied to the semidwarfs produced farinogram curve types which were classified as "abnormal", indicating "tough" gluten properties.

In general, it appears that the treatment of the plots with various amounts of nitrogen fertilizer did not produce quality characteristics in these five semidwarf varieties that were equal or superior to the comparably grown check variety, Waldron.

Waldron and all of the semidwarfs increased in yield of bushels per acre when nitrogen fertilizer was applied. However, the maximum yield for any of the varieties was obtained at lower fertilizer nitrogen rates than the highest level of nitrogen applied.

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