Rice Fissuring

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Fissures are cracks in the rice kernel. During milling, kernels with fissures tend to break, causing lower head and total percentages. Rice is subject to fissuring as it dries below a critical moisture level, either in the field or after harvest.

The cause of fissuring

The kernel fissures when it is exposed to high humidity conditions or water (dew) after it has dried below a critical moisture in the range of 14 to 18%. The critical moisture is believed to differ among varieties, although exact data are not available for most varieties. When the kernel dries it shrinks and when it gains moisture it expands. Apparently above the critical moisture the kernel is pliable enough to allow some expansion and contraction without damage. Below the critical moisture it is brittle and mechanical stress above the strength limit of the kernel can cause it to break and form a fissure. The stress is caused by dry kernels being exposed to high humidity or water. The outside of a dry kernel gains moisture first when exposed to humid conditions and expands against the inside which has not changed dimension.

Damaging exposure to high humidity or water can occur before harvest or in drying and storage operations. For example in the field, grains which have dried below the critical moisture during the day are subject to fissuring at night when the relative humidity rises or dew forms.

Numerous tests have shown that damage occurs at average field moistures above the critical moisture because there is a great deal of moisture variability among individual rice grains. The variation is caused by differences in flowering date along a panicle; variation in plant density and nutrient status that can cause panicles to vary in maturity. Figure 1 shows the kernel moisture variability for a Japanese rice variety raised in California. Some of the rice is below critical moisture and subject to fissuring even though the average moisture is 24.6%. The driest kernels may fissure if they are exposed to high humidity or dew at night. Rice kernels are usually not mature at moistures above 30%, so in the figure a few will actually contribute to low head rice quality because they are chalky. Another test with a Southeastern variety, showed a fissure rate of 23% for the most mature kernels on panicles which had an average moisture of 29.4%.

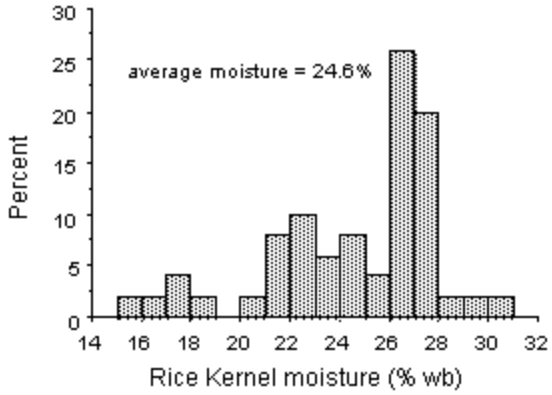

Figure 1. Moisture distribution for individual kernels in a batch of recently harvested Akitakomachi paddy rice.

There are a number of circumstances after harvest that can also cause fissuring. Dry kernels may be exposed to high humidity if they are loaded into a bin and surrounded with rice that has a high moisture content. A layer of dry rice placed on top of wet rice in a bin dryer will be exposed to high humidity when the drying fan is operated.

Fissuring conditions also occur in heated air drying and these limit the amount of moisture removed during each pass through a column dryer. During drying, moisture leaves the kernel mainly near the region around the germ. This area has a low moisture and regions farther from the germ have higher moistures. When the germ region drops below the critical moisture, it may fissure if it is subjected to excessive moisture regain from the wetter portions of the kernel. If continuous moisture loss rates are less than 1.5% per hour internal stresses do not reach a level that causes fissuring. All commercially successful heated air dryers remove several percent moisture during each exposure to hot air, then allow time for moisture redistribution before removing any additional moisture. Moisture removal rate may exceed 1.5% per hour during the 20 to 30 minutes of exposure to hot air, but averaged over both the drying and moisture redistribution periods the rate is below the limit to prevent fissuring.

The moisture redistribution period is called tempering. At 95°F, tempering is 95% complete in two hours and 100% complete in five hours. Rate of tempering drops slightly as temperature drops. A 10°F drop in temperature increases tempering time by 17 minutes. In California, tempering times are often about 24 hours because large batches, requiring about 8 hours to pass through the dryer are common.

How to reduce fissuring

1. Varieties differ in their susceptibility to fissuring. Medium grain rice tends to be more susceptible to fissuring compared with long grain rice. But even within a type of rice there can be significant differences. Varieties with lower range of maturity are subject to less fissuring.

Breeders, though, select rice with some variation in maturity to spread pollination over a number of days so that adverse weather conditions at flowering have less potential to cause significant yield losses. Varieties that are susceptible to fissuring must be handled with particular care to minimize damage.

2. Use cultural practices that tend to produce uniform maturity at harvest.

a) use an adequate seeding rate and apply the seed uniformly to minimize late tillering.

b) apply fertilizer uniformly, areas with low nitrogen ripen earlier than areas with adequate nitrogen.

c) level field to eliminate borrow areas which tend to have later maturing crop or harvest borrow areas separately.

3. Harvest at the correct moisture. Most California varieties should be harvested at moistures above 20%. Figure 2 shows that highest head rice quality for medium varieties is obtained at about 25% moisture and quality does not drop more than 2 points below the maximum, unless the moisture drops below 20% or exceeds 30%. High moisture kernels have a reduced head rice quality because the kernels are chalky and not yet mature. Harvesting at moistures above 25% is usually unacceptable because of high drying costs.

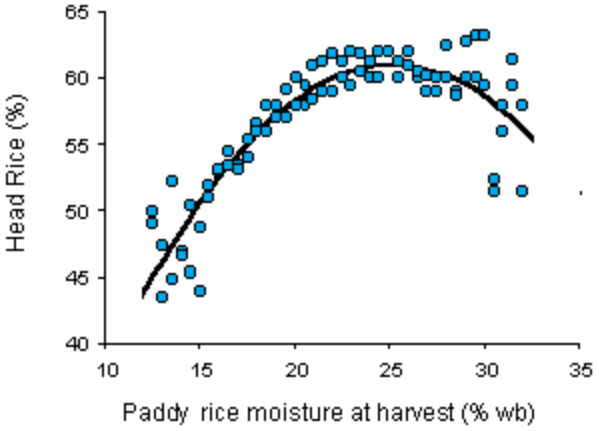

Figure 2. Effect of rice moisture at harvest on head rice quality. Data is for medium grain varieties commercially produced during the 1995 California harvest season.

4. Harvest moisture is particularly important on clear calm days when daytime maximum air temperatures are high and night temperatures are low. The high day temperatures cause relatively fast drying, so there is a great potential for a significant portion of the rice to dry below the critical moisture. Each night the humidity rises and dew forms on the

driest most exposed kernels in each panicle. Later in the season when air temperatures are typically lower the loses are less. Windy low humidity conditions at night will reduce fissuring losses. But since fields dry quickly under these conditions, they must be harvested rapidly before high night humidity conditions return.

5. Keep high moisture and low moisture lots separate after harvest. The dry grain can be cracked by the high humidity caused by the higher moisture rice.

6. In a bin dryer, do not put a layer of dry rice on top of wet rice. The drying air gains moisture as it passes through the wet rice and may cause the dry rice above to fissure.

7. Do not operate aeration fans when rice is dry and outside air humidity is high. (See storage.)

8. In a column dryer, do not remove too much moisture per pass. (This is discussed in more detail in high temperature drying.)