

Bulk Properties of Wheat and Grain Sorghum as Affected by a Mechanical Grain Spreader

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ABSTRACT

BULK density and airflow resistance of wheat and grain sorghum were higher when bins were filled by a mechanical grain spreader than when they were filled from a spout. Aeration systems designed for loosely packed grain may deliver insufficient airflow to grain in a bin filled by a mechanical grain spreader.

INTRODUCTION

Bulk density of shelled corn is as much as 20 percent higher and airflow resistance is as much as 300 percent higher when mechanical grain spreaders are used in filling bins rather than when bins are filled from a central spout (Stephens and Foster, 1976). To determine whether such differences are produced in other grains, the spreader which produced the highest airflow resistance and bulk density in dry shelled corn was used to fill a storage bin with wheat and grain sorghum.

OBJECTIVES

The objectives of the study were to measure the bulk density, airflow resistance, and fine material distribution in wheat and grain sorghum placed in a storage bin with and without the use of a mechanical grain spreader.

EQUIPMENT AND PROCEDURES

The equipment and procedures used were the same as in the study of shelled corn (Stephens and Foster, 1976) with the following exceptions:

- 1 The tests were conducted with hard red winter wheat of unknown history obtained from the Commodity Credit Corporation and with grain sorghum grown near Manhattan, KS in 1975.

- 2 Only one grain spreader, the Spreads-All model E-2, was used.

- 3 We used only one grain lot size, 1290 bu.

- 4 The mechanical sampler cut the grain stream every 5s and groups of 12 samples were combined for analysis.

- 5 The bulk density and airflow resistance of grain lots loaded without the spreader were measured both

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before and after being leveled with a shovel.

6 The fine material (f.m.) content was measured by screening the wheat with a 2-mm (1/12-in.) round hole sieve and the grain sorghum on a 3-mm (8/64-in.) equilateral triangular hole sieve, as provided in the U.S. grade standards (USDA, 1970; USDA, 1952).

RESULTS

Table 1 lists the results of bin filling of wheat and grain sorghum with and without the grain spreader. The properties reported under "Grain conditions before test" were obtained from samples taken by the automatic spout sampler.

The grain spreader increased the spread between the highest and lowest f.m. contents of individual probe samples of grain sorghum. The chi-square values, which are based on all samples rather than the extremes, show that there was less uniformity in distribution of fines in grain sorghum when the grain spreader was used in the filling operation than when filling was from a central spout. There were virtually no differences in the range or uniformity of f.m. distribution in wheat by the two filling methods.

The bulk density reported under grain conditions was obtained with the grading standards test weight device and converted from a bushel to cubic meter basis. Filling the bin from a central spout produced a 3 to 5 percent higher bulk density of grain sorghum and wheat than that measured by the test weight method. Leveling the pile produced an additional 2-percent density increase in sorghum but no increase in wheat. Filling the bin with the grain spreader produced bulk densities 13 percent greater in sorghum and 7 percent greater in wheat than those produced by filling from a central spout.

The largest percentage differences in grain properties were in airflow resistance. Manually leveling the cone-shaped pile produced by filling from a central spout increased the airflow resistance by 10 to 12 percent compared to the resistance of the pile before it was leveled. However, filling the bin with the grain spreader produced airflow resistances 110 percent greater in sorghum and 101 percent greater in wheat than those produced by filling from the central spout.

Figs. 1 and 2 present the specific airflow resistances measured over the range of airflows obtained in these tests. The data from Shedd (1953) are for a loose fill of clean grain.

DISCUSSION OF RESULTS

The segregation of f.m. from whole kernels which is so pronounced when shelled corn is placed in a bin from a central spout (Stephens and Foster, 1976) did not develop in these tests. The greater differ-

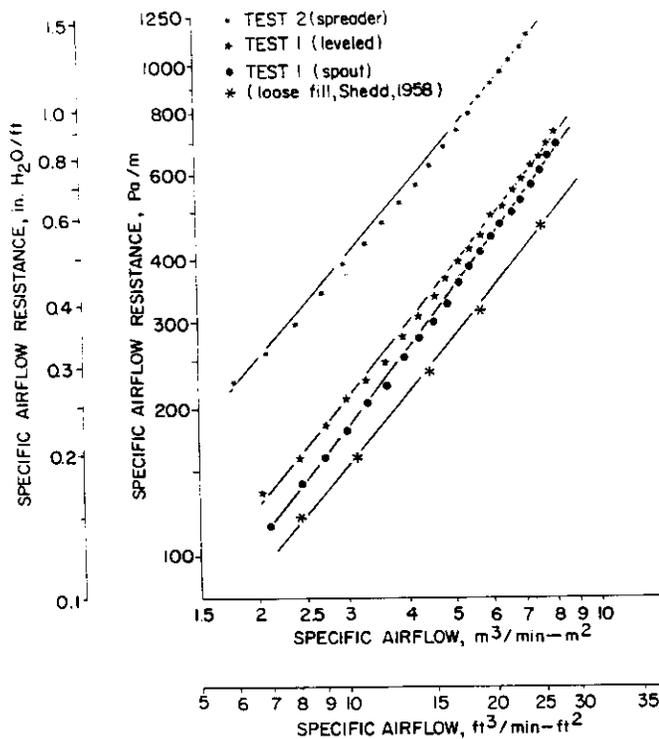


FIG. 1 Specific airflow resistance of grain sorghum in bins filled by different methods.

ences in size and shape between whole kernels and f.m. in corn than in sorghum and wheat may have increased the tendency of the f.m. to sift into spaces between whole corn kernels.

The grain spreader produced a less uniform f.m. distribution in grain sorghum than did spout filling. The flight of the grain from the spreader resulted in an aerodynamic separation of f.m. from whole kernels, resulting in greater variability, reflected in the greater chi-square value. The improvement in uniformity created by the grain spreader in the wheat tests is very slight, since the f.m. distribution was very uniform in both tests.

The increase in average bulk density of grain sorghum and wheat filled with a grain spreader compared to that of grain filled from a spout, had previously been observed in shelled corn (Stephens and Foster, 1976). The bulk density increase in wheat, which had a very low f.m. content, strongly implies that part of the increase was the result of placing the

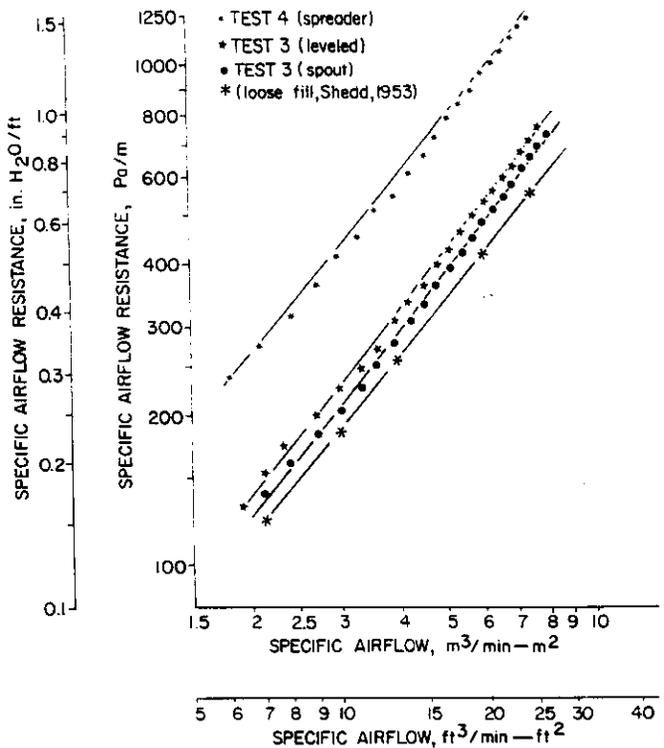


FIG. 2 Specific airflow resistance of wheat in bins filled by different methods.

grain in the bin in a series of thin layers, which allows the kernels to attain an orientation that increases bulk density. In grains with higher amounts of f.m. part of the increase in bulk density arises from f.m. occupying spaces between whole kernels, spaces which would otherwise be filled with air.

CONCLUSIONS

The following conclusions can be drawn from this research:

1 The use of a rotary grain spreader to fill a storage bin can increase the storage capacity of the bin by increasing the bulk density of wheat and grain sorghum compared to filling from a spout.

2 Aeration systems designed for wheat or grain sorghum filled from a spout may deliver insufficient airflow to grain filled with a rotary grain spreader due to the increased airflow resistance of such grain.

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TABLE 1. SUMMARY OF EFFECTS OF MECHANICAL GRAIN SPREADER ON BULK PROPERTIES OF WHEAT AND GRAIN SORGHUM

Test conditions		Grain conditions before test*			Test results				
Test no.	Spreader used	Grain	f.m. Percent	Bulk density kg/m ³	Moisture content Percent	f.m. distribution Range ‡	Chi-sq. §	Bulk density kg/m ³	Airflow resistance† Pa/m
1	no	sorghum	1.53	699	13.7	0.8-5.9	0.23	719	303
1	leveled	do						731	340
2	yes	do	2.03	699	14.0	0.8-9.2	0.41	813	636
3	no	wheat	0.22	809	13.2	0.07-0.95	0.052	845	339
3	leveled	do						846	373
4	yes	do	0.21	814	13.1	0.09-0.89	0.045	901	683

* As determined from samples taken by a spout sampler as grain was moved into test bin.

† Measured at an airflow rate of 4.6 m³/min-m² (15 cu ft/min-sq ft).

‡ Lowest and highest f.m. content obtained from individual probe compartments.

§ A statistic representing the variability in f.m.

Unit conversions: 1 lb/ft³ = 16.02 kg/m³; 1 in. of H₂O/ft of grain = 816.5 Pa/m of grain; 1 ft = 0.3048 m.

Bulk Properties of Wheat and Grain Sorghum

(Continued from page 1218)

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