

SeedCounter v.1.9.5

Manual



Introduction

Grain morphometry in cereals is an important step in selecting new high-yielding plants. Manual assessment of parameters such as the number of grains per ear and grain size is laborious. One solution to this problem is image-based analysis that can be performed using a desktop PC. Furthermore, the effectiveness of analysis performed in the field can be improved through the use of mobile devices. We propose a method for the automated evaluation of phenotypic parameters of grains using mobile devices running the Android operational system. The experimental results show that this approach is efficient and sufficiently accurate for the large-scale analysis of phenotypic characteristics in wheat grains.

Getting started

SeedCounter is available at Google Play (<https://play.google.com/store/apps/details?id=org.wheatdb.seedcounter>). SeedCounter requires **OpenCV Manager** installed on your device (<https://play.google.com/store/apps/details?id=org.opencv.engine>). If **OpenCV Manager** not installed, the app will ask to install it at the first run.

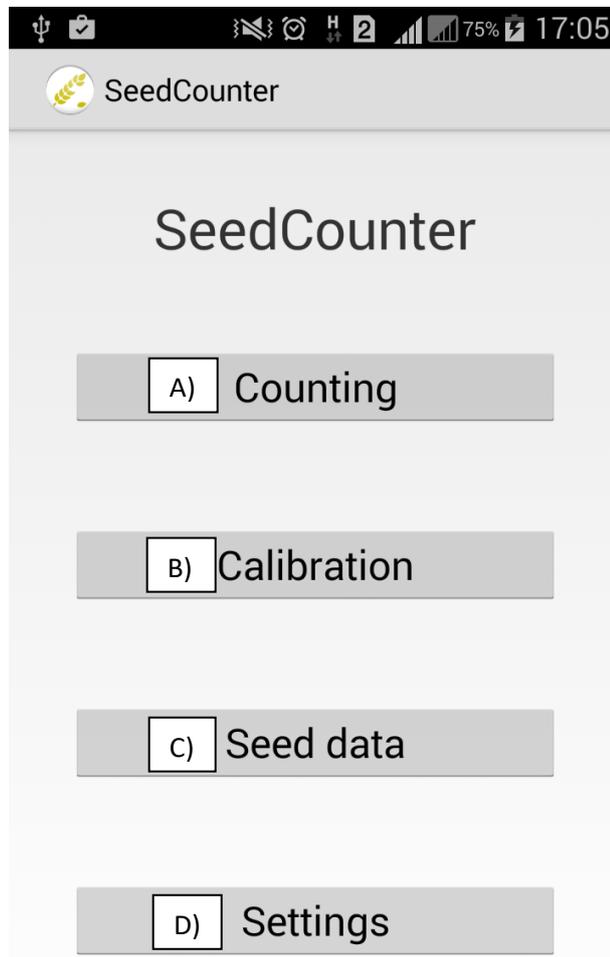


Figure 1. SeedCounter main menu. Four main options available: A) Seed counting operation; B). Algorithm calibration; C). Work with measurement data; D). Change application settings.

Preparation of the sample for analysis

The seed sample preparation consists of the following steps

- 1) Place the standard size sheet of paper in landscape position on the contrasting surface.
- 2) Clean obtained grains from the chaff and debris.
- 3) Scatter grains on sheet so that it sticks together as less as possible.

Counting the number and geometric parameters of seeds

- 1) Run the application and select in the main menu "Counting" option (Fig 1, A).
- 2) Place the mobile device at a distance of 10-30 cm above the sheet of paper so that the long side of the device screen matches the larger side of the sheet and the camera captures sheet with 2-5 centimeters dark boundaries (Fig 2).



Figure 2. Image capture by mobile device camera.

- 3) Click on the mobile device screen and wait for the camera to focus and capture the image. If the camera didn't capture an image or sheet paper wasn't recognized on the obtained image try capture the image again. If the image capture is successful wait for processing the image.



Figure 3. Result of the SeedCounter image processing. Recognized grains shown by red rectangles and the number of grains shown at the top left corner of the image.

- 4) After processing, the resulting image will be displayed with recognized grains highlighted by red rectangles and the number of grains reported at the top left corner of the image (Fig 3).
- 5) To save your image processing results, touch the device screen and enter the name of a series of grain morphometry measurements (Fig 4, A).

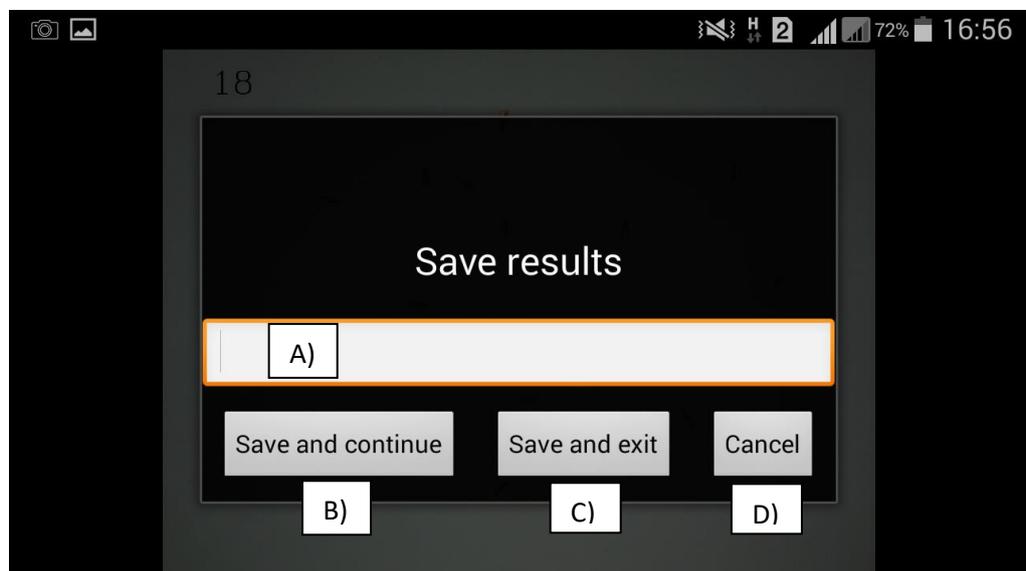


Figure 4. Saving results dialog. A) Text field to enter the data series name; B) Option to save results and working with the next seed sample; C) Option to save result and proceed to the main SeedCounter menu; D) Option to cancel data saving.

- 6) Select "Save and continue" (Fig 4, B) to save the measurement and continue processing next seed sample (go to step 3). The name of measurement series will be saved. It could be changed in the next sample processing steps. To save the measurement and exit to the

main menu choose "Save and exit" option (Fig 4, C). To stop saving and return to display with recognized grains at the step 4 select "Cancel".

View and export data

When you seed sample processing is finished, you can view your data and export it in XML format readable by Excel program. To perform this step, run the application and choose "Seed data" option in the main menu (Fig 1, C).

- 1) The screen will appear that display a summary of the measurement information (Fig 5). To scroll through the measurement slide the touchscreen horizontally. You can also switch the view page by touching the blue menu on the screen (Fig. 5, B)

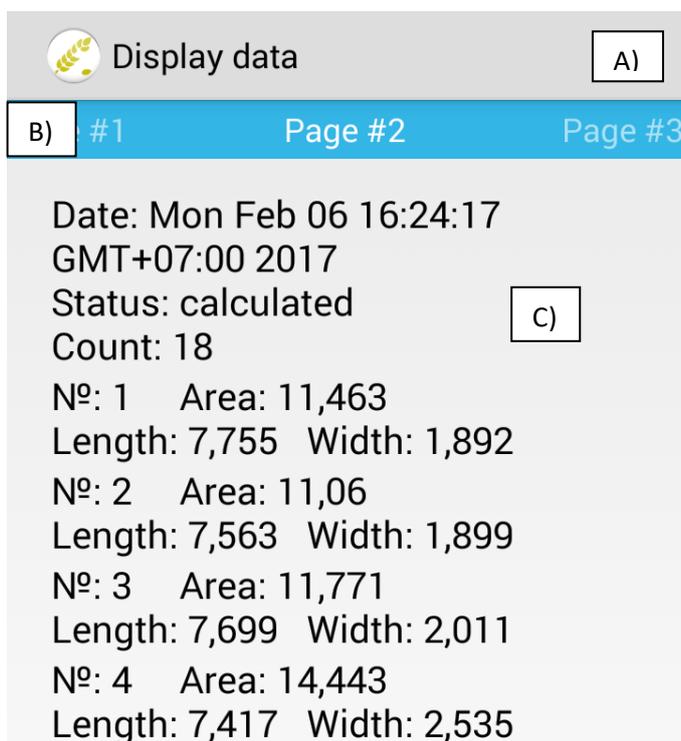


Figure 5. SeedCounter data viewer screen. A) Menu panel; B) Page number panel; C) Data display panel.

- 2) To delete or export data click on the menu button (Fig 5, A).

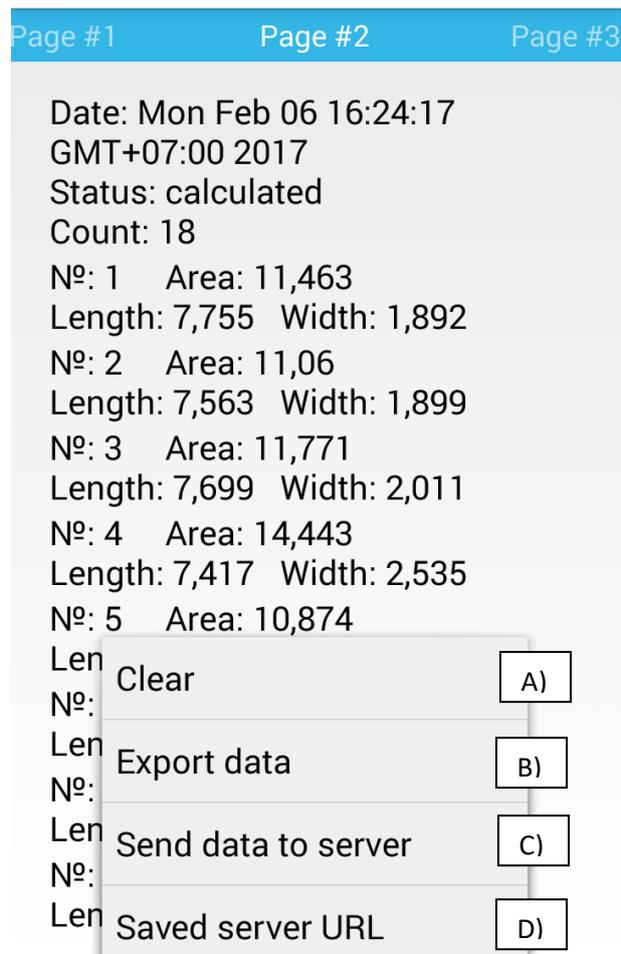


Figure 6. View data pop-up menu. A). Option to clear data; B). Option to export data; C). Option to send data to the web-server; D). Option to retrieve URL to the saved data.

- 3) The pop-up menu will appear with options to work with the data (Fig. 6 A-D).
- 4) To delete the data choose "Clear" button (Fig 6, A).
- 5) To export the data choose the "Export data" option (Fig 6, B). The menu panel will appear with three buttons. To export all collected data click "All" button (Fig 7, A). To choose a portion of the data to save, click "Select" button (Fig 7, B) (Fig 8). Data will be saved in the device in /seedcounter/export.tsv file.

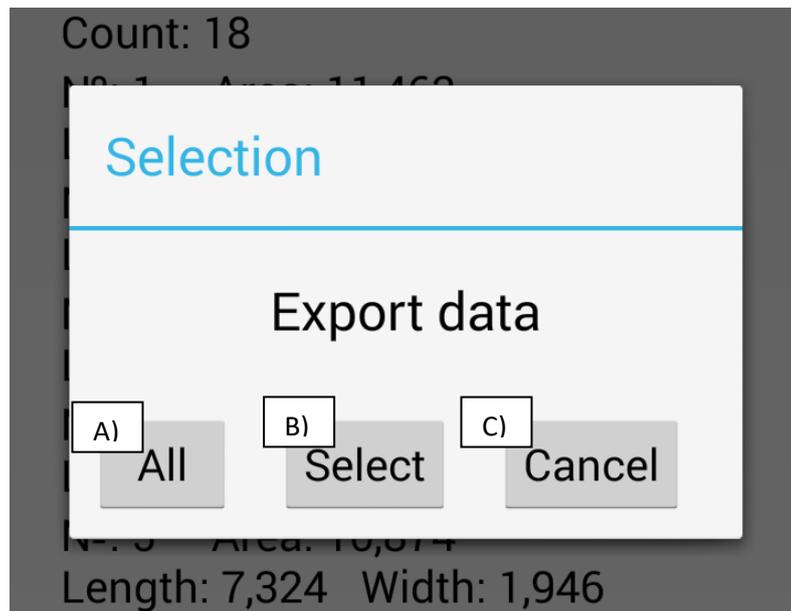


Figure 7. Export data panel. A) Button to save all collected data; B). Option to select part of data to save; C) Cancel button to close export data menu.

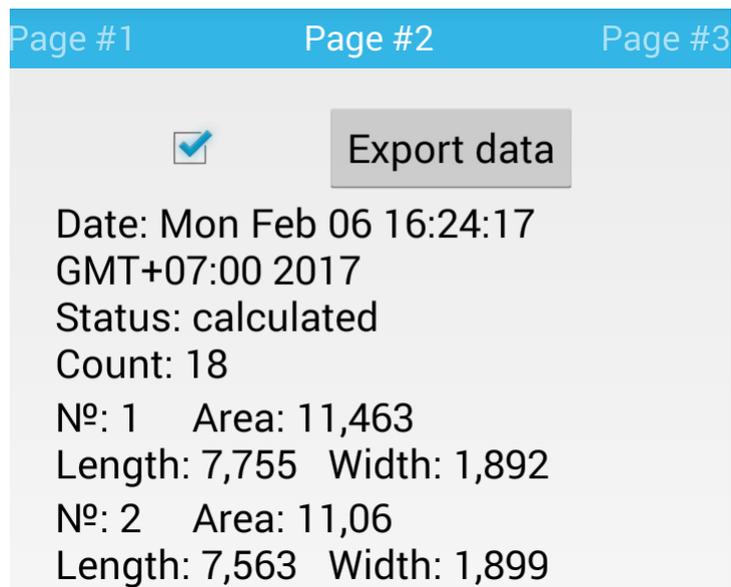


Figure 8. Data export panel.

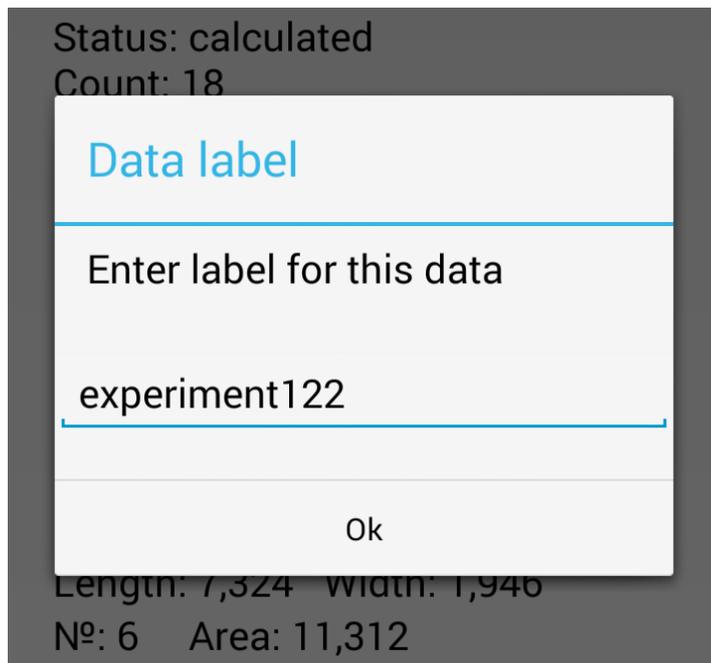


Figure 9. Entering data label before uploading data to the SeedCounter web server.



Figure 10. List of saved URL for data stored at the SeedCounter website.

If your device connected to the Internet, you can upload your data to the SeedCounter web server, obtain link to this data and download it later (for example, to your PC). To upload data to the server choose "Send data to server" option (Fig 6, C) and enter the label for data (Fig 9). Label with URL address will be saved in the mobile device. To view a list of saved URL addresses (Fig 10), select the menu "Saved server URL" (Fig 6, D). The data can be obtained via these links.

The process of data upload to the server and downloading data from server shown in fig 11.

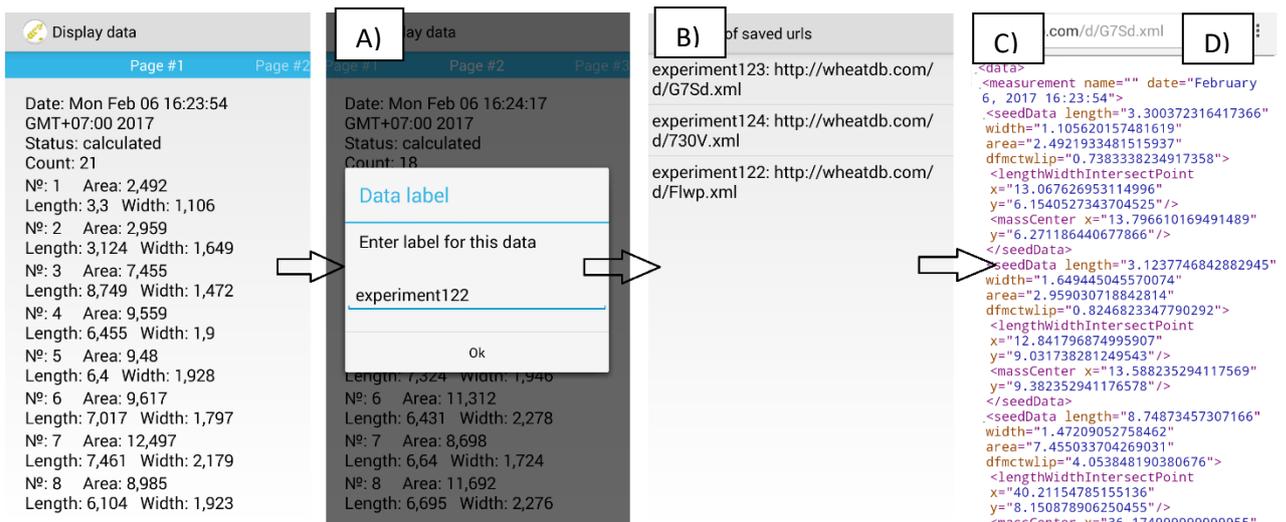


Figure 11. Sending data to server. : A) The stored data. B) Entry label of uploading data. C) The list of saved references. D) Data obtained using a browser.

Change application settings

You can change some application parameters. This option is available from the main menu by choosing “Settings” (Fig 1, D).

Camera settings

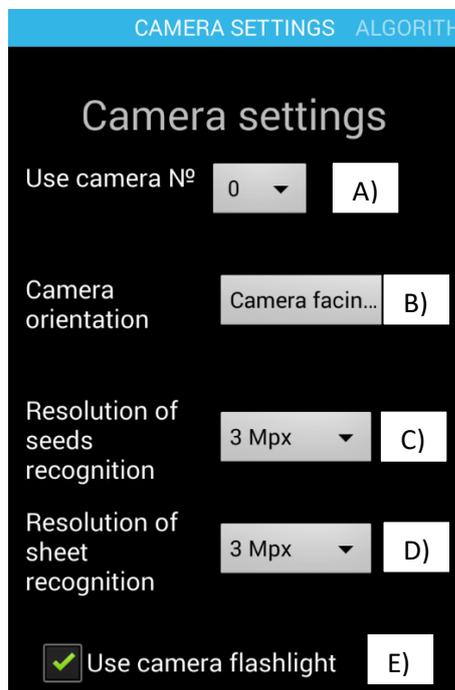


Figure 12. Camera settings panel. A) Button to select a using camera number. B) Button to select a using camera orientation: facing back/facing front. C) Button to select the resolution of seeds recognition. D) Button to select the resolution of sheet recognition. E) Checkbox to enable/disable camera flashlight at image capture step.

To select camera that will be used for capturing images choose one of the options from Camera number (Fig. 12 A) or camera orientation (Fig. 12 B) menus. First menu allow to choose camera by number. Second menu allow to choose camera by type (back or front).

Another parameter is the image resolution. High image resolution enables to obtain fine details on it, however, will result in significant increase in image processing. Low image resolution provide fast processing, however, will result in decrease in algorithm precision. There are two types of image resolution parameters. First is the resolution of seeds recognition (Fig. 12 C). This parameter determines the resolution of image capture and seed recognition. Second is the resolution of sheet recognition. This parameter is applied at the paper sheet recognition stage and should be less or equal then resolution of seeds recognition. For reasonable time of the image processing we recommend to set the resolution at 8 Mpx for seeds recognition parameter and 3 Mpx for sheet resolution even on devices with high camera resolution.

For calculating only the amount of grains on paper the best way is to use a lower resolution camera to reduce the processing time. For calculating the seed geometric parameters is recommended to select a higher camera resolution to improve the accuracy of measurements.

Algorithm settings

SeedCounter enables control the following algorithm parameters: Grain separation option, grain boundary refinement, and delay in image processing.

Grain separation option (Fig. 13 A) enables using watershed algorithm to separate touching grains. This option is useful if a small number of grains stick together.

Grain boundary refinement option (Fig. 13 B) enables procedure that refines the grain boundary on the basis of the color change. This can improve accuracy but slow down the data processing.

Delay calculation option (Fig. 13 C) postpones the image processing. This option saves time during processing of the large series of samples. In this mode at the image capture step detection algorithm performs only the paper recognition. Seeds recognition procedure will be delayed. Grains recognition will be run in the background even you close the application.

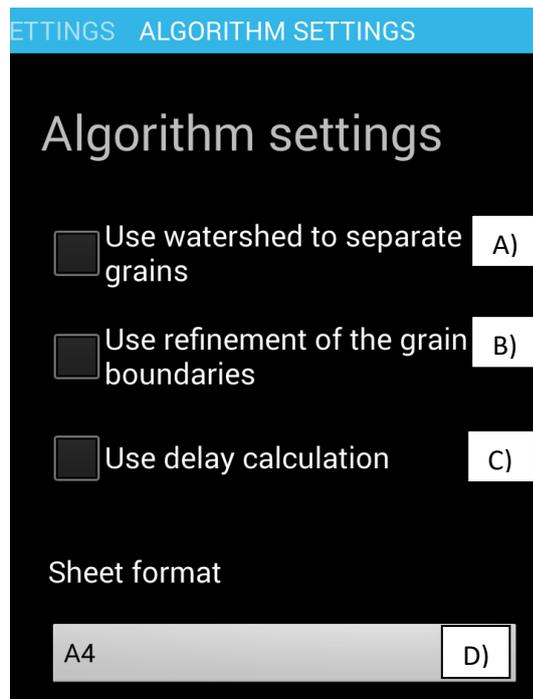


Figure 13. Algorithm settings. A) Checkbox to enable watershed algorithm to separate grains; B) Checkbox to enable grain boundaries refinement procedure. C) Checkbox to enable delay calculation mode. D) Button to select sheet format.

Use watershed to separate grains (Fig. 13 A): it is option that enable watershed method to separate grains.

Use delay calculation (Fig. 13 C): it is option that enable delay calculation mode. In this mode, the main image processing is produced in the application background.

Sheet format (Fig. 13 D): select used sheet format to provide correct scale calculation.

Calibration

Calibration is an auxiliary procedure to adjust the accuracy of measurement of geometrical parameters. We recommend to perform calibration procedure if the grains recognition is not produced properly or to improve recognition accuracy. Calibration process performs grain recognition procedure and evaluates the grain and its shade colors. This allow tuning the parameters that affects the image binarization step. This procedure is useful in poor lighting conditions.

- 1) Run the application and select the menu "Counting" (Fig 1, B).
- 2) Place the standard size sheet of paper in landscape position and put one grain on it.
- 3) Place the mobile device at a distance of 10-30 cm above the sheet of paper so that the long side of the device screen must match the larger side of the sheet and the camera captures sheet boundaries around 2-5 centimeters.
- 4) Click on the mobile device screen and wait for the camera to focus and capture the image.
- 5) If the camera didn't capture an image or sheet paper wasn't recognized on the obtained image try capture the image again.
- 6) Wait for processing the image.

- 7) At the end of processing, the resulting image will be displayed with marked recognized grain.
- 8) To save calibration parameters, click on the screen.

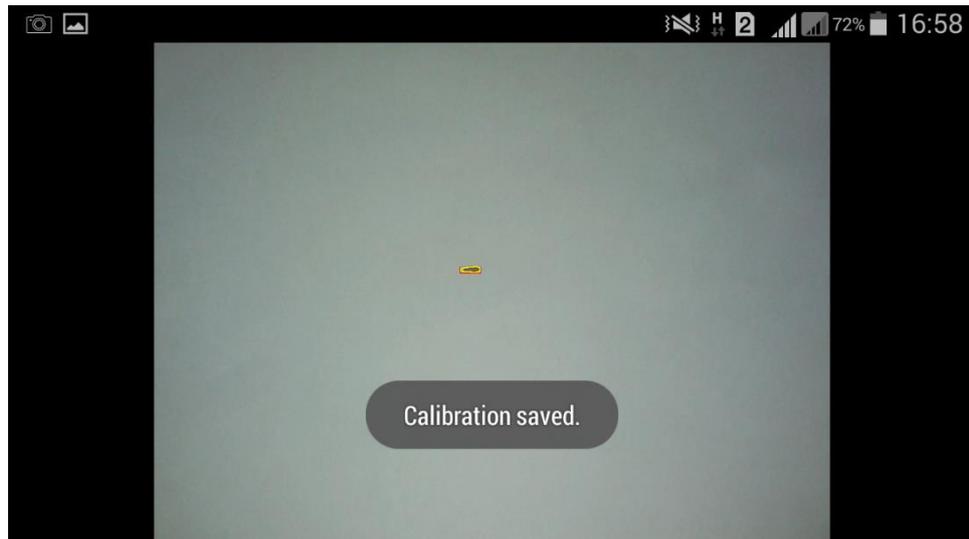


Figure 14. Saving calibration.

- 9) If the application does not properly recognize the grain, try again with another grain or other lighting conditions.