

Using Digital Image Analysis to Quantify Turfgrass Cover and Disease

Aaron Patton, Kristie Walker, Dair McDuffee, Cale Bigelow, Rick Latin and Zac Reicher

Objective

Explore the use of a new technique for replacing subjective measurements with objective measurements of turfgrass cover and disease.

Rationale

Turf scientists have searched over the years for an objective method to collect data on turfgrass coverage and disease rather than using subjective estimates. A technique was recently developed to quantify turfgrass cover using a digital camera and a computer software program (SigmaScan Pro, Systat Software Inc., Richmond, CA). The method termed digital image analysis (DIA) was refined by researchers at the University of Arkansas (Richardson, M.D., D.E. Karcher, and L.C. Purcell. 2001. Quantifying Turfgrass Cover Using Digital Image Analysis. *Crop Sci.* 41:1884-1888.) for use in turfgrass research. This technique allows for the objective measurement of turfgrass coverage, color and disease and allows researchers to collect data that more accurately describes the experimental treatments.

In this article, will provide examples of how this technique is being used at Purdue University to more accurately quantify turfgrass cover and disease in our experiments.

How it is used

The process generally works as follows:

1. Images are taken of plots from a consistent height with a digital camera.
2. Images are then uploaded to a computer and stored in an appropriate folder.
3. Using a macro (short program) created by Dr. Doug Karcher (University of Arkansas) in SigmaScan, images are then selected from a certain folder in the host computer and opened.
4. Once the images are opened with SigmaScan, the program selectively identifies green pixels (leaves) in the images with the hue range set from 47 to 107 and the saturation set from 0 to 100.
5. Once the green pixels are selected the software program reports both the number of green pixels selected and the percent of the image that is comprised off green pixels (leaves).
6. Lastly, the macro saves the data into a spreadsheet. From there researchers can analyze the data with various statistical software programs and report findings.

Quantifying zoysiagrass coverage during establishment

Pictures were taken with a digital camera mounted on a monopod to insure shooting from a consistent height. Zoysiagrass coverage was determined using DIA (Figure 1). To selectively identify green leaves in the images, the hue range was set from 47 to 107 and the saturation was set from 10 to 100. Richardson et al. (2001) analyzed images with the saturation set from 0 to 100. However, when images taken on our soil with our camera where analyzed with a wide range of saturation (0 to 100) the scanning software would overestimate coverage by selecting some of the surrounding soil. To reduce this effect during analysis, the lower limit of the saturation was raised to 10 and as a result coverage could be measured more accurately. Images were taken of a calibration disk (green sheets

of paper with known area) and the data was converted from selected green pixels to zoysiagrass coverage (cm²).

Quantifying creeping bentgrass divot recovery

Pictures were taken with a digital camera mounted on a black stand at a height approximately 18 inches above the turf. The stand had a section cut out the size of the original divot taken from the creeping bentgrass fairway and images were taken of the stand with the divot located towards the center of the picture (Figure 2). Creeping bentgrass coverage was determined using DIA. To selectively identify green leaves in the images the hue range was set from 47 to 107 and the saturation was set from 10 to 100. Since we were only interested in the percent of the green pixels selected inside the divot cutout, the size of the divot in total pixels was determined using Adobe Photoshop (Adobe Systems Inc., San Jose, CA) and the macro calculated percent divot recovery based on the total pixels value we selected which was the total pixels size of the divot not the image (Figure 2).

Quantifying zoysiagrass winter survival

Digital pictures were taken before winter dormancy with a digital camera mounted on a monopod to insure shooting from a consistent height. Zoysiagrass coverage was determined using DIA. To selectively identify green leaves in the images, hue range was set from 47 to 107 and the saturation was set from 10 to 100. Images were calibrated and the data was converted (as mentioned previously) from selected green pixels to zoysiagrass coverage (cm²). Winter survival was determined using the following formula, winter survival = (after winter dormancy coverage ÷ before winter dormancy coverage) * 100. See “Winter survival of zoysiagrass cultivars” in this issue for more information.

Quantifying *Rhizoctonia* large patch severity

Disease usually causes damage that browns turf. We used digital image analysis to quantify the number of green pixels in an image. Plots with more green pixels (actively growing turf) were described as having less disease or having more recovery from disease. Additionally, one could subtract the percent of green pixels from 100 to get the amount of brown pixels in order to also estimate disease. However, our plots were monitored for disease at times near spring green-up or fall dormancy and using the later method would result in an overestimation of disease because of winter dormancy (straw-colored turf not yet greened-up).

Quantifying dollar spot severity

In addition to our visual coverage estimations, digital image analysis is often used by our turf pathologists to quantify dollar spot severity in field plots. This process is used only on greens height creeping bentgrass, where the distinction of diseased turf is easily made. We modified the CoverAnalysis.bas macro (supplied by Dr. Doug Karcher, University of Arkansas) to select for the straw-colored lesions symptomatic of the dollar spot disease (Figure 3). In order to account for glare and small false identifications, a series of filters were added to the macro. The filters erode and dilate the selected lesions, removing all that are under a specified size. An erosion filter strips away the outermost layer of pixels around a selected lesion. This filter is run a number of times, the exact number being user specified, and will reduce the smaller bits of glare and false identifications down

to one pixel. The program removes any one pixel by itself. The dilation filter adds a layer of pixels to the outside of any selected lesion. By running the dilation filter the same number of times as the erosion filter, the other positive identifications are returned to their original size.

Results

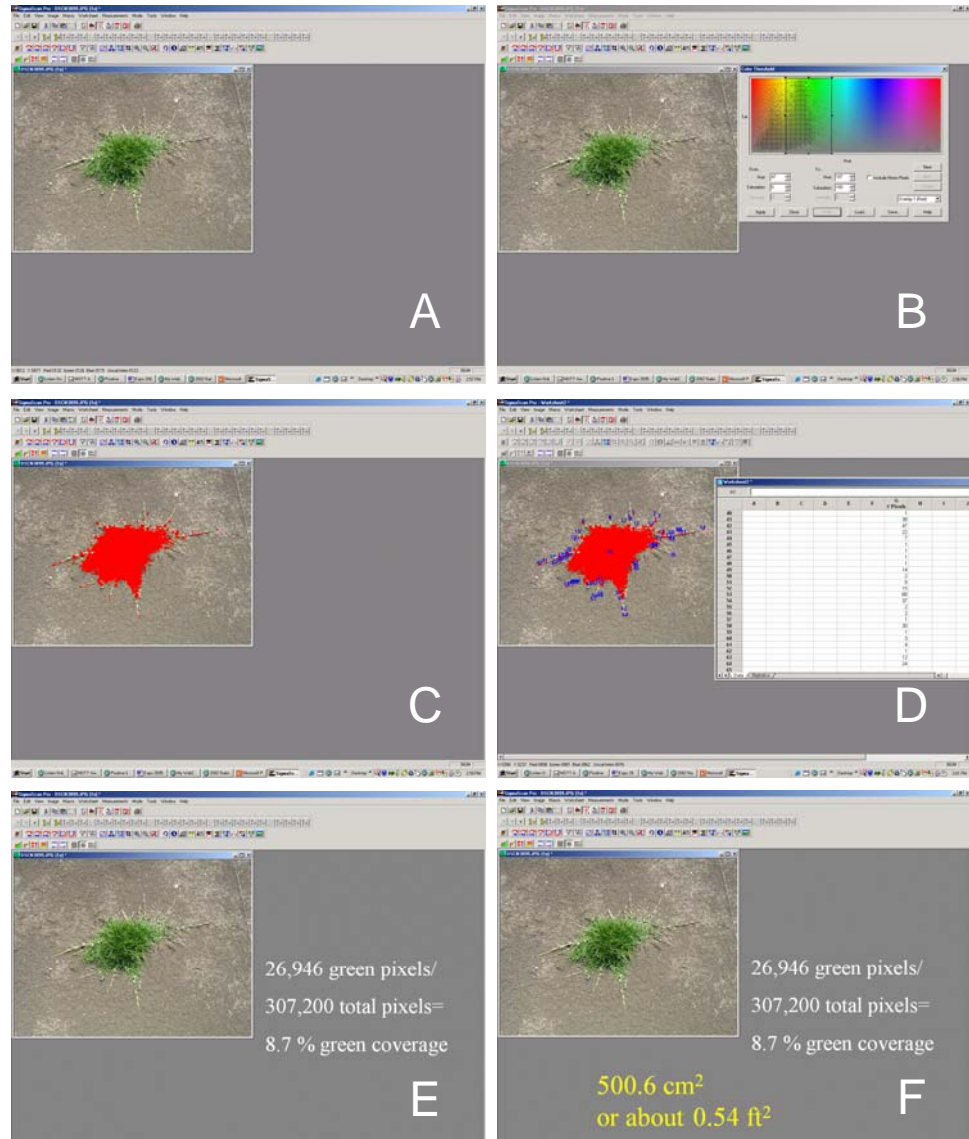


Figure 1. The image is first opened by the macro (A). The macro then analyzes the green spectrum to determine the area of turf present (B). After the green pixels are selected (C), they are counted (D). The spreadsheet will report back how many pixels were selected (E, 26,946 in this example) and how many total pixels are in the image (307,200 in this example). Lastly, using a conversion factor calculated using measuring tape and a sheet (9 in. × 12 in.) of green paper we are able to determine the area of each pixel and convert selected green pixels to area (F).

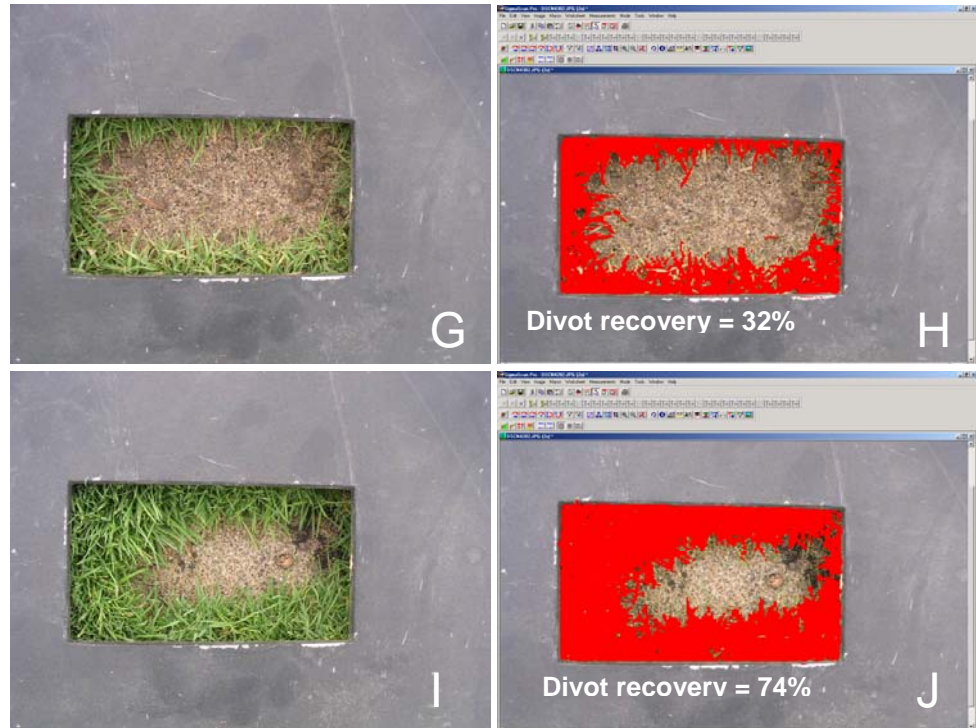


Figure 2. Image G is of a divot removed approximately two weeks previously. Using DIA we were able to determine a value of 32% percent recovery for this particular divot (H). Image I shows the same divot after four weeks with a 74% recovery (J).

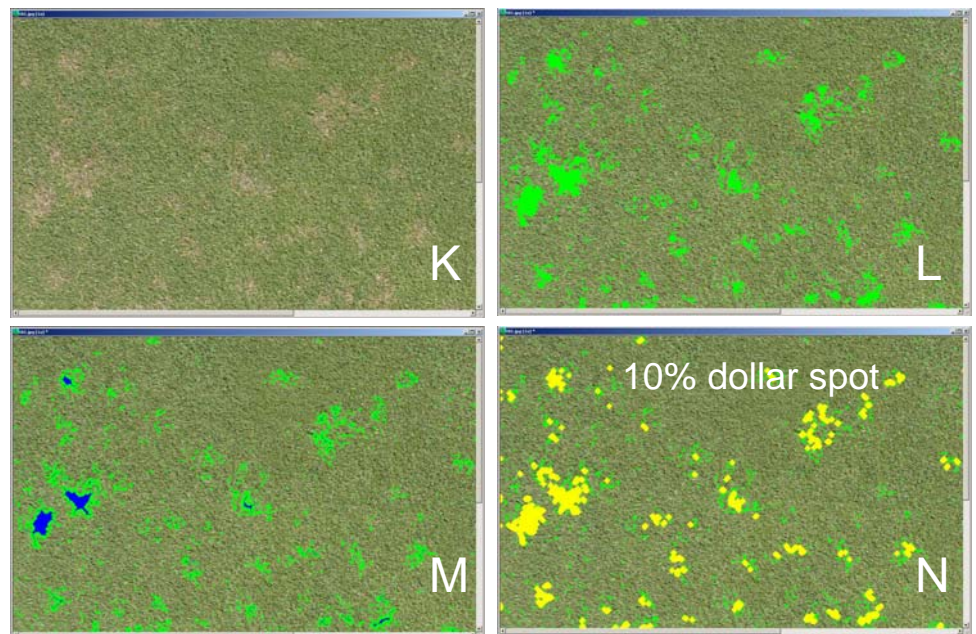


Figure 3. This image was taken on October 6, 2003 (K). Images (L-N) illustrate the filtering process used by the CoverAnalysis macro. Image L shows the first overlay that designates the pixels matching the hue within the user-defined parameters. Image M overlay shows the result of the erosion filter that removes pixels and is run nine times before dilation. Image N shows the result of the dilation filter which adds pixels and is run nine times and the overlays (yellow highlights) are counted to get the final result which was 10% disease in this research plot.