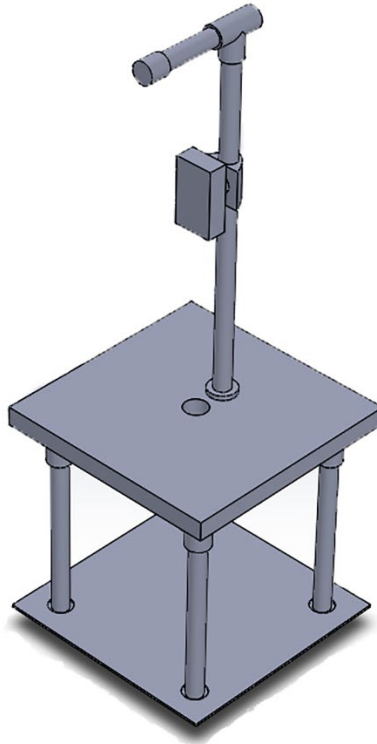# Turf Height Tester

Use Instructions (updated August 21, 2020)

For additional device information, see
Patton, A.J. and R.C. Braun 2021. Measurement of turf height and growth using a laser distance device.
Crop Science In press. https://doi.org/10.1002/csc2.20295

Turf Height Tester (Fig. 1) can be used without the use of Bluetooth functionality and additional free Bosch MeasureOn smartphone app (v 1.3.6 Android, Robert Bosch Tool Corporation) by recording values with pen and paper from the device readout. However, utilizing the Bluetooth functionality in combination with the Bosch MeasureOn smartphone app to record and store values will expedite data collection events.

Required for Use

- Turf Height Tester
- Pen and paper (optional)
- Bosch MeasureOn smartphone app (optional)

HINTS:

The device has an internal memory of up to 30 measurements but can store >500 measurements in the MeasureOn app that are exportable as a .xls or .pdf file. A further advantage of using Bluetooth is that the Bosch GLM 50 C laser distance measure instrument reports values to the nearest 0.5 mm on the display screen but it transmits data via Bluetooth connection to the nearest 0.1 mm when using the smartphone app.
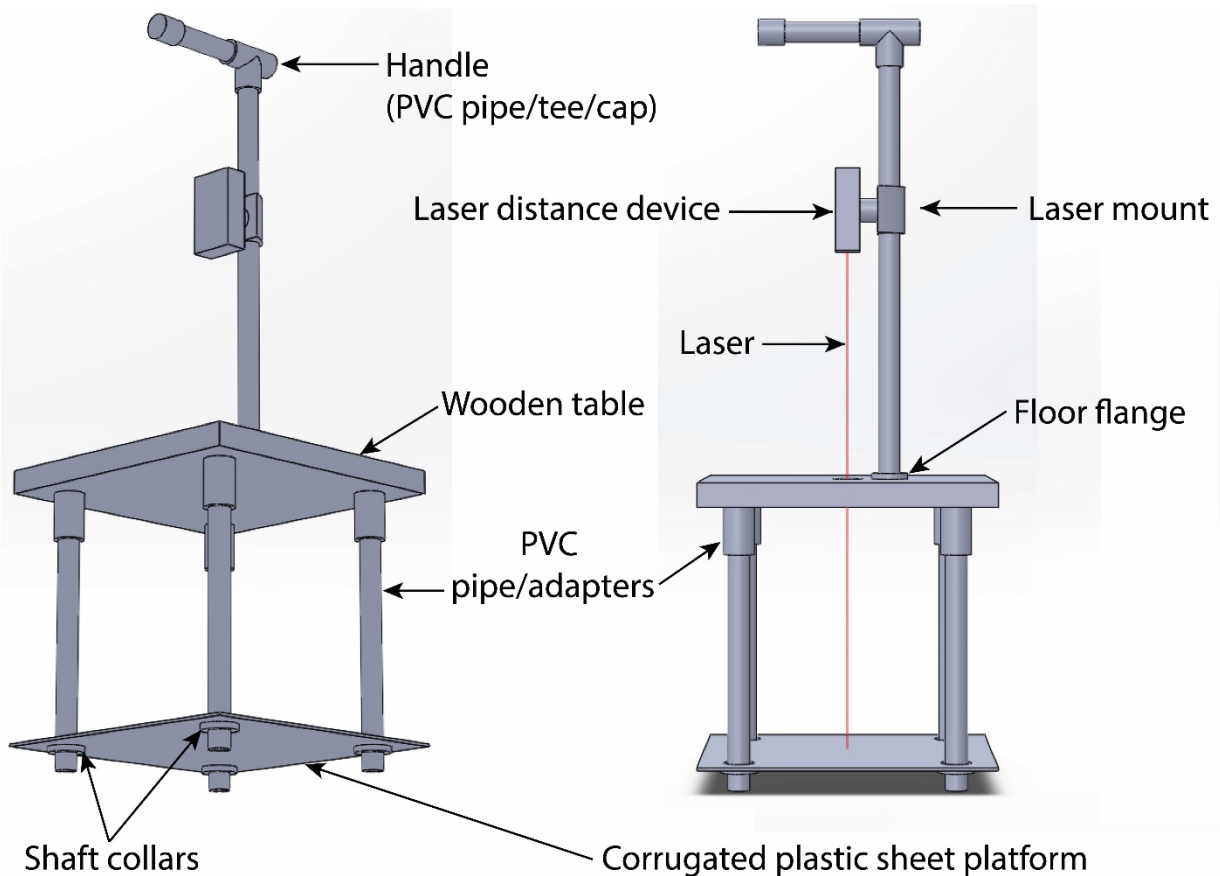

Figure 1. A table with a floating platform, carrying arm (handle), and a mounted laser distance measurement instrument developed to measure turf sward height.

Using the Turf Height Tester with Bosch MeasureOn Smartphone Application

Step 1. Activate the Bluetooth function on your smartphone and turn on the Bosch GLM 50 C laser distance measure instrument and activate the Bluetooth on the laser instrument. Connect your phone to the Bosch laser distance measure instrument via Bluetooth.

Step 2. In the Bosch MeasureOn Smartphone Application, adjust the settings (required only for first time use of app) to "centimeters", "2 decimal places", and "1 cm wall thickness." Select "OK" when finished.

Step 3. Select "+" to create new project (Fig. 2A) and enter project name (e.g., date, "pre" or "post" measurements, experiment identification) for example: "4_22_20_Pre" (Fig. 2B). Select "OK" when finished.

Step 4. Select "Measurement List" on the left side bar (Fig. 2C) and select "On" and then "Measure" to record first measurement. Then the following setting adjustment must be completed before recording additional measurements (this must be done once at the start of each data collection event).

   a. Before proceeding with additional measurements after first measurement, change the measurement type to be a "length" measurement (↑ and solid I (not dashed I) (Fig. 2D). (This is required each time for the first measurement on new measurement list project).
   b. Now all additional measurements will be recorded as the same measurement type.

Step 5. (Optional) If you wish to label each of your measurements or at least first measurement in each plot then you can either select the measurement in the app and type in or use voice-to-text option to enter the plot number or code [e.g., "rep.plot number" ("1.3" = rep 1, plot 3]. **Recommendation:** After the first measurement in each plot or every other plot, select the recent measurement, insert plot name and add an additional space after the label, then select enter. (This label should be automatically be generated for next consecutive measurement only) (Fig. 2D).
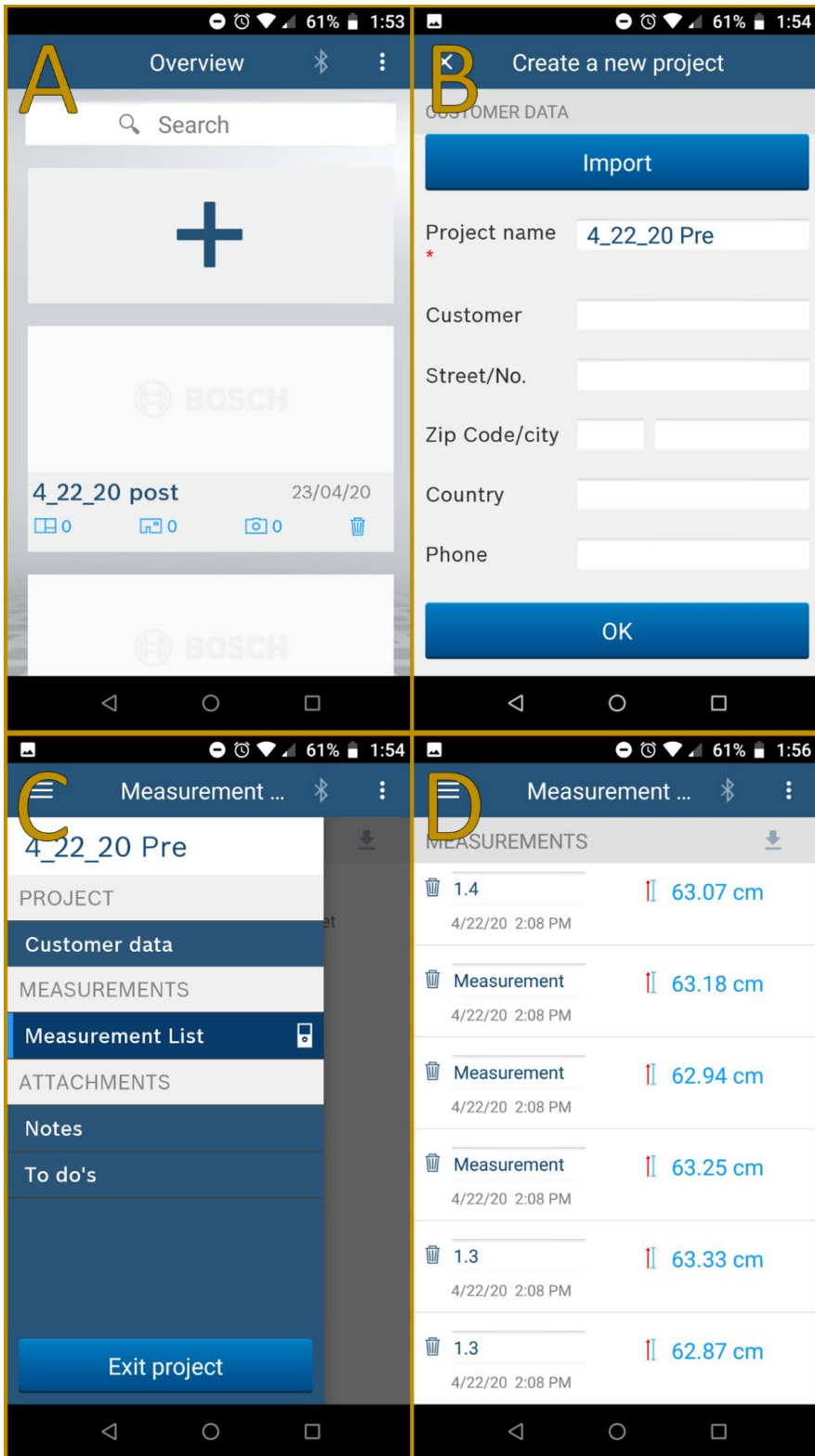
Figure 2. Screenshots of the Bosch MeasureOn Smartphone Application.

Step 6. Once all measurements have been collected on the Bosch MeasureOn Smartphone Application, the data can be uploaded to a cloud-based storage drive (e.g., Dropbox, Google Drive, etc.) (Fig. 3A and 3B).

a. Click on upper right corner, select "export." (Fig. 3A) and select export as XLS (i.e., spreadsheet format that works in Microsoft Excel, Google Sheets and other spreadsheet software or select export as a PDF file (Fig. 3B).

b. Next, select and/or create new cloud-based storage folder with proper naming (i.e., date and experiment or location) and file name will automatically be generated as the "project name title_Measurement List.xls" and select save.

c. The measurements have now been uploaded to your cloud-base storage drive or saved to your saved to your smartphone storage drive.

d. **Note:** If you do not upload the data, the Bosch MeasureOn Smartphone Application will keep your data within the app if you wish to upload over a WIFI connect at a later date.

e. **Note:** The measurements are sorted in the XLS file from most recent recorded measurement to oldest recorded measurement. Therefore, measurement will need to be sorted in your spreadsheet software to have the measurements in sequential plot order you measured.
Suggestion: Relabel measurement ID column in the spreadsheet from top-to-bottom "100, 99, 98…" and then select the relabel measurement ID column sort & filter and sort the expanded selection from "lowest value to highest value". Your measurements should now be in the same sequential plot order you collected them.
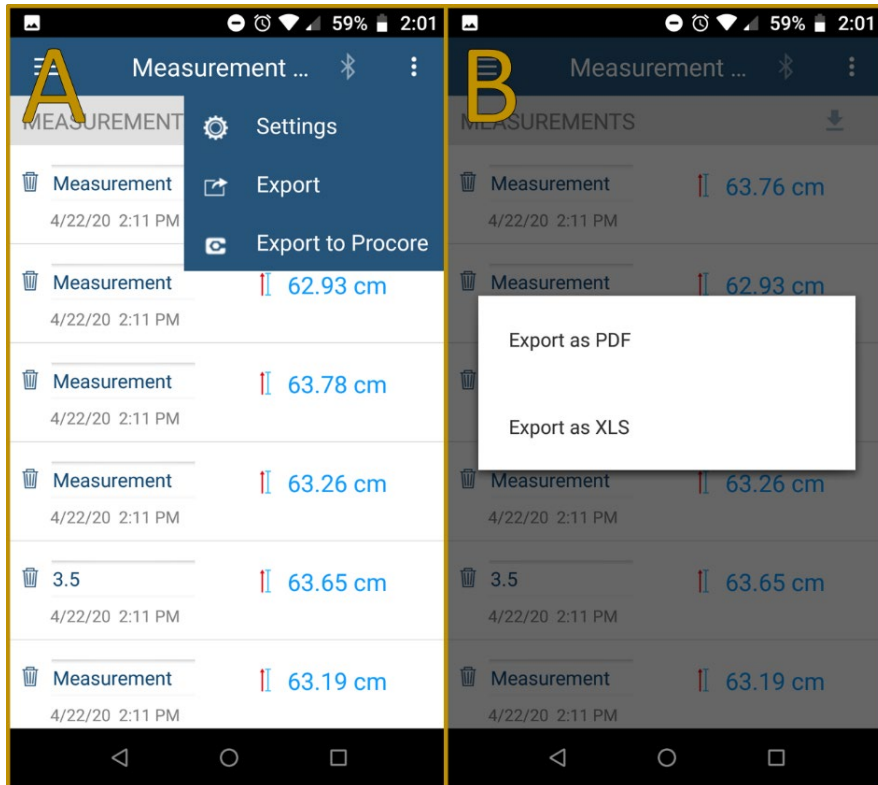

Figure 3. Screenshots of the Bosch MeasureOn Smartphone Application.

Using the Turf Height Tester

Step 1. Hold the Turf Height Tester firmly by the handle (Fig. 1B)

Step 2. Gently lower Turf Height Tester to a random location within plot while being sure all four legs are on even surface (i.e., not placed in voided areas within turf) and an accurate representation of the turf area is under the floating platform.

Step 3. Firmly holding the Turf Height Tester handle and applying slight pressure on handle to make sure the meter does not move, record measurement with smart phone app in your opposite hand (see above instructions) or press red button on laser device (if not using smartphone app) (Fig. 1 and 4).

Step 4. If measurement is the first of *n* plot measurements, then you should label measurement in app (see above instructions). To save time, you can label first measurement of every other or after a desired *n* of plots measured, whichever is more suitable for your data organization.

Step 5. After five or desired *n* plot measurements, move to next plot in respective order until all measurements are completed for data collection event.
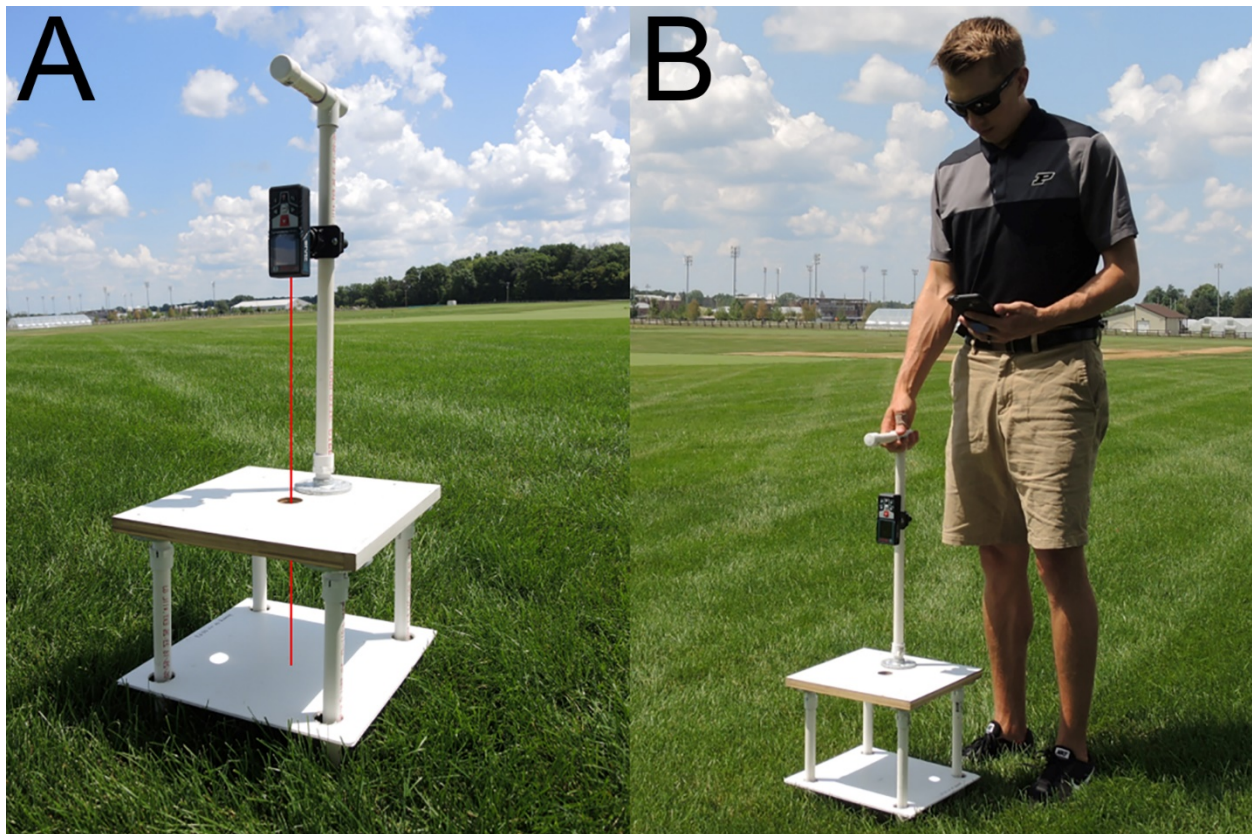

Figure 4. Photographs of the Turf Height Tester, which has a table with a floating platform, carrying arm, and a mounted laser distance measurement instrument developed to measure turf sward height is shown with a drawn laser beam (A) and in use collecting data using Bluetooth and a mobile device (B).

Calculating Height of Turf and Pre- and Post-Mowing Measurements

HINTS:
- Pre-mowing measurements are conducted before mowing the plot.
- Post-mowing measurements are conducted immediately after mowing the plot.

Step 1. To calculate height of turf (pre or post) with Turf Height Tester, use equation 1 from Patton and Braun (2021):

$$H_{turf} = H_{bench} - H_{elevation} \quad [1]$$

where H_{bench} is the laser distance measurement with the shaft collars removed and the platform resting on a hard, smooth, level surface such as a garage floor or laboratory bench, $H_{elevation}$ is the laser distance measurement in the field with the shaft collars installed and the floating platform resting on the top of the turf canopy, and H_{turf} is the calculated distance between H_{bench} and $H_{elevation}$ and represents the mean height of the turf canopy measured across 0.0929 m^2 (1 ft^2) of the turf sward.

Step 2. If the Turf Height Tester is being used to calculate the growth of turf, then you only need to use equations 2 and 3 from Patton and Braun (2021). Calculating the growth of turf can be accomplished by mowing the turf plots and collecting Post-mowing measurements (i.e., starting point for turf growth). Next, after a desired time (i.e., # of days) has passed, then collect Pre-mowing measurements to measure the change in turf height (i.e., turf growth that has occurred). Insert these values and time interval into equations 2 and 3 to calculate growth of turf and rate of growth.

a. Growth of the turf is calculated using (Equation 2):

$$G = H_{turf\ t2} - H_{turf\ t1} \quad [2]$$

where $H_{turf\ t1}$ is the turf height determined at time 1 (t1), $H_{turf\ t2}$ is the turf height determined at time 2 (t2), and G is the change in height or the growth of the turf during interval t2 – t1. Commonly, these units would be cm or mm.

b. The rate of growth can be determined using (Equation 3):

$$R = \frac{G}{t2 - t1} \quad [3]$$

where R is the growth rate over time interval t2 – t1. Commonly, these units would be cm d^{-1} or mm d^{-1}.

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Patton, A.J. and R.C. Braun 2021. Measurement of turf height and growth using a laser distance device. *Crop Science* In press. https://doi.org/10.1002/csc2.20295