Study of Two Hard Red Spring Wheat Varieties Grown Comparably But Differing in Kernel Weight[1]

By

L. R. WALDRON, Plant Breeder

INTRODUCTION

THIS WORK CONTINUES previous studies[2] [3] with wheat varieties planted to study effect of different rates and methods of planting upon yield and other characters of wheat varieties, differing particularly in size of kernel. The wheats used in this report, Thatcher and 2812, differ strikingly in this respect. The 2812 wheat, with heavy kernel, belongs to a group of hybrids which have good yielding capacity one instance of which has been reported.[3] A wheat variety with heavy kernels may have an advantage in producing a stronger plant, when compared with a lighter-kerneled variety. Such a plant might tiller more thus tending to increase yield but high yielding capacity is not necessarily conditioned by size of kernel. The variety producing the larger kernel at harvest may yield more on this account, compared with a small-kerneled variety, but not necessarily so. The small-kerneled plant may compensate by producing more heads per plant or more kernels per head.

Experimental Results

The seed weights of the two wheats used were 26.4 and 40.0 mg. for Thatcher and 2812. Plantings were in guarded 8-foot rows 12 inches apart with half of the experiment space-planted at 2 inches apart in the row and half drilled at 6.2 grams per row. Seed of the two wheats was intermixed in the row in some of the plantings to learn of competitive effects. The tabulation below indicates the plantings expressed in kernels per row.

	Spaced		Drilled	
	Thatcher	2812		
Alone	48	48	236	156
Intermixed	24	24	93	93
do.	29	19	118	78

In three instances the number of kernels per row was equal for the two varieties while for the others the weight of grain seeded per row was equal. The germination of Thatcher at planting was 96 percent and 100 percent for 2812. The data from the intermixed plants were multiplied by two where this was necessary to bring the seedings made alone and intermixed into comparison. As separate analyses seemed necessary for the two methods of plantings, spaced and drilled, for those characters which

[1]Presented as a partial report of work done under project, Adams 10B.

[2]Waldron, L. R.—Analysis of yield of hard red spring wheat grown from seed of different weights and origin. Journ. Agric. Res. 62 (8) :445-460. 1941

[3]Waldron, L. R.—Comparison of large and small kerneled wheat as to yield, grown alone and intermixed in the row. N. Dak. Expt. Stat. Bimonthly Bull. Vol. 5, No. 6, 1943.

had markedly distinct values they were made for all the characters. The plantings were replicated eight times and for each analysis there are 35 error degrees of freedom of a total of 47.

The means are summarized in Table 1 and for the six comparisons given 2812 is expressed in percentages using Thatcher as the base.

DISCUSSION OF TABLE 1

Space Planting

The stand of mature plants in the spaced rows with equal kernels per row is fully as good or a trifle better for Thatcher than for 2812. But in the drilled rows Thatcher shows at a disadvantage. When columns G and H are compared with C and D, 2812 maintains the same percentage stand while the stand of Thatcher lessens 10 percent or more. Evidently the thicker planting of Thatcher is adverse to a plant survival as high as is found in 2812.

With the two wheats space-planted, grown alone and intermixed, Thatcher does not react adversely when competing in the same row with 2812 when equal kernels per row are compared. The yields then are essentially equal. With equal kernels per row and equal weights of seed, seeded intermixed in the row, the disadvantage of Thatcher, grown from an equal number of kernels compared with an equal weight of seed, is very evident.

Thatcher in column C has 5 kernels less per row than in D and its defect in yield is 7.5 ± 2.9 bushels or 22 percent. Similarly 2812 in column D has 5 fewer kernels per row than in column C but here the yield defect is but 1.7 bushels. The difference of these two differences is not significant.

With equal weights of seed per row 2812 had 34 percent fewer kernels than Thatcher per row resulting in 30 and 20 percent fewer plants and culms per row, respectively. This hybrid was further handicapped by fewer fertile spikelets and more sterile spikelets per head than Thatcher. For the other characters in Table 1 the hybrid wheat is in excess of Thatcher. With intermixed planting an increase in the proportion of Thatcher kernels would at some point result in yields above those of 2812.

Results in Drilled Rows

In the drilled rows those seeded alone have equal weights of seeds instead of equal numbers, as in the space-planted. Here, as in the intermixed plantings, discussed immediately above, the 2812 wheat has fewer plants and culms per row, than Thatcher and fewer fertile and more sterile spikelets per head. Nevertheless, here again 2812 is favored in the other characters while the excess of its yield is no less than 16.8 ± 2.2 bushels or 45 percent. When columns E, F and H, are compared, rows seeded alone with rows intermixed and both seeded with equal weights of seed, results do not vary much in the two cases except for sterile spikelets.[4] Here in the intermixed rows 2812 has a significant advantage over the varieties grown individually with a net difference between the two sets of rows of 47 ± 17. The net difference for third-kernel spikelets likewise favors 2812 when the two wheats were grown intermixed but the net difference of 34, for 50 heads, is not significant. The average yield of the two varieties sown separately is 45.6 b.p.a. while the yield of the intermixed row, column H, is 52.7 bushels. This difference of 7.1 ± 2.3 is highly significant. The two varieties show a similar increase. Evidently in this case growing the two wheats intermixed resulted in a distinctly larger yield than when grown individually. There is no appreciable increase for the comparable space-planted rows, A, B, and C.

[4]Sterile spikelets are the axial nodes at the base of the spikes failing to produce true spikelets in the earlier history of the plant because of adverse conditions.

Table 1.—**Values of various characters shown by Thatcher and the hybrid wheat 2812 grown space-planted and drilled with equal number of kernels and with equal weights of grain seeded per row with relationships expressed in percentages.**

	Space-planted									Drilled								
	Alone			Intermixed						Alone			Intermixed					
	A	B		C			D			E	F		G			H		
	That.	2812	%	That.	2812	%	That.	2812	%	That.	2812	%	That.	2812	%	That.	2812	%
Seeds planted per row....number	48	48	100	24	24	100	29	19	66	236	156	66	93	93	100	118	78	66
Plants per row..... do.	39	38	97	40	39	98	47	33	70	151	115	76	130	151	116	167	135	81
Stand of mature plants...percent	81	79	...	83	81	...	81	87	...	64	74	...	70	81	...	71	87	...
Culms.....number	197	210	107	184	217	118	245	196	80	370	341	92	292	423	145	391	360	92
Heads per plant..... do.	5.05	5.5	109	4.6	5.6	122	5.2	5.9	114	2.45	3.0	122	2.25	2.8	124	2.3	2.7	117
Fertile spikelets per 50 hds. number	748	682	91	762	694	91	746	694	93	674	611	91	646	647	100	648	643	99
Sterile spikelets do. do.	92	129	140	77	119	155	90	118	131	136	172	127	173	158	91	171	160	93
Third kernel spikelets do. do.	215	239	111	249	306	123	212	303	143	88	127	144	71	153	215	72	145	201
Grain per 50 heads..... grams	34	53	156	39	53	136	36	59	164	27	43	159	28	46	164	27	46	170
Grain per row..... do.	131	225	172	131	230	176	169	222	131	186	270	145	158	369	234	214	313	146
Grain per plant..... do.	3.5	6.0	171	3.3	5.8	176	3.5	6.7	191	1.3	2.4	185	1.2	2.5	208	1.3	2.3	177
Kernels per plant.....number	141.7	149.2	105	131.5	150.1	114	147.4	173.8	118	50.7	63.1	125	47.3	64.5	136	50.5	60.7	120
Kernels per head..... do.	28.1	27.0	96	28.6	27.0	94	28.3	29.3	104	20.7	21.3	103	21.1	23.0	109	21.6	22.8	106
Kernel weight.....milligrams	23.7	39.7	168	24.9	39.3	158	24.4	38.7	159	24.3	37.2	153	25.7	37.9	148	25.4	38.2	150
Yield per acre.....bushels	26.2	45.0	172	26.2	46.0	176	33.7	44.3	131	37.2	54.0	145	31.6	73.8	234	42.7	62.7	147

Values in the intermixed rows are multiplied by 2 in those cases necessary to bring them into comparison with rows seeded alone.

Table 2.—**The three components of yield: heads per unit area, kernels per head and kernel weight of two wheat varieties Thatcher and 2812, small and large kerneled, when the two are seeded alone and intermixed. The percentages of 2812, with Thatcher as a base, indicate an excess or defect in yield.**

	Space-planted												Drilled											
	Alone			Intermixed						Alone			Intermixed					
	A That.	B 2812	%	C That.	2812	%	D That.	2812	%	E That.	F 2812	%	G That.	2812	%	H That.	2812	%
Heads per row.........number	197	210	107	184	217	118	245	196	80	370	341	92	292	423	145	391	360	92
Kernels per head.........do.	28.1	27.0	96	28.6	27.0	94	28.3	29.3	104	20.7	21.3	103	21.1	23.0	109	21.6	22.8	106
Kernel weight.......milligrams	23.7	39.7	168	24.9	39.3	158	24.4	38.7	159	24.3	37.2	153	25.7	37.9	148	25.4	38.2	150
Cumulative effect..............	....	....	173	....	....	175	....	....	132	....	....	145	....	....	234	....	....	146

Comparison of Space-planted with Drilled

The space-planted rows yield uniformly less than the corresponding drilled rows which is reasonable because the seeding rate of the space plantings for the C column rows was below 20 pounds per acre with the drilled rows seeded at field rates. This difference in yield and in other characters is more pronounced with 2812 than with Thatcher. The greater gain of 2812 over Thatcher from the space-plantings to the drilled rows is of significance for number of plants, number of fertile culms, fertile spikelets per head, weight of grain per plant and yield per acre. The net decrease in sterile spikelets for 2812 is also of significance. The net excess of yield for 2812 is extremely high at 22.4±4.4 bushels. This indicates that Thatcher did relatively better with the greater space for plant development. Or 2812 did relatively better under the more crowded conditions of the drilled rows where plants were in closer competition.

A comparison of rows shown in columns D and H indicates the same condition with respect to yield. The net increase of 2812 over Thatcher when drilled rows are compared with space plantings is 9.3±4.5 bushels. From this it is evident that Thatcher has less relative yielding capacity at the standard rate of seeding than when space-planted, compared to 2812, even when seeded with about 50 percent more kernels per unit area than 2812. The above difference is significant but it is relatively small when compared with the corresponding difference of 22.4 bushels when equal kernels per unit area were seeded. The final net difference is 13.1±6.3 bushels. The implication of this last value is not entirely clear but generally it seems evident that Thatcher is less able to tolerate an increase in rate of seeding than is 2812. This being true it is fair to presume

that Thatcher would be less able to tolerate the increased competition resulting from a mixture of weeds than would the other wheat used in this experiment, 2812. The practical extension is obvious for under farm conditions fields seeded to wheat often carry a moderate or heavy infestation of weed seeds, aside from weedy seed in the drill. Soil infested with weed seed is not always the result of indifferent methods of farming. Whether this is the case or not a variety well able to compete with weed growth seems desirable.

Components of Yield

As in a previous paper[3] it is possible from this experiment to assign proportional differences in yield to certain characters expressed in percentages. The cumulative percentage values are essentially equal to the percentage value of one yield based on the other, an expected result. These relationships are shown in table 2.

The percentage cumulative effects, with Thatcher as a base, agree very closely with the percentage yields of Table 1. The heavier kernel weight of 2812 contributes mainly to its larger yield. With equal kernels seeded, intermixed and drilled, as in column G, the markedly greater number of heads per row of 2812 was a potent factor in raising its yield. The picture shown in Table 2 is much the same as shown in a similar table in the paper just cited except here Thatcher is relatively much lower yielding than was 1348 in the other comparison, a difference clearly traceable to leaf rust. By using the average cumulative yield effects of each component it can be calculated the excess yield of 2812 distributed among the components is due to 6.6 percent for heads per unit area, 2.2 percent for kernels per head and 91.2 percent for kernel weight.

Leaf rust, present in epidemic form, resulted in the lower Thatcher yields and introduced an undesirable factor in this experiment. The main effect was to cut down kernel weight. It is doubtful if kernels per head was much lowered. As Thatcher ordinarily has a low kernel weight this reduction caused by leaf rust was not so severe as one might anticipate. In a late-planted experiment in 1942 the kernel weight of Thatcher was 38 percent below its

Table 3.—**Comparisons essentially the same as shown in Table 2 for Thatcher, 1348, 2907, and 3121 in two experiments, early and late planted.**

	Series 642				
	Thatcher	1348	Percent	2907	Percent
Fertile culms.....number	357	316	88	336	94
Kernels per head..... do.	20.7	24.8	120	23.0	111
Kernel weight.....milligrams	20.1	29.0	145	35.1	175
Cumulative effect.....percent	....	....	153	....	183
Yield per acre.....bushels	29.6	45.3	...	54.2	...
Percentage yield.....	....	....	153	....	183

	Series 648				
	Thatcher	1348	Percent	3121	Percent
Fertile culms.....number	352	326	93	279	79
Kernels per head..... do.	18.8	23.2	123	22.7	121
Kernel weight.....milligrams	20.1	28.9	144	39.9	198
Cumulative effect.....percent	....	....	164	....	189
Yield per acre.....bushels	26.6	43.6	...	50.5	...
Percentage yield.....	....	....	164	....	190

weight in this experiment. Regardless of the lowered yield of Thatcher because of rust it is not likely that the yield relationships with 2812 in a comparison of the methods of planting was much influenced.

Data are available to supplement the information of Table 2 where Thatcher was grown comparably with the hybrid 1348 and two larger-kerneled hybrid selections, 2907 and 3121. Equal weights of seed were drilled in all cases. The results are shown in Table 3.

The results in Table 3 are best compared with columns E, F of Table 2 and 2907 and 3121 are to be compared with 2812. The percentage yield of 2812 is definitely below those of 2907 and 3121 due mainly to the relatively low kernel weight of Thatcher shown in Table 3. The contributions to yield made by fertile culms and kernels per head are slightly to the advantage of 1348 and 2907, compared with Thatcher in Series 642. In Series 648 this is more definitely true for 1348 but here Thatcher has the advantage over 2907. It is evident enough from Table 3 that kernel weight plays the major part in determining differences in yield.

Summary

A large-kerneled wheat hybrid 2812 was compared with the small-kerneled Thatcher when the two were grown both space-planted and drilled, and seeded individually and intermixed in the row. The main interest is yield per acre. When the two wheats were seeded with equal weights of grain per row Thatcher had about 50 percent more kernels seeded than 2812. Even with the resulting extra stand of Thatcher, the 2812 wheat was ahead in yield from 31 to 47 percent. This excess yield of 2812 was greater, and significantly so, when the wheat was drilled in the row at field rates than when the wheats were space-planted at less than 20 pounds per acre. This evidently was due to the greater competition exerted upon Thatcher in the thicker seeding.

When the two wheats were seeded with equal numbers of kernels per row the excess of yield of 2812 over Thatcher was significantly greater than the similar excess when the two varieties were seeded with equal weights of seed per row. The excess of yield of 2812 over Thatcher was again much greater when the wheats were drilled at field rates versus space-planted, the latter seeded thinly, both with equal kernels per row. This excess for the space-planted was 76 percent against 134 percent for the drilled wheats. This indicates again less competitive capacity for Thatcher when seeded more thickly, which perhaps is a disadvantage if the variety has to compete with weeds.

Of the three components determining yield: heads per row, kernels per head and kernel weight, the first was responsible for 6.6 percent, the second for 2.2 percent while kernel weight resulted in 91.2 percent of the excess in yield of 2812 above Thatcher.

Leaf rust caused loss of yield in Thatcher but the relationships between the various plantings was probably not affected.