

Application Note SC008: SeedCount Corn Module

The SeedCount Corn module is a member of a family of grain testing programs that use digital image analysis to measure quality factors of grain, pulses, beans, nuts and the like. At the present time there are completed modules for wheat, barley, and rice. For these a demonstration program is available for downloading, as well as a user's manual, and a tutorial. The corn module will be similar and will be an integral component of the SeedCount family.

The corn module is work in process. It is in a demonstrable form in which its seven tests can be run on samples of corn and on individual kernels. Various parameters that determine how the tests work can be varied by the user for the purpose of optimization and calibration. The final program will run automatically, testing all the kernels in the sample, displaying the results, and accumulating the results in an output spreadsheet file.

The corn module can test corn samples using either incident light or transmitted light.

Incident light tests

- Size (sieving fractions by weight percentage)
- Red streaks
- Dent
- Color
- Crown

Transmitted light tests

- Horneous endosperm
- Stress cracks

The incident light tray is used in a standard SeedCount cabinet. It is inserted into a slot in the face of the instrument. There is a modified scanner that creates a high resolution color image in a form that can be analyzed in a standard Windows based personal computer. The figure below shows the incident light tray loaded with a sample of corn.

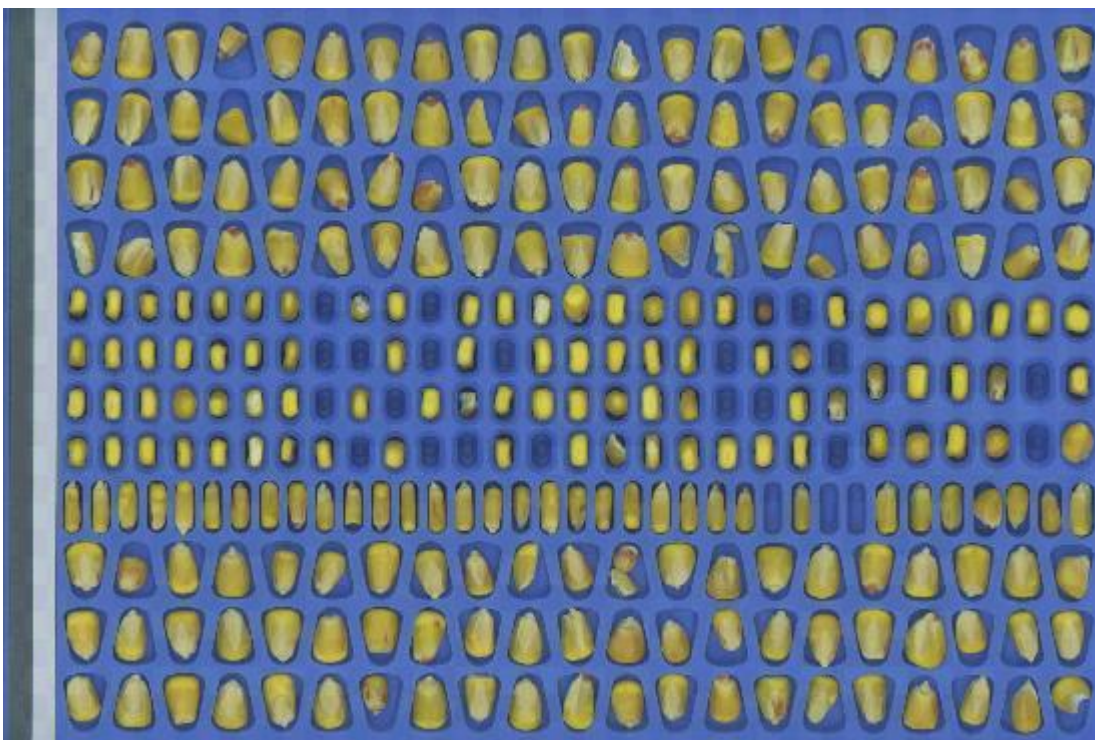


Fig 1. Incident Light Corn Tray with corn sample.

The tray has features that permit accurate and repeatable color measurements. On the top are two color strips that go from the left edge to the right edge. One of these is an off white color and the other is a dark gray color. The spectral qualities of these strips are accurately known. Each time an image is created, the individual color sensors in the CCD array are automatically calibrated. Thus SeedCount images are repeatable from instrument to instrument and are traceable to international color standards.

The (patented) tray has indents designed to hold the kernels in desired orientation for particular measurements. On the left and right side there are 147 triangular indents designed to hold the kernels flat so that the side of the kernel can be viewed and measured. Note that kernels in these indents do not have to be oriented with their wide end matching the indent. Only in the rare event that a kernel is too large to fit the indent laying flat is it necessary to flip the kernel. In the triangular indents, size distribution, dent, color, and crown measurements are made.

Near the center is a column with 36 narrow indents designed to hold the kernels on their edge. In this position the thickness of kernels can be measured.

In the center there are columns of smaller indents designed to hold the kernels in an end-on position so that the crown can be viewed directly. There are 106 such indents in three sizes. In this position the dent can be measured. It is also possible to use this position to determine the sieve width of the kernel that determines which hole in the standard sieve will fit through.

This corn tray has 289 indents in all. It should be pointed out that the current arrangement of indents is arbitrary and other arrangements may be better for particular purposes. It would be possible to have a tray entirely with flat indents in which case there would be room for about 260 indents. It is possible to decrease the number of end-on indents to make room for more flat ones.

The 36 edge on indents in the current tray have no immediate purpose in the seven tests performed by this corn module. They are present because other grains have them to permit a statistically derived average kernel shape and this may be useful in the future..

The transmitted light tray

Figure 2 and 3 show the transmitted light tray with a sample of corn.

The tray is made of black anodized aluminum with a transparent bottom. It has 54 triangular indents and a working area of about 25 square inches. The tray is used with a separate desk top scanner capable of scanning positive transparencies. When the tray is placed on the scanner and scanned, a masked image is created in which the individual kernels are separated out as shown in figure 3. Separate image files for each kernel are created. These image files can be accessed by the horneous endosperm test procedure and by the stress cracks procedure

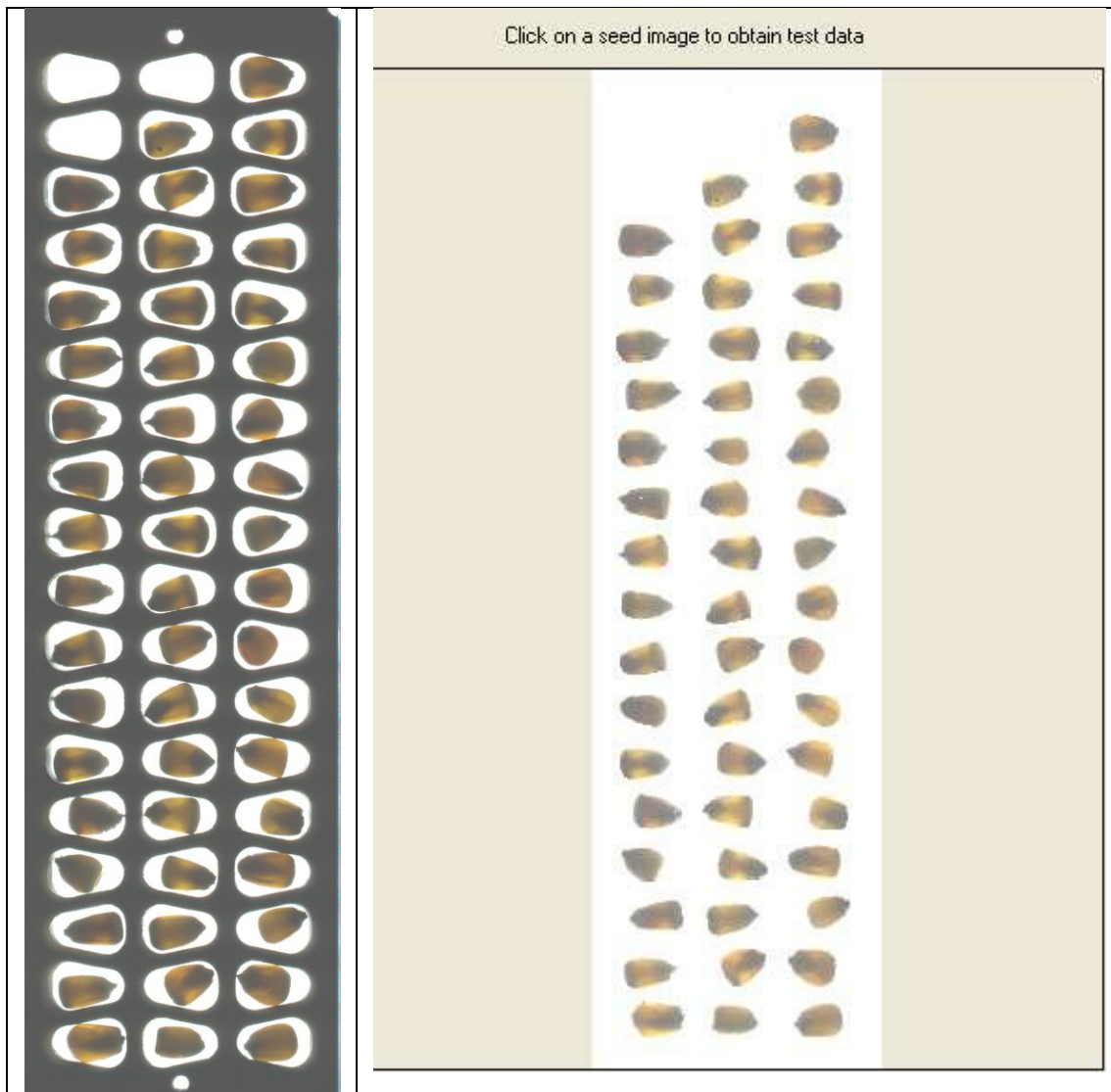


Figure 2 and 3 Transmitted Light Tray with Sample

Switching between incident and transmitted light scanning

To switch between incident light scanning and transmitted light scanning it is necessary to disconnect the USB data cable from the SeedCount cabinet and connect it to the separate desk top scanner.

The main user interface screen

Figure 4 shows the main user interface screen after an incident light tray has been scanned. Prior to scanning sample clean weight and sample volume must be entered on the left side. Note that size measurements have already been made and the results displayed in the lower right corner. These are based on the standard corn sieve hole values and give the percentage weight of each fraction.

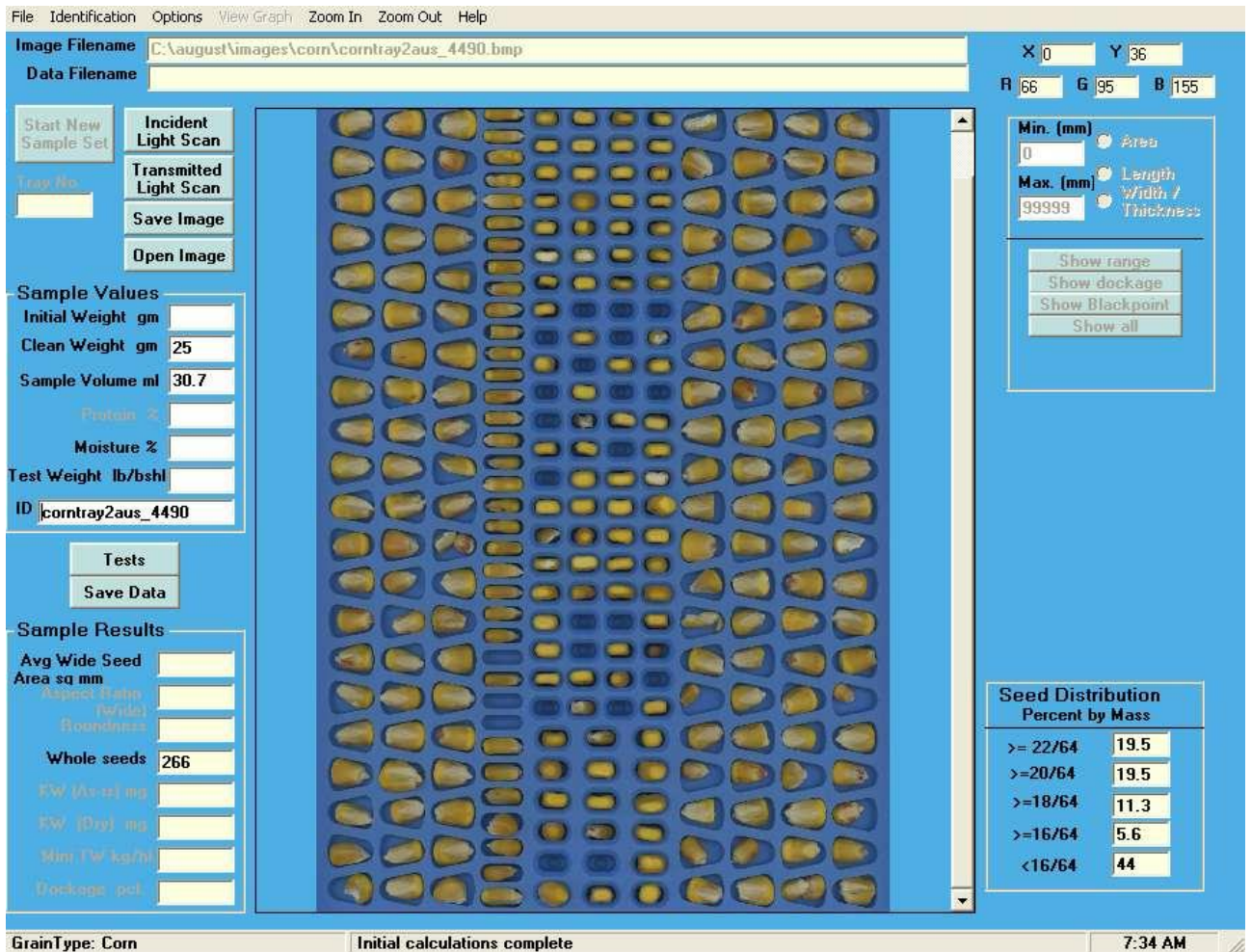


Figure 4. The main user interface screen

The main user interface screen is similar to the standard SeedCount main screen although not all the functions have been implemented in the corn module at this time. Functions that are not implemented are grayed out. The image can be zoomed and panned to display any kernel or group of kernels in any size. The position of the cursor and the color of the pixel under the cursor are displayed.

Note that there are two scan buttons one for incident and the other for transmitted light scanning.

Size Measurements

Each kernel is evaluated to determine which sieve hole it can pass through. This is done by measuring the sieve width of the kernel. The standard corn sieves have round holes whose diameters are 22/64, 20/64, 18/64 and 16/64 inches. These are steps of 1/32 inch. SeedCount imaging is done at 300 dpi. There are therefore about ten pixels per step.

The weight of each kernel is estimated by extrapolating from its area and the weight of the sample. From this the weight of each size fraction is determined.

The sieve width of three kernels (the red or green line) are shown in figures 5.

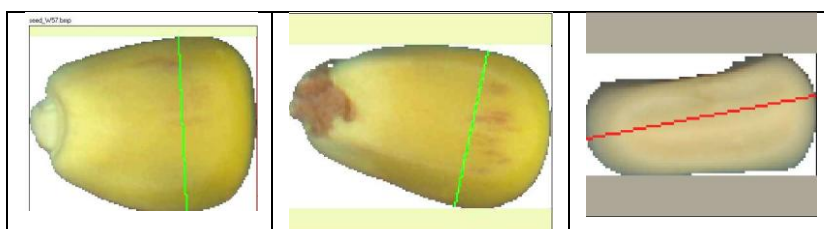


Figure 5. Sieve widths of three kernels. Note that the third kernel shown is an end-on view.

Invoking individual tests

After loading an existing image file or scanning a new one, the individual tests can be invoked by pressing the Test button. This opens a screen where a test can be selected. If the image is an incident light image then the Dent, Color, Red Streaks, or Crown test can be selected. If the image is a transmitted light image then the Horneous Endosperm or the Stress Cracks test can be selected.

Dent Measurement

Dent measurements are made on the end-on view of the kernels. When this test is selected only the end on area in the image is available. Clicking on a kernel image will cause an enlarged image to be presented on the right. The dent area is shown in dark brown and its area in square millimeters is indicated. Although contrast is low, dents are visible as dark areas in the crown and can be isolated and measured. Various parameters associated with dent measurement can be modified by the user to optimize and calibrate the dent measurement.

Two images of kernels with and without the indicated dent are shown in figure 6.

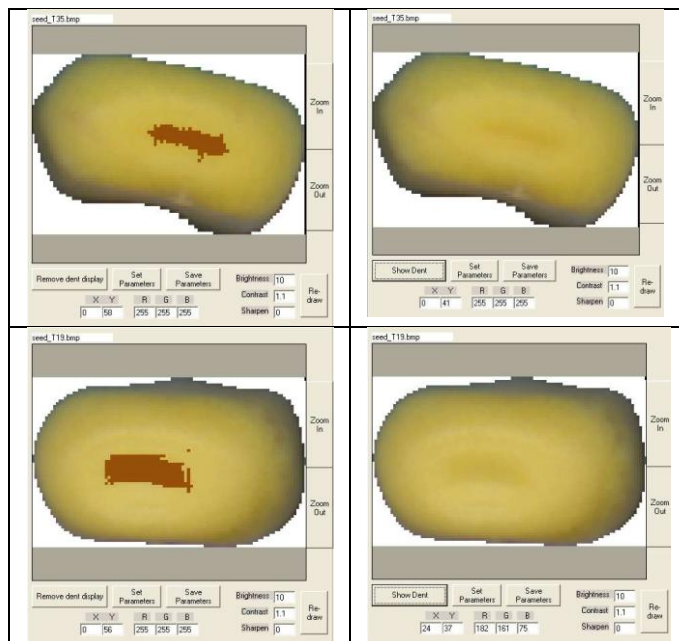
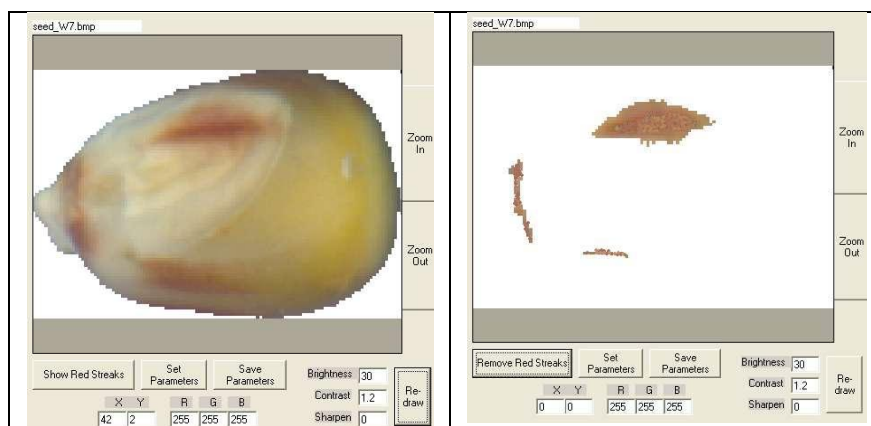


Figure 6. Dent measurements

Red Streaks

The red streaks test is invoked by selecting it after pressing the Test button on the main screen. Clicking on a kernel in the scanned image will cause an enlarged image of the kernel to appear on the right. Red streaks, if any, can be displayed or removed from the display. The percent area of the red streaks is shown. Various parameters associated with this test can be varied to optimize and calibrate the test. Two examples of kernels with red streaks are shown in figure 7.



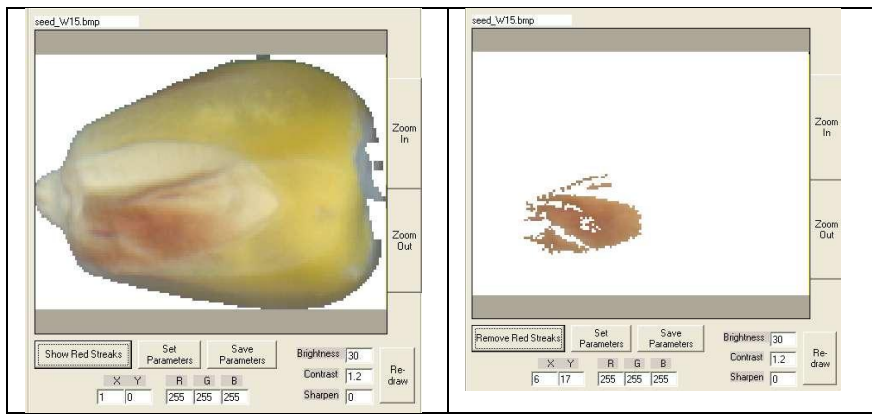


Figure 7. Examples of red streaks

Crown Test

The crown test is invoked by selecting it after pressing the Test button on the main screen. Clicking on a kernel in the scanned image will cause an enlarged image of the kernel to appear on the right. The yellow crown area, if any, can be displayed or removed from the display. The percent area of the crown is shown. Various parameters associated with this test can be varied to optimize and calibrate the test. Two examples of kernels with crown are shown in figure 8.

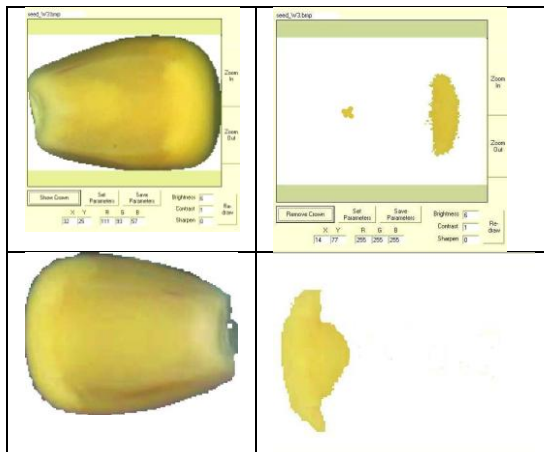


Figure 8. Examples of Crown test

Color Test

The color test is invoked by selecting it after pressing the Test button on the main screen. Clicking on a kernel in the scanned image will cause an enlarged image of the kernel to appear on the right. The single characteristic color of the kernel can be displayed or removed from the display.

Eight standard colors are displayed near the bottom. The program matches the characteristic color with the nearest standard color and displays its choice on the top right of the display. Various parameters associated with this test can be varied to optimize and calibrate the test. Two examples are shown in figure 9.

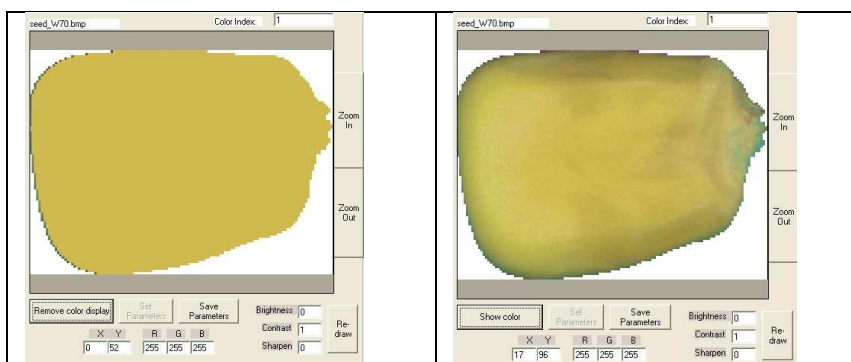




Figure 9. Characteristic colors of kernels

Transmitted Light Imaging

When the image scanned or loaded is a transmitted light image and the test button is pressed, the user has a choice between the horneous endosperm test or the stress crack test.

Horneous Endosperm Test

When this test is invoked and a kernel is clicked on, the display on the right side consists of the translucent portion of the kernel image. The opaque portion is masked off. The percentage of horneous endosperm is displayed above the image. The user can switch between a full view of the kernel and the masked view. Sample images are given in figure 10.

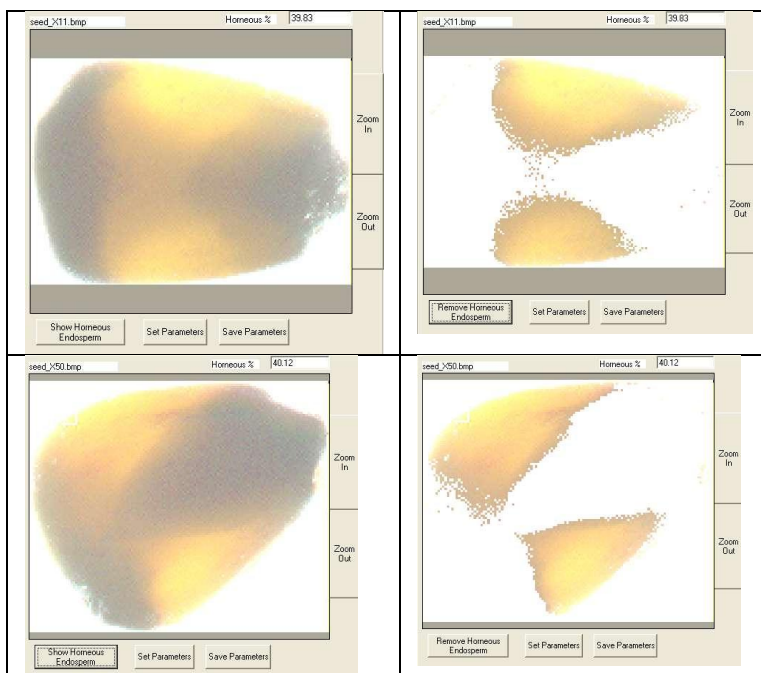


Figure 10 Horneous endosperm tests

Stress Cracks

When the stress cracks test is invoked and a kernel is selected, the program displays an enlarged, contrast enhanced and sharpened image made with transmitted light. The stress cracks are easy to see and count. The user counts the stress cracks and enters the number via the keyboard. The number is displayed adjacent to the kernel image. Also displayed is the total number of stress cracks, the average number, and the number of kernels that have been counted..

Images of kernels with stress cracks are shown in figure 11.

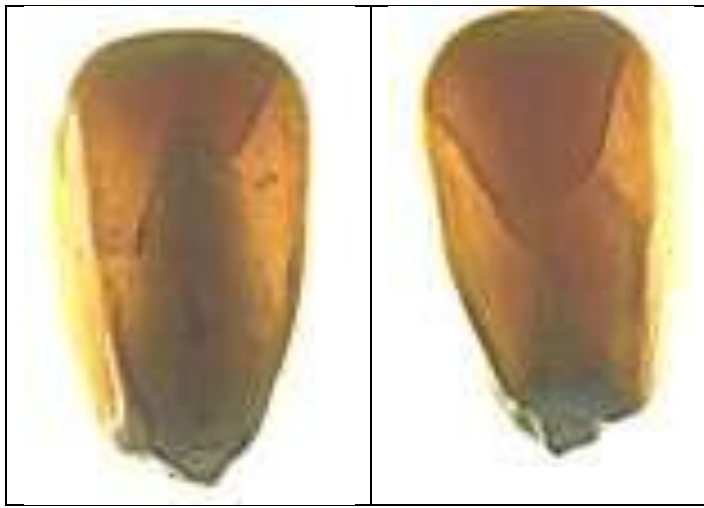


Figure 11. Stress Cracks