Stress Cracking and Breakage Susceptibility as Affected by Moisture Content at Harvest for Four Yellow Dent Corn Hybrids

Curtis Weller
University of Nebraska-Lincoln, cweller1@unl.edu

M. R. Paulsen
University of Illinois at Urbana-Champaign

M. P. Steinberg
University of Illinois at Urbana-Champaign

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STRESS CRACKING AND BREAKAGE SUSCEPTIBILITY AS AFFECTED BY MOISTURE CONTENT AT HARVEST FOR FOUR YELLOW DENT CORN HYBRIDS

C. L. Weller, M. R. Paulsen, M. P. Steinberg
ASSOC. MEMBER ASAE
MEMBER ASAE

ABSTRACT
Four hybrids of yellow dent corn were harvested at three levels of moisture content. After drying, samples were analyzed for stress cracking and susceptibility to breakage in Wisconsin (WBT) and Stein (SBT) breakage testers. Significant differences in stress cracking and breakage susceptibility as determined with the WBT and the SBT were observed among the four hybrids. Breakage susceptibility as measured with the WBT and SBT significantly increased as the harvest moisture increased. Stress cracks increased significantly as harvest moisture increased within the drying air temperatures of 49, 71, and 93°C. WBT breakage susceptibility significantly increased as drying air temperature increased. Stress cracking was more highly correlated with WBT breakage than with SBT breakage.

INTRODUCTION
Since the description of stress crack formation in yellow dent corn by Thompson and Foster (1963), numerous studies on stress cracking have followed (Watson 1987). The studies have resulted in a clearer understanding of the formation of stress cracks (Gunasekaran et al., 1985) and how their formation is controlled (Gustafson et al., 1983).

Among the studies, efforts have been directed towards developing devices that measure breakage susceptibility of corn and for correlation with stress cracking. The goal of developing devices for measuring breakage susceptibility is to provide rapid and reliable methods of estimating the potential for breakage during subsequent handling (Gunasekaran, 1988). Ultimately, the devices may be useful for predicting the relative value of corn for end uses such as dry milling (Paulsen and Hill, 1985).

Eight such devices were recently compared in a collaborative study by Watson and Herum (1986). The control device used in the study was the Stein breakage tester, model CK-2M (SBT) which has historically been used in corn breakage studies (Thompson and Foster, 1963; McGinty, 1970) and is the device recommended for use by AACC Method 55-20 (AACC, 1983). The device Watson and Herum (1986) judged most acceptable on the basis of precision, rapid throughput, sturdy design, and rotor uniqueness was the Wisconsin breakage tester (WBT). The SBT and the WBT are the most widely used breakage testers (Gunasekaran, 1988).

Additional studies have reported breakage susceptibility measured with the SBT and the WBT to be very sensitive to the moisture content of the corn samples at the time of testing (Herum and Blaisdell, 1981; Paulsen, 1983; Hurburgh, 1984). Interpretation of the combined information reported by Paulsen (1983) and Herum and Blaisdell (1981) further shows that the sensitivity of breakage susceptibility to moisture content (as measured with the SBT) increased as the air temperature used for drying the corn samples increased.

No published studies, however, have specifically evaluated the effects of moisture content level at harvest on stress cracking and breakage susceptibility after drying. Bemis and Huelsen (1955) found that moisture content at harvest had a significant effect on the number of fractures observed in one hybrid of popcorn but not in another. Thompson and Foster (1963) studied stress cracking in combine harvested yellow dent corn dried in continuous-flow and batch dryers at temperatures between 60 and 143°C. They observed that the percentage of kernels with stress cracks decreased from 97.8 to 93.2% as harvest moisture decreased from approximately 30 to 20% (wet basis). However, they did not propose an explanation for their observation. They also noted that corn dried from 20% initial moisture content was less susceptible to breakage than corn dried from 30% initial moisture content.

Brown et al. (1979) suggested that moisture content prior to high temperature drying could affect stress crack formation in yellow dent corn. Their data also suggest that the effect of moisture varies among hybrids. White et al. (1982) were not able to establish a relationship between moisture content before drying and stress crack formation in a limited number of popcorn samples. Nevertheless, they concluded the relationship should be more fully evaluated.

Although the studies cited suggest that harvest moisture and hybrid can affect stress cracking and breakage susceptibility, they give no clear conclusions. Therefore, an analysis of data available from a wet milling study (Weller et al., 1988) was performed. Samples of four hybrids of yellow dent corn, prepared by Weller et al. (1988) with different drying treatments, were analyzed for the effect of harvest moisture on stress cracking and breakage susceptibility.
The objectives of the study were to:

- Compare stress cracking and breakage susceptibility among four different hybrids of yellow dent corn harvested at three levels of moisture content.
- Determine the effect of moisture content at harvest on stress cracking and breakage susceptibility for the corn hybrids.
- Determine the effect of drying air temperature on WBT breakage susceptibility for the corn hybrids.

PROCEDURES

SAMPLE PREPARATION

Four hybrids of yellow dent corn (Table 1) were grown in Champaign County, IL during the 1985 crop year. These hybrids ranged from high (hard) to low (soft) in vitreous-to-floury endosperm ratio as characterized by Weller et al. (1988). A 37 kg sample of each hybrid was hand-picked at monitor field moisture content and indicated when to harvest. Harvest moisture contents (Table 1) were determined using ASAE Standard S352.2 (ASAE, 1988). The harvested samples were hand-shelled, stored in sealed plastic bags and held at 4°C for up to 48 hr until the corn could be dried.

The corn samples were dried with the same laboratory dryers used by Gunasekaran and Paulsen (1985). Drying temperatures were controlled to within ±2°C at 22, 49, 71, and 93°C. Each dryer was equipped with a fan, heater and temperature controller, and an airflow of 2.0 m³/min per cubic meter of corn was maintained throughout drying. The drying was conducted in an environmentally controlled room at 22°C and 55% relative humidity.

A removable drying tray containing corn leveled to a depth of approximately 2 cm was placed over the plenum chamber of each dryer. The grain was mixed intermittently during drying to obtain uniform drying. The corn and tray were periodically weighed for moisture loss calculations. When a grain sample reached 14% (wb) moisture based on the initial electronic moisture meter reading, it was transferred to a nylon mesh bag. The mesh bag was then sealed inside a plastic bag and allowed to equilibrate at room temperature before storage. Four replications of each hybrid-harvest moisture-drying air temperature combination were prepared such that the total number of samples was 192 (4 hybrids x 3 harvest moistures x 4 drying temperatures x 4 replications). Each dried sample weighed approximately 2.5 kg.

After they had cooled to room temperature, the samples were removed from the plastic bag and placed inside an environmental chamber maintained at 20°C and 70% relative humidity by an Aminco-Aire unit (Parameter Generation and Control, Inc., Black Mountain, NC). All the samples were equilibrated in the chamber for at least 4 weeks before further testing.

Proximate analysis of the dried corn samples is given in Table 2. Moisture content was determined using ASAE Standard S352.2 (ASAE, 1988). Oil, protein, and starch contents were determined using methods described by Weller et al. (1988).

STRESS CRACKS

Fifty whole, apparently undamaged, kernels were selected from each sample and examined over a small rectangular opening in an opaque glass plate. The kernels were placed germ side down on the glass plate. Light from a 150 W incandescent floodlamp passed through the opening and kernels. Any kernel with one or more internal fissures was considered stress cracked. Percent kernels with stress cracks for any sample was calculated as the number of kernels cracked internally divided by 50 multiplied by 100%.

BREAKAGE SUSCEPTIBILITY

Breakage susceptibility for the dried corn samples was determined using both a Wisconsin Breakage Tester (WBT) Serial No. C017P and a Model CK-2M Stein Breakage Tester (SBT). Samples of 200 g of whole, unbroken kernels were used in the WBT while only 100 g were used in the SBT. The testing was done at a room temperature of 21 ±2°C on dried corn samples ranging in moisture content from 12.3 to 14.6% (wb). Before testing, the samples were sieved for 30 cycles on a sieve shaker (Gamet Mfg. Co., Minneapolis, MN) using a 4.76 mm round-hole sieve.

A vibratory feeder (Fritsch Laborette Type 24.001, Tecator, Inc., Herndon, VA) was used to feed each sample to the WBT at a rate of 600 g/min. WBT design and operation have been reported by Singh and Finner (1983). SBT test procedures followed the American Association of Cereal Chemists Method 55-20 (AACC 1983) with samples impacted for 2 min. The samples were resieved after impacting and breakage susceptibility was determined as the weight percent of the initial sample which passed through the sieve.

Observed values of breakage were corrected, as suggested by Hurburgh et al. (1987), to reflect values of breakage at a standard moisture content of 13.5% (wb). Both WBT and SBT values were corrected with the following equation:

\[ B_f = B_0(K)(M_f-M_0) \]

where

- \( B_0 \) = breakage susceptibility at original moisture, %,
- \( B_f \) = breakage susceptibility at final moisture, %,
- \( M_f \) = original moisture, % (wb),
- \( M_0 \) = final moisture, % (wb),
- \( K \) = breakage constant.

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**TABLE 1. Harvest moisture contents for four hybrids of yellow dent corn**

<table>
<thead>
<tr>
<th>Moisture Content</th>
<th>Hybrid†</th>
<th>Mean‡</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level</td>
<td>At Harvest</td>
<td></td>
</tr>
<tr>
<td></td>
<td>FR27 x FRM617</td>
<td>B73 x LH58</td>
</tr>
<tr>
<td></td>
<td>39.9(0.3)</td>
<td>29.6(0.3)</td>
</tr>
<tr>
<td></td>
<td>24.0(0.3)</td>
<td>21.9(0.3)</td>
</tr>
<tr>
<td></td>
<td>19.5(0.2)</td>
<td>17.0(0.2)</td>
</tr>
</tbody>
</table>

*Wet basis
†Means (SD) of 16 samples
‡Means (SD) of 64 samples
TABLE 2. Proximate analysis, test weight means, stress crack means, and corrected WBT and SBT breakage susceptibility means among hybrid for yellow dent corn harvested at three moisture content levels and dried with four drying air temperatures*

<table>
<thead>
<tr>
<th>Hybrid</th>
<th>Moisture at testing (%wb)†</th>
<th>Oil (%db)‡</th>
<th>Protein (%db)§</th>
<th>Starch (%db)¶</th>
<th>Test weight (kg/m³)</th>
<th>Stress cracks (%)</th>
<th>Corrected breakage susceptibility (%) WBT</th>
<th>Corrected breakage susceptibility (%) SBT</th>
</tr>
</thead>
<tbody>
<tr>
<td>FR27xFRMol7</td>
<td>13.6(0.4)</td>
<td>4.1(0.1)</td>
<td>9.1(0.6)</td>
<td>69.3(1.7)</td>
<td>772.9(11.0)</td>
<td>67.1(38.8)b</td>
<td>5.2(1.6)c</td>
<td>0.52(0.30)c</td>
</tr>
<tr>
<td>B73xLH38</td>
<td>13.5(0.5)</td>
<td>4.3(0.1)</td>
<td>9.3(0.4)</td>
<td>67.4(1.7)</td>
<td>772.0(12.2)</td>
<td>59.7(38.4)e</td>
<td>4.8(1.7)c</td>
<td>0.71(0.47)b</td>
</tr>
<tr>
<td>LH51xLH119</td>
<td>13.6(0.5)</td>
<td>4.1(0.1)</td>
<td>8.4(0.6)</td>
<td>70.0(2.2)</td>
<td>798.4(12.2)</td>
<td>75.4(41.4)a</td>
<td>7.0(2.3)b</td>
<td>0.71(0.38)b</td>
</tr>
<tr>
<td>FR27xVa22</td>
<td>13.3(0.5)</td>
<td>4.6(0.1)</td>
<td>8.8(0.4)</td>
<td>69.3(1.8)</td>
<td>820.9(10.1)</td>
<td>77.3(39.0)a</td>
<td>10.6(3.6)a</td>
<td>1.17(0.73)a</td>
</tr>
</tbody>
</table>

* Means (SD) of 48 samples. Means within column with different letters differ significantly (P<0.05) using Tukey's standardized range test after hybrid differences were found to be significant (P<0.05) in the split-plot analysis.
† Wet basis
‡ Dry basis
§ Significantly different in split-split plot design analysis.

The breakage constants for the SBT were derived using figure 1 from the study of Herum and Blaisdell (1981) and figure 8 of Paulsen (1983). K (2.01) for corn samples dried with 93°C air was calculated using the slope of curve D in figure 1 of Herum and Blaisdell (1981) for the range of moisture contents in this study. K (1.28) for corn samples dried with 22°C air was calculated using the slope of a curve drawn through the triangular points of figure 8 of Paulsen (1983) within the moisture range of this study. K values (1.52 and 1.77) for corn samples dried with 49 and 71°C air, respectively, were calculated by interpolating between the high and low temperature K values. Correction of SBT breakage susceptibility values for temperature of air used in drying prohibited analyzing for statistical significance of the effect of drying air temperature on SBT breakage means.

The breakage constant for the WBT was derived using curve F of figure 1 of Herum and Blaisdell (1981) and a curve through the triangular points of figure 6 of Paulsen (1983). Both curves had similar slopes resulting in the same K of 1.32. This K was then used for all drying temperatures since, for the range of moistures found in this study, the calculations indicated that drying temperature did not affect the relationship between breakage susceptibility and moisture content change.

**STATISTICAL ANALYSES**

A split-plot experimental design (Steel and Torrie, 1960) with a 5% level of significance was used to evaluate the effect of the hybrid genotype, harvest moisture and their interaction on stress cracking and breakage susceptibility for the four hybrids of yellow dent corn. A split split-plot design (Steel and Torrie, 1960) was used to determine the effect of drying air temperature on WBT breakage values. Significant main effects and interactions were subsequently analyzed using Tukey’s standardized range test at a 5% probability level (SAS, 1985).

**RESULTS AND DISCUSSION**

**STRESS CRACKS**

The stress crack means observed for each hybrid are shown in Table 2. Hybrid B73 x LH38 had the lowest percentage of stress cracking (59.7%), while stress cracking of FR27 x FRMol7 (67.1%) was significantly higher. Hybrids LH51 x LH119 and FR27 x Va22 had stress crack percentages (75.4 and 77.3%, respectively) significantly greater than the other two hybrids but not significantly different from each other. The relative difference in stress crack means observed between FR27 x FRMol7 and FR27 x Va22 is consistent with the relative difference observed by Gunasekaran and Paulsen (1985) for the same hybrids grown in a previous crop year.

Moisture content level at harvest within the four hybrids and the four drying air temperatures had no significant effect on stress cracking value (Table 3). The large standard deviation observed for each mean was primarily due to the low levels of stress cracking at the low drying air temperature of 22°C in contrast to much higher levels at the other three temperatures. Nevertheless, a decrease in stress cracking with decreasing moisture content at harvest was observed. This trend has been observed by others, as noted in the introduction.

The interaction of hybrid with harvest moisture did not have a significant effect on stress cracking. Examination of the stress crack percentages of Table 4 reveals that hybrids LH51 x LH119 and FR27 x Va22 have smaller ranges, 73.6 to 77.3% and 74.4 to 82.9%, respectively, than the other two hybrids. The ranges for FR27 x FRMol7 and B73 x LH38 were 55.9 to 75.3% and 40.9 to 71.4%, respectively.

Stress cracking values at drying air temperatures of 49, 71, and 93°C were analyzed with a split-plot design to reduce the large standard deviations noted above for all four temperatures. It is widely accepted that stress cracking occurs during drying above ambient conditions (Watson, 1987). This analysis found not only a significant difference in stress cracking among hybrids but also a significant increase in stress cracking as harvest moisture increased. Stress crack means of 99.0 and 99.1% for LH51 x LH119 and FR27 x FRMol7 and FR27 x Va22 is consistent with the relative difference observed by Gunasekaran and Paulsen (1985) for the same hybrids grown in a previous crop year.

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Stress cracking values at drying air temperatures of 49, 71, and 93°C were analyzed with a split-plot design to reduce the large standard deviations noted above for all four temperatures. It is widely accepted that stress cracking occurs during drying above ambient conditions (Watson, 1987). This analysis found not only a significant difference in stress cracking among hybrids but also a significant increase in stress cracking as harvest moisture increased. Stress crack means of 99.0 and 99.1% for LH51 x LH119

**TABLE 3. Stress crack means, and corrected WBT and SBT breakage susceptibility means among moisture content level at harvest for four yellow dent corn hybrids dried with four drying air temperatures**

<table>
<thead>
<tr>
<th>Moisture content level at harvest</th>
<th>Moisture at testing (% wb)†</th>
<th>Stress cracks (%)</th>
<th>Corrected breakage susceptibility (%) WBT</th>
<th>Corrected breakage susceptibility (%) SBT</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>13.7(0.5)</td>
<td>76.2(38.6)‡</td>
<td>7.1(3.4)‡</td>
<td>1.04(0.73)a</td>
</tr>
<tr>
<td>Medium</td>
<td>13.6(0.5)</td>
<td>72.2(40.5)ns</td>
<td>7.1(3.3)ns</td>
<td>0.84(0.36)b</td>
</tr>
<tr>
<td>Low</td>
<td>13.2(0.4)</td>
<td>61.2(39.2)ns</td>
<td>6.4(0.4)ns</td>
<td>0.46(0.28)c</td>
</tr>
</tbody>
</table>

* Means (SD) of 64 samples. Means within column with different letters differ significantly (P<0.05) using Tukey’s standardized range test after effect of moisture content at harvest level was found to be significant (P<0.05) in the split-plot analysis.
† Wet basis
‡ Not significant in split-plot analysis within 22, 49, 71, and 93°C drying air temperatures.
§ Significantly different in split-split plot design analysis.
and FR27 x Va22, respectively, were significantly greater than the means for the other two means but not significantly different from each other. The stress crack mean of 88.3% for FR27 x FRMol17 was also significantly greater than the mean of 79.2% for B73 x LH38. Means of 97.8 and 95.1% for high and medium harvest moisture levels, respectively, were significantly greater than the mean of 81.2% for the low harvest moisture level. The means for the high and medium harvest moisture content levels were not significantly different.

The interaction of hybrid and harvest moisture for samples dried at 49, 71, and 93°C significantly affected stress crack means as shown in Table 4. Stress crack means for LH51 x LH119 and FR27 x Va22, at all harvest moisture levels, were not significantly different from each other. They were significantly greater than the means of FR27 x FRMol117 at the low harvest moisture level, and B73 x LH38 at the low and medium harvest moisture levels. Stress cracking decreased in all four hybrids as harvest moisture decreased.

LH51 x LH119 and FR27 x Va22, the hybrids with the greatest mean stress cracks (Table 2), were the hybrids that had the smallest ranges of stress cracking within harvest moisture (Table 4), the greatest test weight (Table 2), the lowest protein contents (Table 2), and a mixed ranking of harvest moisture (Table 4), the greatest test weight (Table 2), the lowest protein contents (Table 2), and the greatest mean stress cracks (Table 2), were the hybrids that had the smallest ranges of stress cracking within harvest moisture level and hybrid for yellow dent corn dried with four drying air temperatures.
columns were significantly different from each other. With the exception of LH51 x LH119 tested with the WBT, WBT and SBT breakage susceptibilities of all hybrids were greater at the high and medium moisture levels than at the low harvest moisture.

The split-plot design used to determine the effect of drying air temperature on WBT breakage values found the same significant differences among hybrids as noted for the split-plot analysis. Significant increases in WBT breakage susceptibility means were observed as temperature of the drying air increased from 22° C to 93° C (Table 5) and as harvest moisture increased (Table 3). The means of 7.1% for high and medium harvest moisture levels were significantly greater than the low harvest moisture level mean of 6.4%. The significant effect of harvest moisture in the split-plot analysis was not found in the split-plot as inclusion of the drying air temperature effect in the analysis of variance made the test more sensitive. The significant effect of harvest moisture level on WBT breakage is supported by work of Dutta (1986) and Fox (1989).

The interactions of hybrid and drying air temperature, and harvest moisture level and drying air temperature significantly affected WBT breakage susceptibility (Table 5). Among the temperatures within each hybrid or harvest moisture level, WBT breakage means for samples dried with air at 22° C were significantly less than samples dried at all other temperatures. The sample means for the other drying temperatures were generally twice as large as the 22° C mean and similar in value to each other.

Significant differences in WBT breakage susceptibility means among the interaction of hybrid, harvest moisture level and drying air temperature are shown in Table 6. As similarly noted for the interactions above, among the temperatures within harvest moisture level within each hybrid, WBT breakage means for samples dried with air at 22° C were significantly less than samples dried at all other temperatures except for FR27 x FRM017 and B73 x LH38 at low harvest moisture. The sample means for the other drying temperatures were also generally twice as large as the 22° C mean and similar in value to each other.

**CORRELATIONS**

For the 192 samples, the correlation of stress crack percentages with WBT breakage susceptibility had an R value of 0.72. This is less than the 0.99 and 0.85 values for correlation of mean WBT breakage susceptibility with stress cracks observed by Paulsen and Hill (1985) and Jackson et al. (1988), respectively. However, the corn samples of Paulsen and Hill (1985) were obtained from a dry miller and were probably mixtures of similar commercial genotypes. The samples of Jackson et al. (1988) were from a hard white kernel hybrid and two softer yellow kernel hybrids.

The correlation of stress crack percentage with SBT breakage susceptibility had an R value of 0.47. The lower correlation of SBT breakage as compared to WBT breakage may be attributed to the fact that only SBT breakage susceptibility was significantly affected by harvest moisture. Legitimate comparison of the 0.47 value with a 0.79 correlation coefficient reported by Thompson and Foster (1963) can not be made since this study examined the correlation between total stress cracks and SBT breakage. Thompson and Foster examined only percentages of checked (multiple stress cracks) kernels and compared these to increases in SBT breakage susceptibility above breakage levels for a control sample.

The R value for correlation of WBT with SBT breakage susceptibility values observed in this study was 0.64. The value is lower than the correlation coefficients of 0.928 (12% moisture) and 0.724 (16% moisture) observed by Pomeranz et al. (1986). However, the study by Pomeranz et al. (1986) used a CK-2 SBT with a 4 min time while this study used a CK-2M SBT and a 2 min time.

**CONCLUSIONS**

Stress cracking and breakage susceptibility as measured with the Wisconsin and Stein breakage testers were determined for four hybrids of yellow dent corn. Based on these observations, the following conclusions were made:

1. The four hybrids tested showed significant differences in stress crack means and means of WBT and SBT breakage susceptibility.

**TABLE 5. Corrected WBT breakage susceptibility means among drying air temperature interaction of hybrid and drying air temperature, and interaction of harvest moisture level and drying air temperature for yellow dent corn**

<table>
<thead>
<tr>
<th>Drying Air Temp. (°C)</th>
<th>FR27 x FRMO17</th>
<th>B73 x LH38</th>
<th>LH51 x LH119</th>
<th>FR27 x Va22</th>
<th>Harvest moisture level</th>
<th>Corrected WBT breakage susceptibility</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All*</td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>3.4(0.9)c</td>
<td>3.0(0.2)i</td>
<td>2.7(0.3)i</td>
<td>3.4(0.4)i</td>
<td>4.7(0.5)h</td>
<td>3.5(0.9)f</td>
</tr>
<tr>
<td>49</td>
<td>7.9(3.5)b</td>
<td>5.2(1.1)gh</td>
<td>5.4(1.6)fgh</td>
<td>7.9(0.9)d</td>
<td>13.1(1.2)a</td>
<td>8.3(3.6)abc</td>
</tr>
<tr>
<td>71</td>
<td>8.6(3.2)a</td>
<td>6.2(0.8)ef</td>
<td>5.9(1.5)fgh</td>
<td>9.0(1.3)c</td>
<td>13.3(0.7)a</td>
<td>8.5(3.2)ab</td>
</tr>
<tr>
<td>93</td>
<td>6.3(1.1)b</td>
<td>6.3(1.1)e</td>
<td>5.2(1.0)gh</td>
<td>7.9(0.7)d</td>
<td>11.3(0.7)b</td>
<td>8.2(2.1)bc</td>
</tr>
</tbody>
</table>

* Mean (SD) for 48 samples. Means within column with different letters differ significantly (P<0.05) using Tukey’s standardized range test after differences due to interaction of harvest moisture level and drying air temperature were found to be significant (P<0.05) in the split split-plot analysis.
† Mean (SD) for 12 samples. Means within hybrid section with different letters differ significantly (P<0.05) using Tukey’s standardized range test after differences due to interaction of hybrid and drying air temperature were found to be significant (P<0.05) in the split split-plot analysis.
‡ Mean (SD) for 16 samples. Means within harvest moisture level section with different letters differ significantly (P<0.05) using Tukey’s standardized range test after differences due to interaction of harvest moisture level and drying air temperature were found to be significant (P<0.05) in the split split-plot analysis.

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Moisture content level at harvest had no significant effect on the stress crack means within all four drying air temperatures. Stress crack means increased significantly as the level of harvest moisture increased within the drying air temperatures of 49, 71, and 93°C.

Stress breakage susceptibility means as measured using the WBT and the SBT were significantly affected by the interaction of hybrid and harvest moisture content.

6. WBT breakage susceptibility means significantly increased as drying air temperature increased.

7. The interactions of hybrid and drying air temperature, harvest moisture level and drying air temperature, and hybrid and harvest moisture drying air temperature significantly affected WBT breakage susceptibility means.

8. The correlation coefficients between stress crack means and WBT and SBT breakage susceptibility means were 0.72 and 0.47, respectively.

REFERENCES


