INDIVIDUAL KERNEL WEIGHT DISTRIBUTION OF 12 VARIETIES OF HARD RED WINTER WHEAT[1,2]

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ABSTRACT

Individual kernel weight distribution data for 12 varieties of hard red winter wheat grown at four locations are reported. Pattern distributions show differences among and within varieties as affected by the environment. Kernel weight distributions are discussed in relation to the general quality and genetic background of the varieties. The kernel weight distribution curves revealed that potential flour yields were positively related to the percentage of the distribution above 20 mg/kernel (r = 0.76**). Potential flour yield was positively correlated (r = 0.93**) with kernel weight.

Test weight, 1000-kernel weight, and kernel density are gross measurements used as parameters to predict quality indices, *i.e.*, flour yield of wheat. However, they do not provide precise information about the kernel size distribution of the grain. Shuey (1) showed that percentage of wheat remaining on sieves of various sizes is a better predictor of flour yield (r = 0.957) than test weight (r = 0.744). Shuey and Gilles (2) increased flour extraction and decreased mineral content of the flour by removing the small kernels in the wheat. Removing the small kernels minimized the effect of dissimilar kernel sizes and allowed for adjusting the mill to a narrow range of kernel size. Johnson and Hartsing (3) and Baker and Golumbic (4) reported a higher relation between kernel weight and flour yield than between test weight and flour yield. Phillips and Schlesinger (5) showed a relation between protein content and kernel size of hard red spring and winter wheats. The protein content of hard red winter wheat decreased with increasing kernel size, whereas the protein content of hard red spring wheat increased with increasing kernel size. Kernel size distribution in barley is used as a quality factor for malting barley. Recent technology and instrumentation make it feasible to determine the individual kernel size distribution of grains and it is therefore possible to relate precise kernel weight data to genetic and quality characteristics of grains (6,7). We are not aware of any data relating individual kernel weights of wheat samples to their processing quality.

In this paper, kernel weight distributions are discussed in relation to the general quality, genetic background, and potential flour yield of 12 varieties of hard red winter wheat grown at four locations.

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[2]Mention of a trademark name or proprietary product does not constitute a guarantee or warranty of the product by the U.S. Department of Agriculture, and does not imply its approval to the exclusion of other products that may also be suitable.

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TABLE I

Kernel Weight Means in mg/Kernel and Standard Error and Standard Error of the Mean of Individual Kernel Weight Distribution for 12 Winter Wheat Varieties Grown at Four Locations in Kansas in 1973

Variety	Location															
	St. John				Hutchinson				Newton				Parsons			
	$\bar{x}_1$[a]	$\bar{x}_2$[b]	s[c]	$s_{\bar{x}}$[d]	$\bar{x}_1$	$\bar{x}_2$	s	$s_{\bar{x}}$	$\bar{x}_1$	$\bar{x}_2$	s	$s_{\bar{x}}$	$\bar{x}_1$	$\bar{x}_2$	s	$s_{\bar{x}}$
Centurk	25.6	26.5	5.91	0.19	28.9	29.4	6.16	0.20	24.9	24.6	6.62	0.21	23.6	24.4	7.00	0.22
Parker	28.7	28.6	5.97	0.19	30.9	30.7	6.30	0.20	26.6	25.7	6.99	0.22	24.9	24.3	6.90	0.22
Cloud	28.8	28.2	6.09	0.19	30.8	31.4	5.90	0.19	27.5	26.7	7.09	0.23	28.5	28.0	7.51	0.24
Satana	27.6	28.5	6.40	0.20	29.2	29.4	6.25	0.20	27.3	27.3	7.09	0.22	25.5	24.8	7.43	0.24
Turkey	29.8	30.8	6.11	0.19	29.5	30.0	6.40	0.20	26.2	25.6	7.41	0.24	24.0	24.5	7.85	0.25
Trison	34.7	34.2	6.46	0.20	36.9	37.4	6.23	0.20	32.7	33.6	7.64	0.24	30.2	30.2	7.64	0.24
Kirwin	29.6	29.3	6.12	0.19	31.2	31.4	6.73	0.21	28.8	28.2	7.01	0.22	26.2	26.7	7.84	0.25
Triumph-64	32.6	32.1	6.63	0.21	35.4	35.9	6.72	0.21	32.2	32.3	7.34	0.23	28.8	28.5	7.82	0.25
Sage	31.0	30.8	6.57	0.21	34.2	34.1	6.61	0.21	30.0	30.0	7.89	0.25	26.2	26.0	7.95	0.25
Eagle	31.7	31.8	6.95	0.22	34.5	35.3	6.98	0.22	28.9	28.7	7.55	0.24	29.7	29.5	7.99	0.26
Scout	32.1	31.5	7.20	0.23	34.7	35.3	7.58	0.24	29.2	30.0	7.36	0.24	29.4	29.7	8.13	0.26
Danne	32.2	32.6	7.26	0.23	36.0	36.0	7.06	0.22	28.5	29.2	7.51	0.24	28.9	29.6	8.16	0.26

[a]Determined by counting the number of kernels in approximately 30 g.
[b]Determined by averaging the individual kernel weights of approximately 1000 kernels.
[c]Standard error of the kernel weight distribution.
[d]Standard error of the mean of the kernel weight distribution.

TABLE II
Analysis of Variance of the Mean Kernel Weights and the Standard Errors of the Individual Kernel Weight Distribution

Source	Degrees of Freedom	Sums of Squares	Mean Square	F-value
		Mean Kernel Weight		
Total	47	484.39	...	...
Location	3	205.07	68.36	66.89**
Variety	11	245.60	22.33	21.85**
Error	33	33.72	1.02	...
		Standard Error		
Total	47	22.55	...	...
Location	3	12.71	4.24	61.70**
Variety	11	7.57	0.69	10.03**
Error	33	2.27	0.07	...

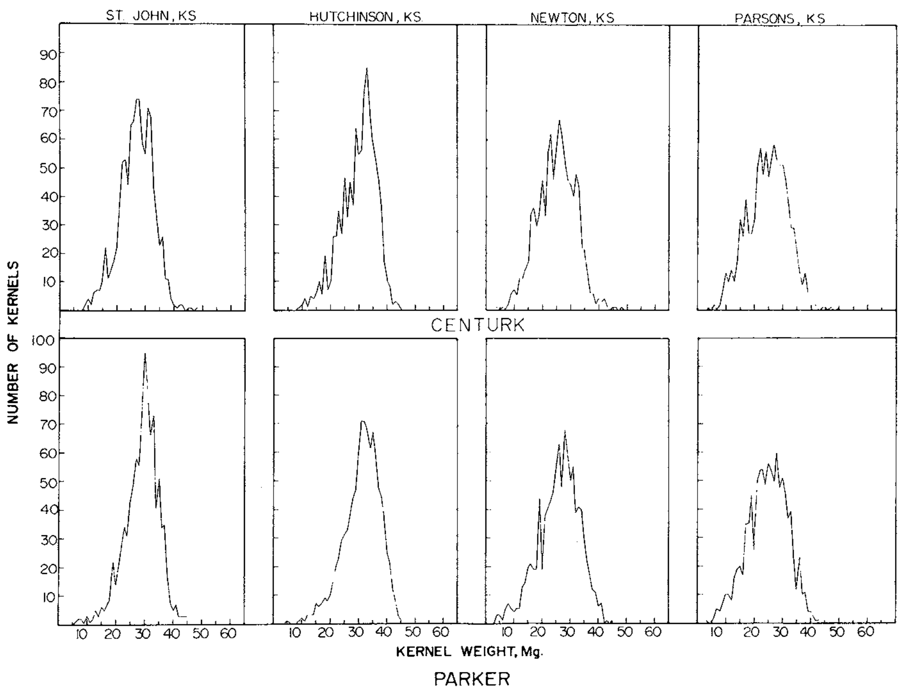

Fig. 1. Kernel weight distribution curves of Centurk and Parker, hard red winter wheats grown at four locations in Kansas in 1973. These two varieties had the smallest standard error of kernel weight distribution.

MATERIALS AND METHODS

Twelve varieties of hard red winter wheat ('Centurk,' 'Parker,' 'Cloud,' 'Satana,' 'Turkey,' 'Trison,' 'Kirwin,' 'Triumph-64,' 'Sage,' 'Eagle,' 'Scout,' and 'Danne') grown at four locations (Newton, Parsons, Hutchinson, and St. John) in Kansas in 1973 were studied.

An automatic system (2,3) was used to determine the individual kernel weight of 1000 kernels.

Potential flour yield based on kernel size distribution was determined according to Shuey's method (1), except a 100-g sample was used. The sizer was clothed as follows: top sieve, Tyler No. 7 (2.92-mm opening); middle sieve, Tyler No. 9 (2.24-mm opening); and bottom sieve, Tyler No. 12 (1.65-mm opening). Potential flour yield is determined by multiplying the percentages of the overs of each sieve (Nos. 7, 9, and 12) by the value 78, 73, and 68%, respectively. The accumulated percentage is the potential flour yield.

RESULTS AND DISCUSSION

Kernel weight means, standard errors, and standard errors of the mean of individual kernel weight distributions for each variety at each location are

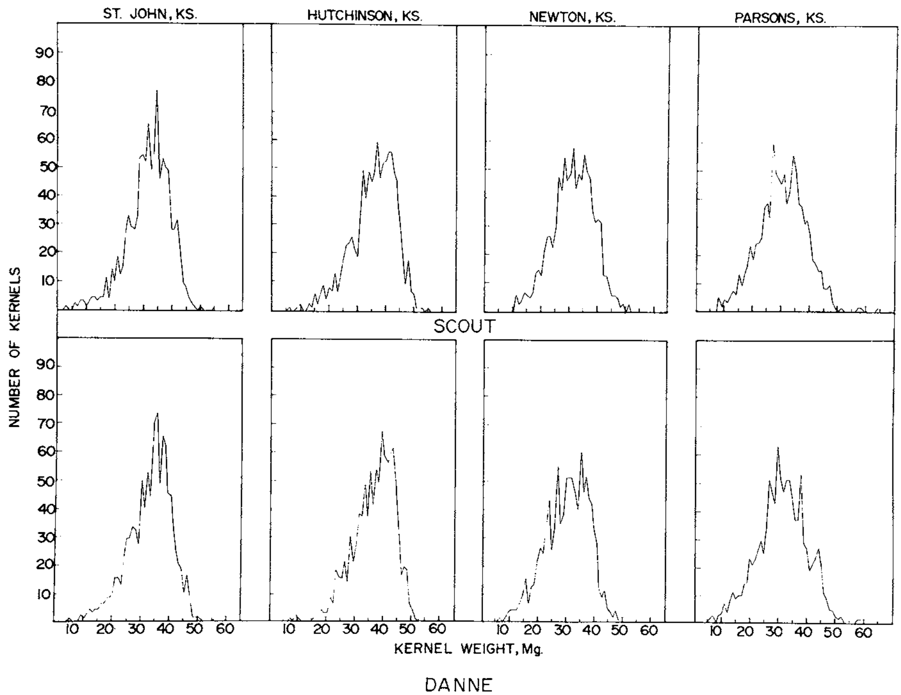

Fig. 2. Kernel weight distribution curves of Scout and Danne, hard red winter wheats grown at four locations in Kansas in 1973. These two varieties had the largest standard error of kernel weight distribution.

reported in Table I. Kernel weights determined by counting the number of kernels in 30 g of seed and the mean of individual kernel weights of about 1000 kernels agree remarkably well (r = 0.99), indicating that the individual kernel weight data were accurate. Analyses of variance of the mean kernel weights and standard errors of the means of the individual kernel weight distributions (Table II) show that both location and variety significantly affected kernel weight.

Standard errors of kernel weight distributions of varieties ranked about the same regardless of the location (Table I). For example, Centurk, Parker, and Cloud had lower standard errors than Eagle, Scout, and Danne at all locations, suggesting variety differences for the samples examined. The individual kernel weight histograms for four varieties plotted in 1.0-mg increments appear in Figs. 1 and 2. The varieties Centurk and Parker (Fig. 1) had the smallest and Scout and Danne (Fig. 2) had the largest standard errors of kernel weight distributions (Table I). Small standard errors resulted from narrow histograms.

The varieties with low kernel weights generally had small standard errors. However, this was not always true, *i.e.*, Trison had larger kernels and smaller standard errors than Eagle, Scout, and Danne. Standard errors were larger for varieties grown at Parsons, Kans., than those grown at St. John, Kans.

We did not determine the actual flour yield and milling characteristics of the varieties because of limited amounts of sample. However, these properties had been established before the varieties were released for commercial production. To provide some indication of the association of kernel size distribution with flour yield, potential flour yield was determined. Potential flour yield (data not shown) was positively correlated (r = 0.93**) with kernel weight, but the standard errors of the individual kernel weight distributions were not (r = −0.13). The areas above 20.0 mg/kernel under the kernel weight distribution curves were correlated (0.76**) with potential flour yields.

All 12 varieties are hard winter wheats of different origins, but with Turkey in the pedigree. From the breeding history, 9 of the 12 varieties are of pureline origin; that is, the increase of a relatively homozygous plant. Differences in kernel weight among the varieties were not associated with the generation of inbreeding before varietal derivation.

CONCLUSION

There were differences in kernel weight distribution of the wheat varieties tested, even though most of the varieties have similar genetic backgrounds. Differences probably would be greater for material of wider genetic variation. The data on these samples indicate that although kernel distribution may be variety-associated, it is more strongly influenced by environment. Additional studies on the specific factors of the environment affecting kernel weight distribution are needed.

Definite conclusions cannot be made regarding the relation between kernel weight distribution and wheat yield and actual flour yield. However, wheats with maximum uniformity of kernel size are easier to process (2) than wheats with large variations in kernel size. Although we did not test barley, barley with uniform kernel size generally germinates more uniformly than barley with nonuniform kernel size, and so it is better for malting. Therefore, wheats and barleys with more uniform kernel size distribution than those now grown might be developed to facilitate processing.

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