

A Color Determination Sensor as a Tool to Measure Soil Color



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ABSTRACT

Field and rapid laboratory determination of soil color and other properties is often subjective due to environmental conditions and human error. The objective of this study was to compare soil color determination using the Nix Color Sensor to the Munsell soil color chart (MSCC) for different soil types. Munsell color codes were converted into cyan, magenta, yellow, and black (CMYK) color values, and the Nix Color Sensor's scan results were tested against the predetermined Munsell color values using unpaired t-tests for all treatments. There were no significant differences between the color values for the Munsell system and the Nix sensor under indoor and outdoor lighting conditions for dry soil samples. There was a significant difference in color for wet and dry soil samples, however there was no significant difference between indoor and outdoor lighting conditions in both wet and dry samples. The data suggest that there are some differences between the two methods of color determination that will require further research.

INTRODUCTION

- **Munsell Soil Color Chart:** the standard of color determination for decades (Thompson et. al., 2013). Consist of pages with a range of color chips. Costs \$205 (Pantone.com).
- **Color determination sensor Nix:** the newly available sensor with its own standardized light source. Controlled through Bluetooth by mobile devices. Produces color results in various color codes such as CMYK, RGB, HEX, and HTML codes. Costs \$149 (Nix).

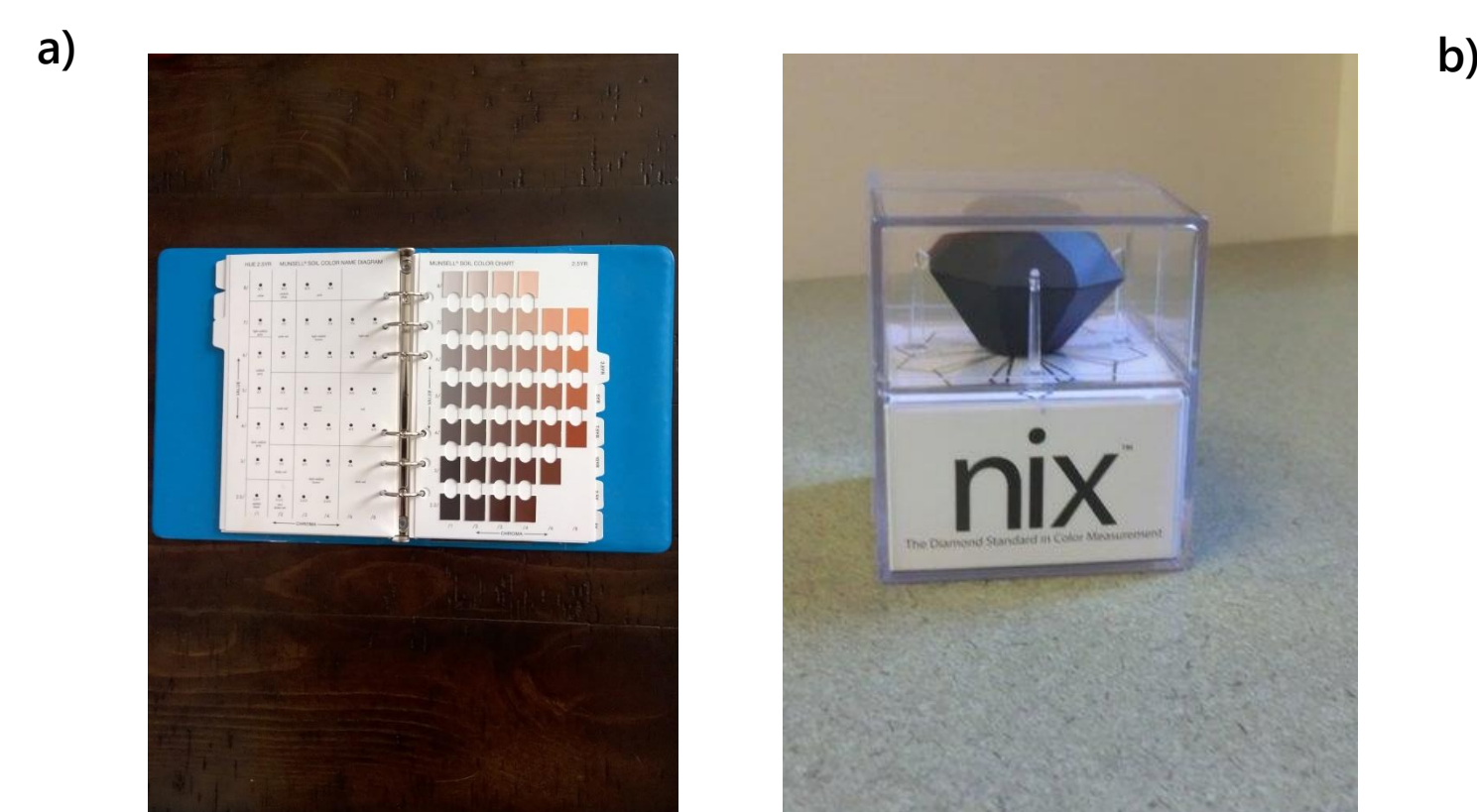


Figure 1. a) Munsell Soil Color Chart, MSCC (left), and b) Color determination sensor (right).

OBJECTIVES

- To convert MSCC codes to CMYK color codes.
- To compare soil color measurements using a color sensor to a standard Munsell Soil Color Chart using soil samples that have already been expertly assessed for color.

MATERIALS AND METHODS

Soil Samples

The soil samples were obtained from different soil types from different topographical positions, and land use/vegetation. Soil samples were collected from various locations and depths. Soil measurements included: 1) soil color using Munsell Soil Color chart (moist and dry); 2) soil color using Munsell Soil Color chart (in/outdoor lighting conditions). The soil color was determined in the field and in the laboratory setting.



Figure 2. Dry soil samples to be scanned using the Nix sensor.

Laboratory Analyses

- Munsell Soil Color Chart measurements were obtained on crumbled moist and dry soil samples (approximately 68 samples).
- An innovative, low-cost color sensor (<\$200) with an integrated light-source was used to measure soil color on the same samples. The provided software routines calculate the Munsell Soil Color equivalent values.

Data Analyses

- The Nix Color Sensor was used to scan the soil samples in four different treatment conditions: inside dry, outside dry, inside moist, and outside moist. Multiple scans were conducted for each soil sample. The results were recorded in CMYK color percent values to make statistical analysis easier.
- MSCC color codes previously determined by professionals were converted to RGB color codes (Munsell Color Palette, ptomys.melonisland.net/code/rainbow/munsell.html)
- The RGB codes were then converted to CMYK codes for comparison using an online reference and tools table Rapid Tables (www.rapidtables.com/convert/color/rgb-to-cmyk.htm).
- Using the software GraphPad Prism, the CMYK color codes produced by the Nix Color Sensor were compared to the CMYK color codes generated from the MSCC color codes determined by professionals.

Statistical Analysis

The results were determined by analysis of variance as seven factor (soil color method, SOC, soil type, topography, depth, land-use, and place of measurement: field vs lab) experiment, t-test, and One-way ANOVA analysis by GraphPad Prism 6 software.

RESULTS AND DISCUSSION

Determination of the precision of the Nix Color Sensor

- The Nix Color Sensor is precise based on the graphical comparisons between each set and the corresponding averages. (Fig. 3)

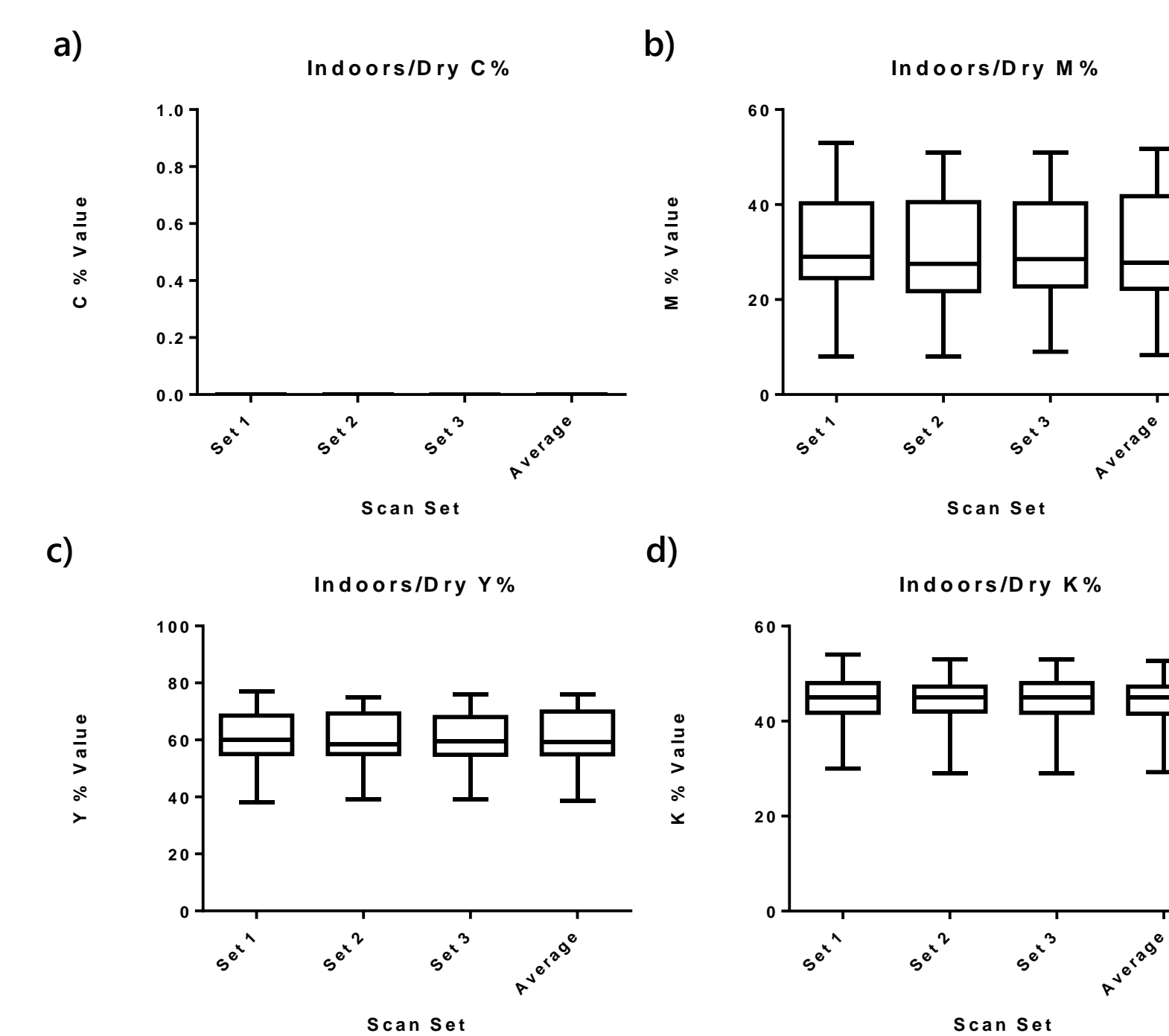


Figure 3. a) Cyan (C%) results of samples for indoors/dry conditions (all values were 0), b) Magenta (M%) results of samples for indoors/dry conditions, c) Yellow (Y%) results of samples for indoors/dry conditions, d) Black (K%) results for samples in indoors/dry conditions.

The effect of moisture on soil color

- Moisture has an effect on soil color based on the graphical comparison of dry soil treatments to moist soil treatments in both indoor and outdoor lighting conditions (Fig. 4).

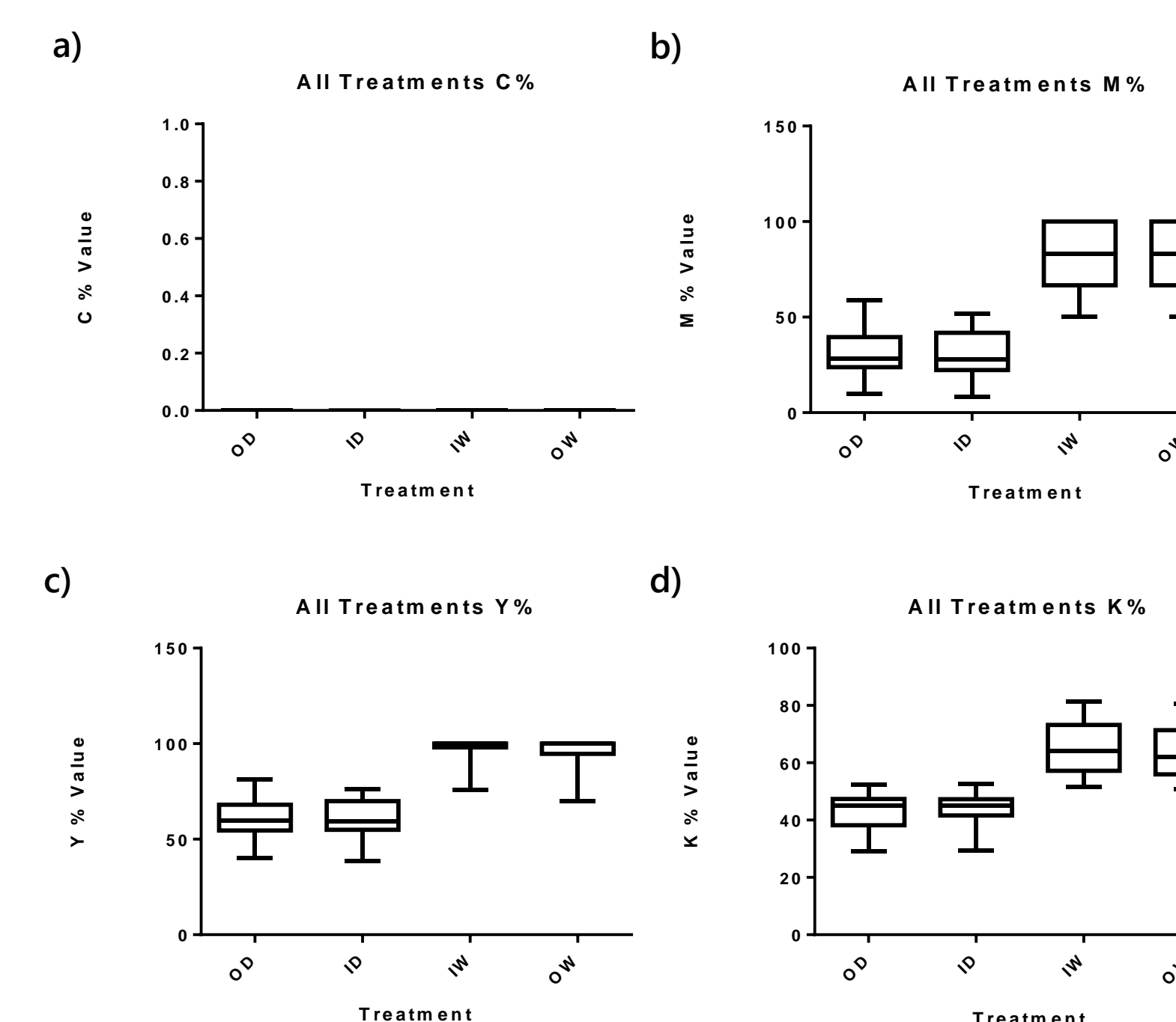


Figure 4. a) comparison of soil cyan (C%) for all treatments (all values were 0), b) comparison of soil magenta (M%) for all treatments, c) comparison of soil yellow (Y%) for all treatments, d) comparison of soil black (K%) for all treatments.

- Color values were statistically different between dry and moist samples in both indoor and outdoor lighting conditions.

RESULTS AND DISCUSSION

Variation between Munsell Color Chart and Nix Color Sensor

- Nix color results vary greatly from MSCC color results based on the graphical comparison of the corresponding color averages. (Fig. 5)

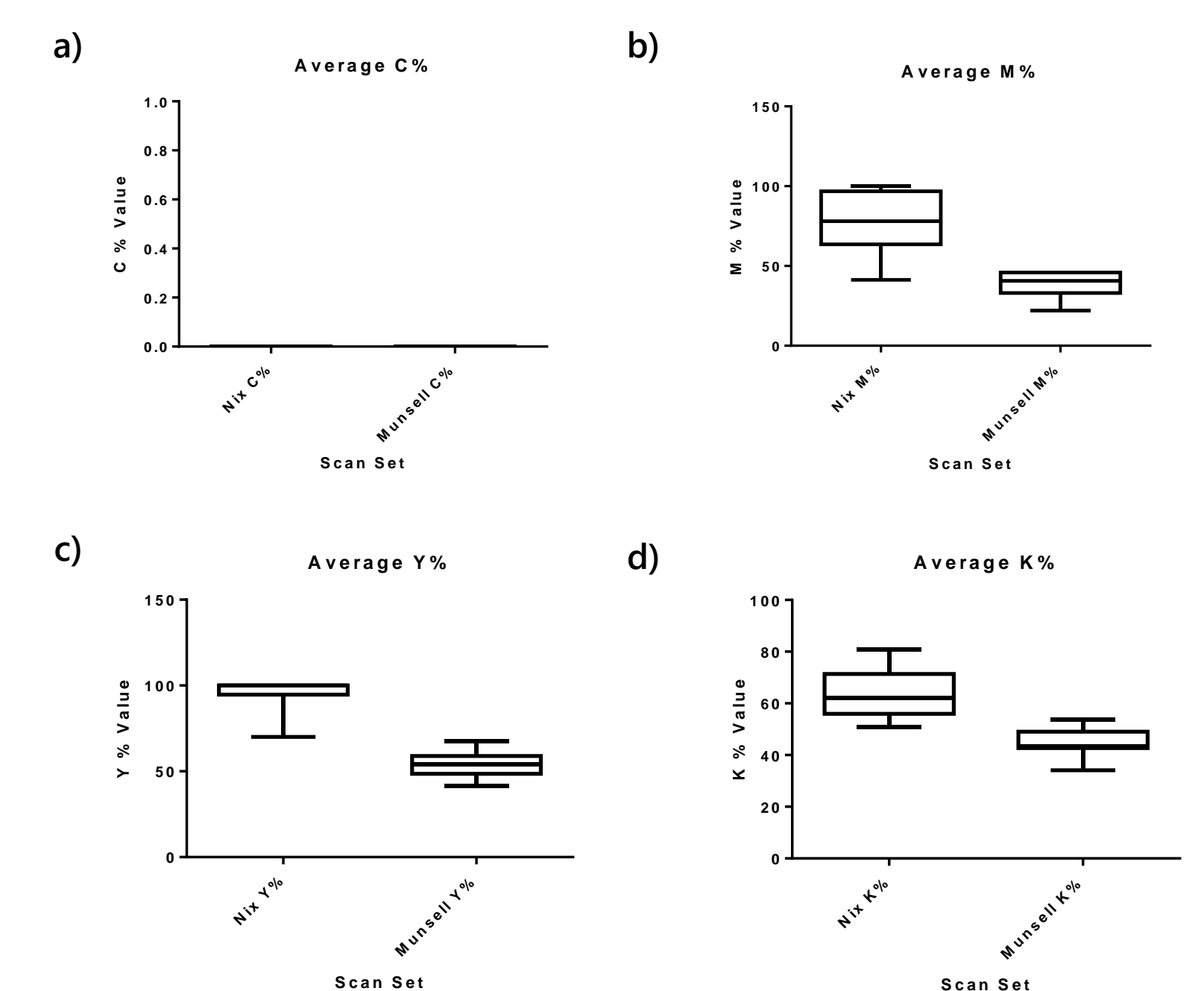


Figure 5. Nix/MSCC comparison in indoor/wet conditions of: a) soil cyan (C%) (all values were 0), b) soil magenta (M%), c) soil yellow (Y%), d) soil black (K%).

CONCLUSIONS

- The Nix Color Sensor is precise based on no statistical difference between Nix scans for soil samples in indoor and outdoor lighting conditions.
- Moisture has a significant effect on soil color based on a statistical difference between Nix scans for moist vs. dry soil samples in indoor and outdoor lighting conditions.
- Munsell Color Chart colors for soil samples (indoor dry/moist and outdoor dry/moist), were significantly different from the Nix color values for the same treatments based on the CMYK color values.

ACKNOWLEDGEMENTS

- Clemson University provided funding for this study;
- Technical Contribution No. 6304 of the Clemson University Experiment Station. This material is based upon work supported by NIFA/USDA, under project number SC-1700452.

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