An Analysis of Kernel Traits and Their Potential Influence on Test Weight in Winter Wheat

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PROBLEM STATEMENT

- Wheat test weight (TW) refers to the bulk density of wheat. As one indicator of quality, it is important to buyer, and therefore, identifying kernel traits that influence TW should enable breeders to select for higher TW.

CONCEPT

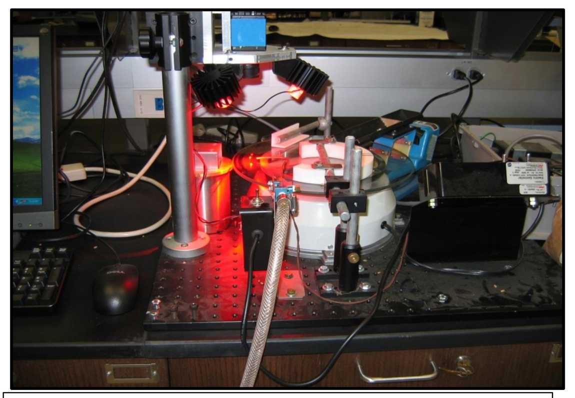
- Test weight is expected to be influenced by kernel characteristics such as; length, width, size, shape, density, and packing efficiency (PE, a measure of how much space remains between kernels when fitted to a specific volume).

OBJECTIVES

- Determine kernel traits that contribute to test weight.
- Determine the most significant genotypic and environmental variances for the traits that influence test weight.

MATERIALS AND METHODS

- **Plant material** used in this study include 16 winter wheat cultivars adapted to the Midwestern region.
- **Design:** Each cultivar was planted to a 13 by 5 foot plot. Plots were laid out in a randomized complete block arrangement across three locations in the 2011 and 2012 growing seasons with four blocks per location.
- **Data was collected:** (1) Packing efficiency, (2) kernel size, (3) kernel length and width using a grain analyzer, (4) protein content using a near-infrared machine (NIR), (5) thousand kernel weight (TKW) by counting a thousand kernels with a seed counter and weigh them, kernel shape (LW; length to width ratio) as well as (6) kernel density.
- **Data analysis** for the results presented here was done using SAS 9.3.1.



Grain Analyzer: Kernel L, W, & size

NIR machine: For protein content assessment

Seed counter: For kernel counts

RESULTS

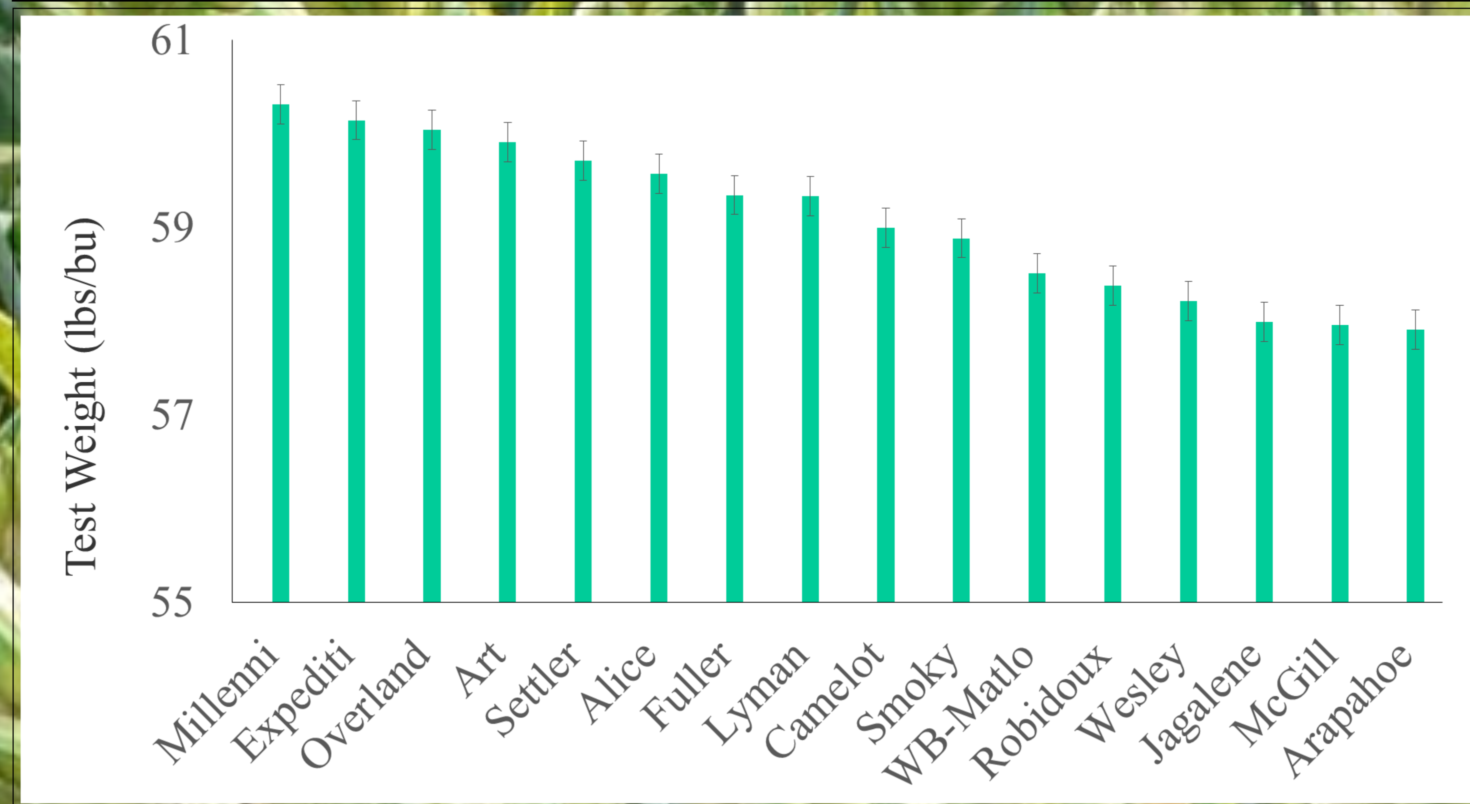


Figure 1. Differences in test weight (TW) among the 16 cultivars across 6 environments between 2011 to 2012.

Table 1. Variance analysis of TW, kernel density, and protein content of cultivars grown across 6 locations.

		Mean Square		
Source of variation	**DF**	**TW**	**Density**	**Protein**
Environments	5	180.46 *	0.062 *	27.67 *
Genotype	15	16.73 *	0.007 *	3.94 *
Rep(Environments)	18	4.88 *	0.002 *	0.54 *
G x E	75	8.43 *	0.002 *	0.68 *
h_b^2		0.47	0.75	0.81

* = Significant at 0.05

Table 2. Relationship between TW and other kernel characteristics.

Parameter	Estimate	Confidence Limits 95%		Pr-ChiSq
Intercept	-57.8724	-58.8946	-56.8502	***
Protein	-0.0162	-0.0236	-0.0089	***
TKW	-0.0001	-0.0004	0.0003	NS
Density	40.5114	40.3826	40.6402	***
PE	1.0864	1.0826	1.0903	***
Length	-0.0038	-0.0097	0.0021	NS
Width	0.0064	-0.0061	0.0188	NS
Size	0.0000	-0.0000	0.0000	NS
LW	-0.0123	-0.0337	0.0090	NS

*** = Significant at 0.0001; NS = Not significant at 0.05.

Table 3. Linear relationship between packing efficiency (PE) and kernel length, width, size and shape (LW)

Parameter	Estimate	Confidence Limits 95%		Pr > ChiSq
Intercept	44.30	11.75	76.85	*
Length	0.012	-0.18	0.20	NS
Width	0.28	-0.14	0.70	NS
Size	-0.00	-0.00	-0.00	*
LW	-0.04	-0.75	0.67	NS

* = Significant at 0.05; NS = Not significant at 0.05.

SUMMARY

- There were significant differences in TW among the cultivars (**Fig. 1**), and the differences attributed to genotype (G) accounted for approximately 47% of the variation in TW; whereas, the remainder of the variation was due to environment (E), and G x E interactions (**Table 1**).
- Kernel density had the highest positive contribution to TW, followed by PE (**Table 2**). Genotype contributed 75% to the variation in density (**Table 1**).
- Protein content has a negative and significant relationship to TW, and kernel size has a negative but significant contribution to packing efficiency (**Table 3**).

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ACKNOWLEDGEMENTS

SD Wheat Commission, SDSU WWBP for funding this research. Dr. Tom Pearson, USDA Engineering personnel at Manhattan, Kansas for the grain analyzer.