Lodging Effects on Yield and Quality of Soft White Wheat[1]

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ABSTRACT

Intensive management expected to produce higher grain yields has resulted in occasional early lodging of soft white wheat (*Triticum aestivum* L.). Standing and lodged wheats were sampled in fields where lodging occurred before or during head emergence. Grain yield and test weight were determined and milling and baking characteristics of the grain evaluated. Lodged wheat yielded 1,440 kg/ha less grain than standing wheat. Grain from lodged wheat averaged 6 kg/hl lower in test weight and had consistently lower milling scores. Slower feeding into the mill, lower flour yield, higher ash in the flour, and greater water absorption by the flour contributed to the lower milling score. Observed and corrected diameters of cookies baked from grain of lodged wheat were consistently smaller than those of cookies baked from grain of standing wheat.

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Lodging, not associated with diseases, has been occurring in intensively managed, sprinkler-irrigated fields of soft white wheat (*Triticum aestivum* L.) in the Pacific Northwest. Pinthus (1973) concluded that lodging at heading reduced yield of small grain 27–30%, reduced test weight, increased the N (protein) content of the grain, and might have reduced the milling quality of wheat. Yield reduction from lodging has been reported for grain sorghum (Larson and Maranville 1977) and for soybeans (Cooper 1971, Weber and Fehr 1966).

Little information is available to show the extent that lodging affects milling and baking qualities of wheat. Yamazaki (1976) reported that shriveled kernels of soft red winter wheat produced less flour, flour with more ash and protein, and cookies of smaller diameter than did normal kernels. This article is the result of a three-year study of the milling and baking qualities of grain from lodged and standing soft white wheat in addition to the effect of lodging on grain yield and test weight.

MATERIALS AND METHODS

Samples of soft white wheat to be used in tests for grain yield and quality were taken at harvesttime from pivot-irrigated fields in north-central Oregon. Lodged and standing wheat were sampled in a field in which some of the wheat lodged just before or during

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heading. Sampling sites within a field were selected so that lodged and standing samples were usually less than 10 m apart. The straw at the crown was examined for foot and root rot diseases; if evidence of disease as a possible cause for lodging was observed, the location was discarded and another was selected. Five samples, each from approximately 1.8 m^2, were taken from lodged and standing wheat in each field. Four fields were sampled for each of three consecutive years.

Grain samples were weighed and test weight determined (USDA 1953). Grain from five fields was subjected to milling and baking tests. The five like samples (lodged or standing) from each field were composited, conditioned at 14% moisture for 18–24 hr, and milled to produce a straight-grade flour. Samples were assigned a milling score, which was calculated from the amount of flour produced, percent of patent flour, flour ash content, feed rate of the wheat on the mill, and the amount of conditioning water applied (Seeborg 1953). Each flour was tested for ash, protein (N × 5.7, 14% moisture basis), and water absorption (AACC 1962) and baked into cookies (Finney et al 1950).

TABLE I
Grain Yield, Test Weight, and Variety of Standing and Early Lodged Wheat

Field No. and Year	Grain Yield (kg/ha)		Test Weight (kg/hl)		Cultivar[a]
	Standing	Lodged	Standing	Lodged	
1-78	7,250	4,930[b]	77	71[b]	Stephens
2-78	6,750	5,910[c]	76	73[b]	Stephens
3-78	5,550	4,230[c]	76	72[b]	McDermid
4-78	6,520	5,030[b]	76	70[b]	McDermid
1-79	5,980	4,060[b]	78	68[b]	Stephens
2-79	6,330	5,320[b]	77	73[b]	Twin
3-79	5,620	3,460[b]	78	70[b]	Stephens
4-79	5,780	4,520[b]	73	67[b]	Twin
1-80	5,350	4,110[b]	75	69[b]	Hyslop
2-80	6,870	5,750[b]	76	71[b]	Stephens
3-80	5,570	4,190[b]	77	68[b]	Stephens
4-80	7,930	6,640[b]	76	67[b]	Stephens
Mean	6,290	4,850	76	70	

[a] Cultivars Stephens, McDermid, and Hyslop are soft white winter wheat, and Twin is a soft white spring wheat.
[b] Significantly different at $P = 0.01$.
[c] Significantly different at $P = 0.05$.

Paired plot analysis (Steel and Torrie 1960) was used to analyze grain yield and test weight data (Table I). Sample means-paired observations (Steel and Torrie 1960) were used to analyze milling and baking quality data.

RESULTS AND DISCUSSION

Grain Yields

Grain yield of the standing wheat was consistently higher than the yield of the lodged wheat (Table I). The smallest yield reduction from lodging within a field was 840 kg/ha; the average reduction was 1,440 kg/ha, which is a 23% decrease from the yield of the standing wheat.

Wheat with the greatest tendency for lodging had characteristics associated with overmanagement (Pinthus 1973). The wheat was planted relatively early and fertilized with great amounts of nitrogen (more than 250 kg/ha) applied before planting or during early tillering in the spring. These practices, combined with favorable growing conditions, resulted in massive vegetative growth before the boot stage of growth.

Test Weight

Test weight of the standing grain was 3–10 kg/hl higher than the test weight of the lodged grain (Table I). Grain from the lodged wheat graded one to four grades lower because of the lower test weight (data not shown). Visual observation indicated that the lower test weight of the lodged grain resulted from the large amount of shriveled kernels it contained. Mean test weight of the conditioned grain from standing wheat was 5.7 kg/hl higher than the test weight of the conditioned grain from lodged plants (Table II).

Milling Score

Grain from lodged wheat had a slower feed rate into the mill, which contributed to its lower milling score (Table II).

Flour

The plumper kernels of the standing wheat compared to the less plump kernels of the lodged wheat had a higher ratio of flour to bran, as indicated by the flour yield (Table II). Flour from the standing wheat was lower in ash and protein and absorbed less water than flour from lodged wheat (Table II). Low levels of ash, protein, and water absorption are desirable characteristics of soft white wheat flour.

TABLE II
Milling and Baking Qualities of Soft White Wheat Grain Samples from Standing and Lodged Wheat

Wheat Sample[a]	Test Weight (kg/hl)	Milling Score	Flour				Cookie Diameter, cm	
			Yield (%)	Ash (%)	Protein (%)	Water Absorption[b] (%)	Observed	Corrected[c]
1 Standing	79.6	82.7	71.6	0.42	10.9	58.8	8.91	9.01
1 Lodged	72.1	76.6	68.1	0.42	11.1	61.0	8.72	8.85
2 Standing	78.8	81.2	71.2	0.45	8.9	55.9	9.25	9.13
2 Lodged	75.2	78.6	70.4	0.46	10.1	57.4	8.81	8.82
3 Standing	78.3	81.7	70.7	0.40	9.2	59.0	8.97	8.89
3 Lodged	71.2	77.7	68.5	0.41	10.3	60.6	8.80	8.83
4 Standing	69.1	72.1	67.2	0.49	10.8	60.0	8.42	8.51
4 Lodged	67.6	72.2	67.6	0.50	12.3	63.9	8.24	8.49
5 Standing	76.7	79.0	71.3	0.49	7.6	58.0	8.67	8.41
5 Lodged	68.0	69.5	66.4	0.52	10.4	59.4	8.21	8.26
Mean difference[d]	5.7	4.4	2.2	0.01	1.3	2.2	0.29	0.14
Significant difference[d]	0.02	0.05	0.1	0.1	0.05	0.02	0.02	0.05

[a] Wheat cultivars: samples 1, 3, and 5 = Stephens; sample 2 = Twin; sample 4 = Hyslop.
[b] Observed values corrected to 14% moisture basis.
[c] Observed value corrected to 10% protein.
[d] Mean difference and level of significant differences between standing and lodged values.

Cookie Diameter

Cookies baked from flour of the standing grain consistently had larger diameters than cookies baked from flour of the lodged grain (Table II). Cookie diameters were corrected to a flour protein content of 10% as a means of comparing inherent pastry baking qualities at a standard protein content (Finney et al 1950). Half the difference measured between mean diameter of cookies from standing vs lodged grain was due to protein difference in the flour (Table II). After correcting for protein differences, cookies from standing grain were significantly larger at the 0.05 level of probability.

These data indicate that milling and baking quality are adversely affected by early lodging of soft white wheat. The lower milling score and flour yield are of particular importance to the miller. Grain from lodged wheat produces an inferior baked product compared to grain from wheat that does not lodge.

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