GRAIN QUALITY
Task Force

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Drying of White Food Corn for Quality

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The need for high quality corn is continuing to increase in the Midwestern United States. This is especially true for high value specialty corn hybrids such as food-grade white corn. Corn of high quality is essential for end users producing products such as corn chips, tortillas, masa flour, and breakfast cereal. High quality corn should be low in stress cracks and have a low, uniform moisture content. Stress cracks are one of the most troublesome types of corn damage caused by improper drying and cooling. Stress cracks are fine cracks in the endosperm of the kernel, located just below the surface. Kernels with a large number of stress cracks are more susceptible to breakage, yield smaller grits during dry milling, absorb water too rapidly during wet milling, and are more susceptible to insect and mold damage during storage.

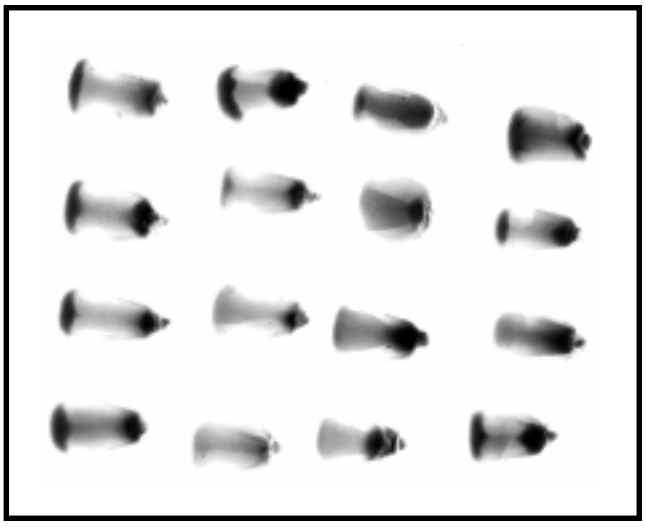

Figure 1: Zero, single, double, and multiple stress cracks in white corn kernels

Stress Cracking

Small numbers of stress cracks occur naturally in all corn (usually less than 3% due to field drying). However, this background level of stress cracking is greatly increased during post-harvest handling. High drying and cooling rates are the major factor in stress crack development. When moisture is removed from the kernel too quickly, the structure of the kernel fails and stress cracks form. In order to maintain quality, and therefore maximize premiums, producers must strive to minimize the increase in the number of stress cracks caused by drying and cooling.

Stress cracks in corn kernels can be broken down into four categories (Figure 1).

The first stress crack category includes kernels with zero stress cracks. This is obviously the most desirable category and the goal producers should strive for. The second stress crack category includes kernels with a single stress crack. Kernels with a single stress crack are often acceptable to corn processors. The third stress crack category includes kernels with two stress cracks (double crack). The most severe stress crack category includes kernels with more than two (multiple) stress cracks. These kernels are often referred to as checked or crazed kernels and are least desired by processors.

Stress cracks are easily determined by carefully inspecting kernels that are placed germ-down on a light-board. A sample of 50-100 kernels is usually sufficient to provide a representative indicator of the severity of stress cracks out of a dryer, in a storage bin, or in a truckload.

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By counting the number of kernels in each stress crack category, the stress crack index can be calculated. Stress crack index (SCI) is a measure of the severity of damage in the corn and is calculated as follows:

SCI = Single + 3*Double + 5*Multiple

Where single, double, and multiple are the number of kernels with single, double, and multiple cracks, respectively. White corn generally has a harder endosperm than commodity yellow corn, and thus is more susceptible to stress cracking. Every quality-conscious producer should determine the level of stress cracks (and possibly SCI) in their white corn before ever marketing or delivering the first load off their farm. Knowing your stress crack count beforehand avoids surprises at the grading station and gives producers an additional marketing tool to maximize value-added premiums.

Effect of Kernel Temperature

Recent thin layer drying tests at Purdue University have demonstrated the relationship between the kernel temperature during drying and the formation of stress cracked kernels in white food corn. In these tests, small samples of white food corn were dried on a screen one kernel deep from approximately 20% w.b. moisture to 14% w.b. moisture. Drying tests were performed at 100°F, 130°F, 160°F and 200°F. After drying, samples were subjected to either rapid cooling to 40°F or tempering for one hour before being allowed to cool to room temperature. Figure 2 shows the combined results of each drying treatment.

From this figure, it is clear that as the kernel temperature increased during drying, the level of stress crack damage increased as well. Between 100°F and 130°F there was a large step increase in the amount of stress crack damage that occurred. In other words, once kernel temperatures exceed 100-110°F, stress crack damage was so severe that increasing the temperature from 130°F to 160°F or 200°F did not make a significant difference. Thus, in order to minimize the amount of stress cracking damage, kernel temperatures should be kept below 100-110°F. Dryer operators must realize that the kernel temperature is not the same as the drying air temperature. The drying air temperature is the temperature set at the burner. The maximum kernel temperature is the highest allowable temperature the kernels should reach during the drying process. The less heat and the slower the drying (and cooling) process, the higher the final white corn quality will be.

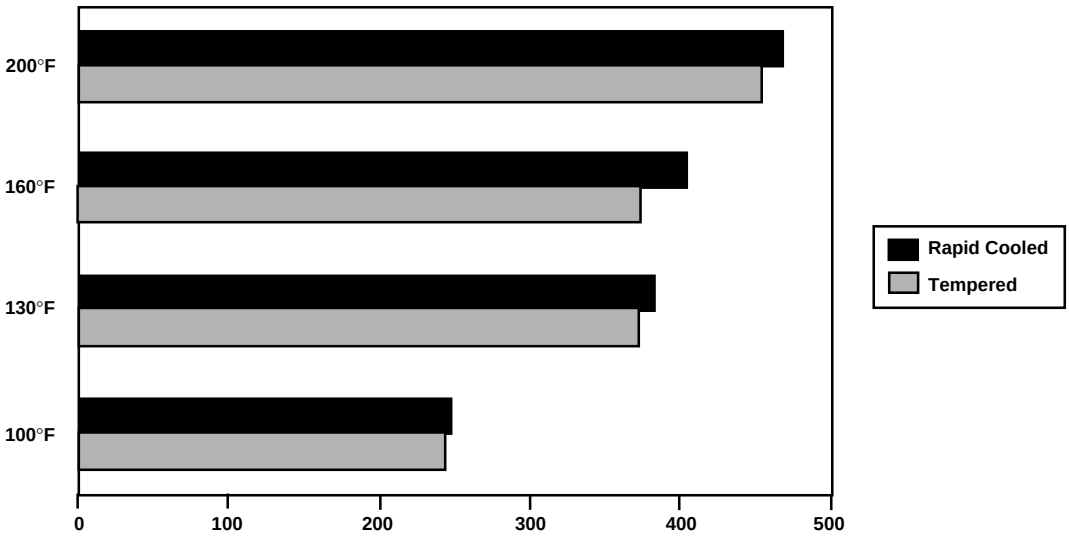

Figure 2: Average stress crack index for all white corn hybrids in each drying treatment

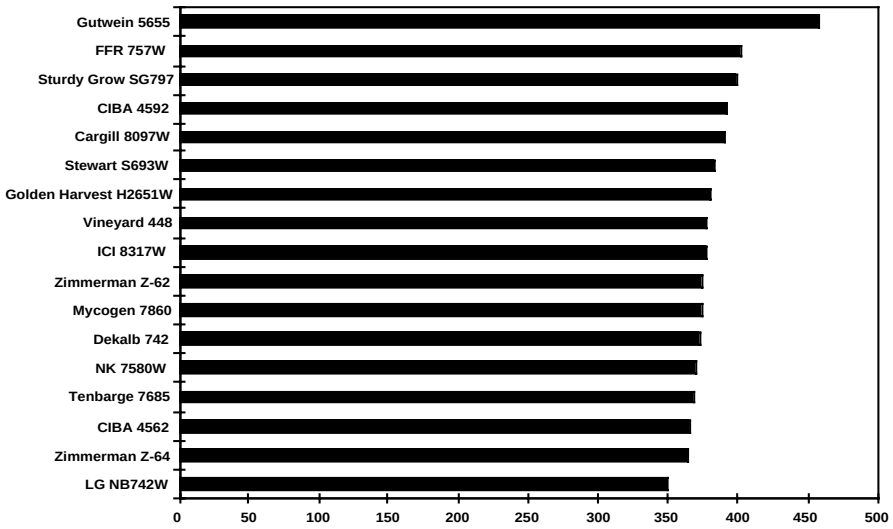

Figure 3: Stress crack index of 17 white corn hybrids dried at 130°F and 160°F

Effect of Tempering

Based on this data it is also interesting to note that rapidly cooling the white corn or tempering it first did not make a significant difference when corn was dried to 14% w.b. In other words, the stress crack damage was caused due to the high kernel temperature and drying rate (moisture removal). In order to take full advantage of tempering, white corn should be transferred out of a full-heat dryer at kernel temperatures of 100-110°F and 17-18% w.b. moisture in order to reduce stress crack formation further.

Effect of Hybrid

Figure 3 shows a plot of the stress crack index versus 17 white corn hybrids dried at 130°F and 160°F. This data indicated that variations in stress crack susceptibility of over 20% existed among white corn hybrids. Processors that specify approved hybrid lists for their contract growers need to include post-harvest drying and storage treatment testing in addition to end-use performance criteria for white corn hybrid selection.

Drying System

This research clearly shows the benefit of using lower kernel temperatures to dry white food corn with respect to stress cracking. Drying methods that keep the maximum corn kernel temperature below 100-110°F such as in-bin natural air, low temperature, and stir drying, as well as full-heat drying with hot corn transfer (dryeration and in-bin cooling) should be utilized to maximize white food corn quality. Tempering of corn before cooling and slow cooling of the corn reduces the number of stress cracks, but only for intermediate moisture contents of 17-18% w.b. The amount of moisture removed during drying should be limited to 4 to 5 points per hour and overdrying must be avoided.

Drying Rate

This research also investigated the drying rate of white corn hybrids. It was shown that the difference between a fast versus slow drying hybrid was as high as 25%. This means that when under the same drying conditions, the fast drying hybrid reached 14% w.b., while the slow drying hybrid had only reached 16 % w.b. This has a significant effect on drying capacity.

Producers should not only choose hybrids based on their agronomic yield but also based on susceptibility to post harvest handling, drying, and storage behavior. Hybrid development research by seed companies in the future should not only include end-use characteristics critical to the processor but also post-harvest characteristics that affect the producer.

For a complete report of this research, contact the authors by e-mail (maier@ecn.purdue.edu), phone (765-494-1175), or fax (765-496-1356) and request ASAE paper No. 97-6065 *Thin Layer Drying Rates and Stress Cracking of White Food Corn Hybrids.*

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