SOIL COMPACTION ACROSS THE OLD ROTATION

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ABSTRACT

Evaluating soil compaction levels across the Old Rotation, the world's oldest continuous cotton (*Gossypium hirsutum* L.) experiment, has not been conducted since the experiment transitioned to conservation tillage and high residue cover crops with and without irrigation. Our objective was to characterize soil strength measurements across the experiment using a new approach to complement traditional soil strength analyses collected with a multi-probe cone penetrometer. Soil strength measurements were collected across all thirteen plots with and without irrigation in Dec. 2014 and average cone index values were calculated across five row positions. The cone index values were plotted, and the area under each line was calculated. The calculated area corresponds to the area under the curve for the cone index values. This value was used to compare soil strength measurements across irrigated and non-irrigated areas of the six rotations represented. Results indicate a trend of lower soil strength with more variability across the 3-year rotation compared to the other rotations. Lower soil strength values for the 3-year rotation appear to correspond to previously documented soil organic carbon increases. Soil strength measurements analyzed with the new method allowed treatment effects to be easily quantified to facilitate simple comparisons to aid interpretation of treatment effects.

OBJECTIVE

Describe and demonstrate a complementary approach to quantify differences in soil strength data among treatments collected with a multi-probe cone penetrometer across the Old Rotation.

MATERIALS AND METHODS

- A set of penetrometer measurements were collected from the Old Rotation (circa 1896) in Auburn, AL (32°35′36″N, 85°29′08″W), the world's oldest continuous cotton experiment (Mitchell et al., 2008), following cotton harvest on 12 December, 2014 (Fig. 1).

- The Old Rotation consists of 13 plots measuring 6.5 m x 41.4 m that were split in 2003 to form 26 plots measuring 6.5 m x 20.7 m to accommodate dryland and overhead sprinkler irrigated areas (Fig. 2). The soil is a Pacolet fine sandy loam (clayey, kaolinitic, thermic, Typic Hapludults).

Procedures for the new method using the No Legume, No N treatment (Fig. 3).

Step 1 – average all soil strength values used to generate the contour graph across all depths within each of the five row positions and plot the average values as a line graph.

Step 2 – calculate the area under the curve for the cone index values ($AUC_{C.I.}$). These calculations can be performed with various computer methods, but Fig. 3 illustrates how the area of each rectangle and right triangle are summed to obtain the $AUC_{C.I.}$ value.

Step 3 – Plot or statistically analyze the $AUC_{C.I.}$ values that represent the measurement area of the penetrometer.

Fig. 1. Soil strength measurements collected with a multi-probe soil penetrometer (Raper et al., 1999) from the Old Rotation on 12 December 2014 in Auburn, AL

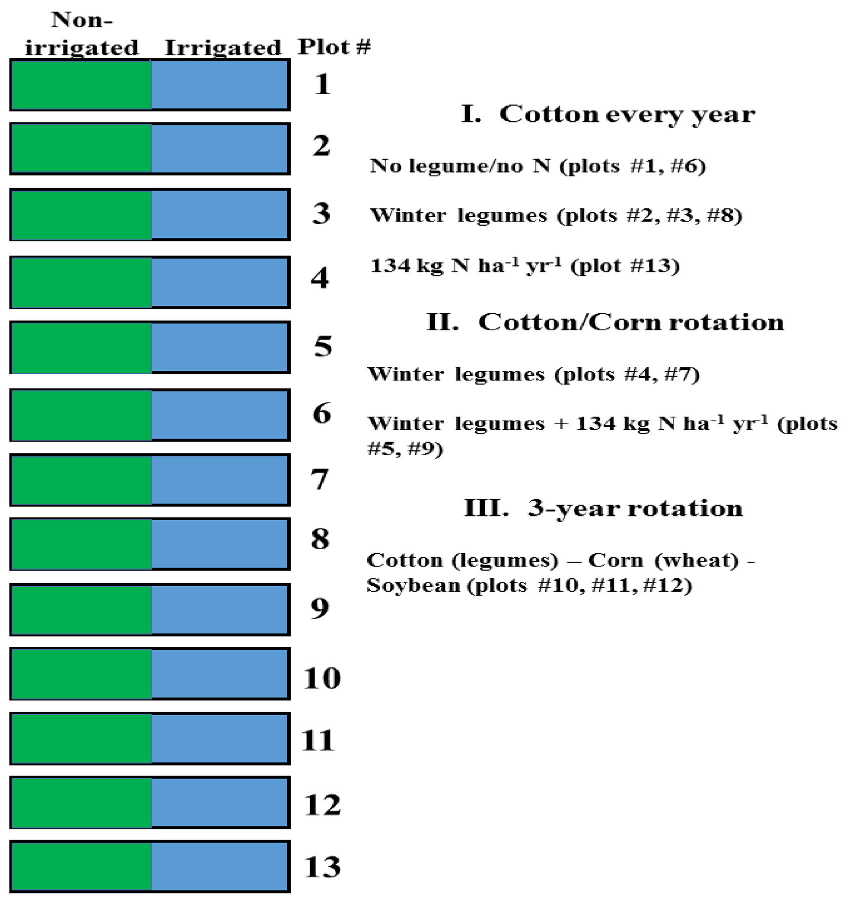

Fig. 2. Experimental layout of the thirteen plots that represent different rotations from the Old Rotation established in 1896. Non-irrigated and irrigated phases of each plot that were established in 2003 are also shown. Main treatment replications for the rotations range from one to three illustrated by plot numbers.

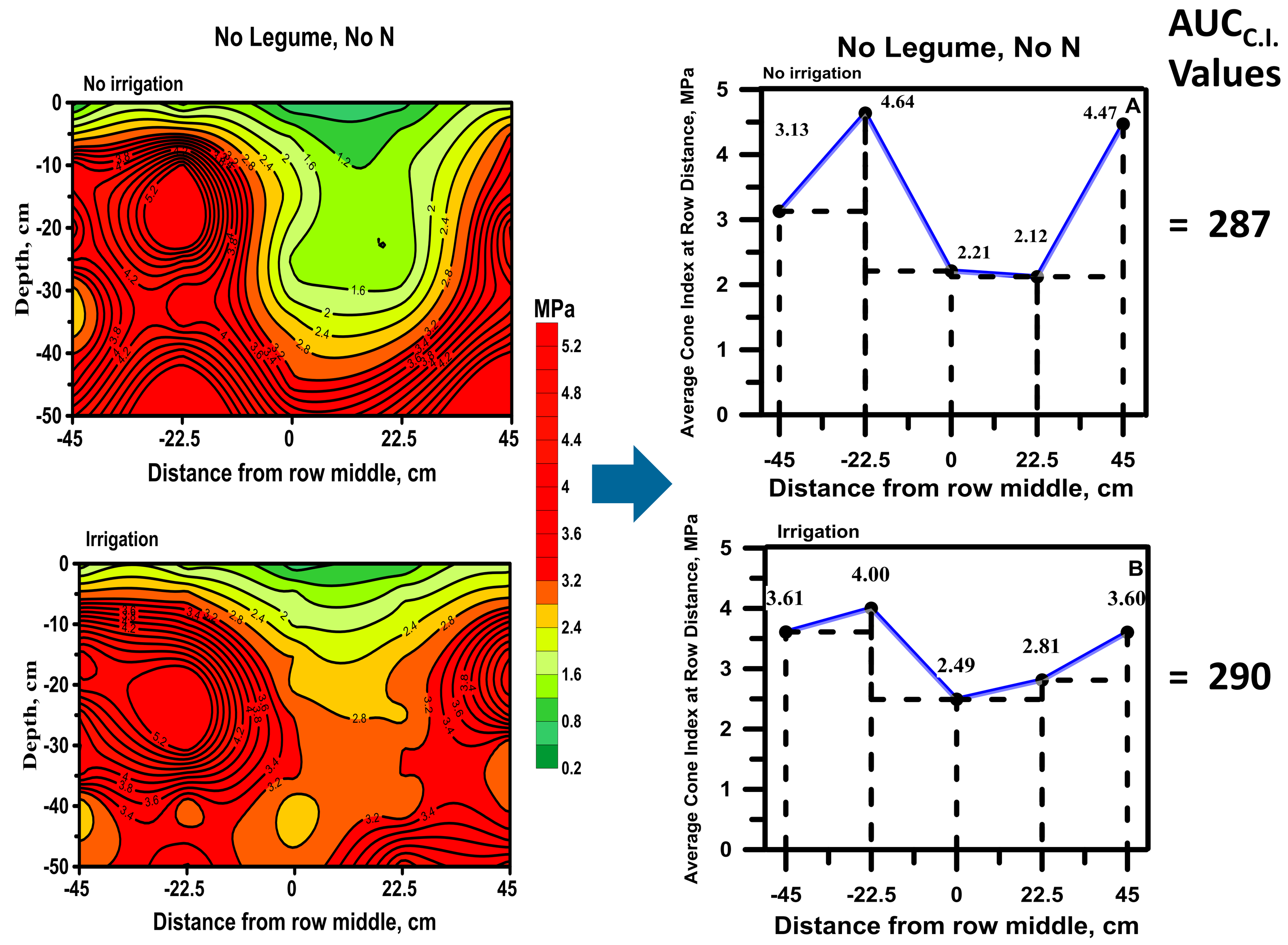

Fig. 3. Schematic illustrating averaging contour graph values and plotting as a line graph (step 1), calculating the area under the curve (step 2) to obtain the area under the curve for cone index ($AUC_{C.I.}$) values for plotting from the No Legume, No N rotation (step 3).

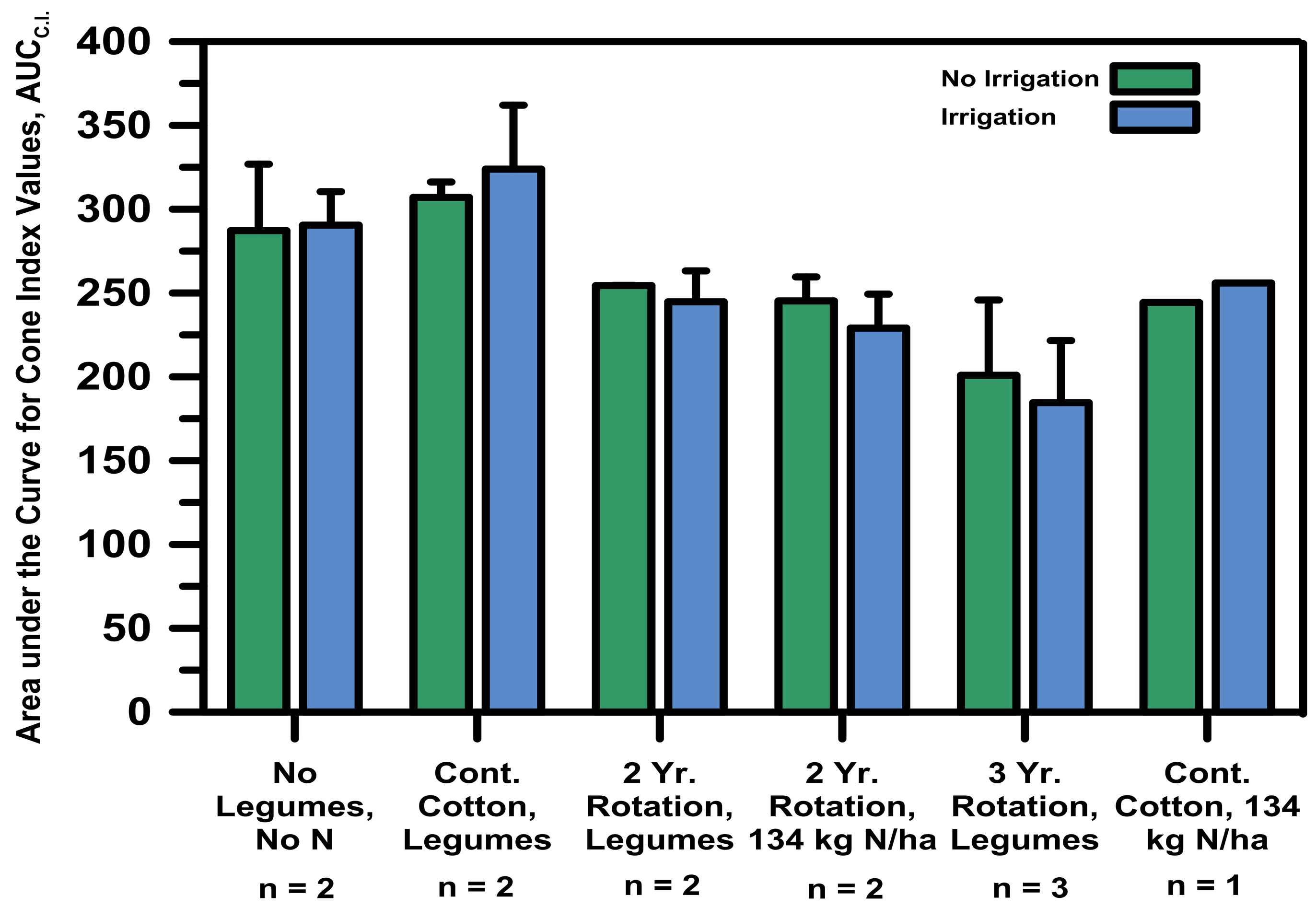

Fig. 4. Area under the curve for cone index ($AUC_{C.I.}$) values calculated from soil strength measurements collected in December, 2014 for each irrigation level and rotation on the Old Rotation. Error bars represent standard errors of the mean.

RESULTS AND DISCUSSION

- Treatment comparisons of $AUC_{C.I.}$ values for non-irrigated and irrigated levels across cotton rotations of the Old Rotation are shown in Fig. 4. If multiple replications exist, a measure of variability is also provided.

- The continuous cotton rotation that included legumes had the highest $AUC_{C.I.}$ values indicating soil strength was highest in this rotation (Fig. 4).

- The lowest $AUC_{C.I.}$ values were observed for the 3-year rotation, although variability was high, indicating soil strength was lower for this rotation as compared to the other rotations (Fig. 4).

- Lower soil strength observed for the 3-year rotation can be attributed to increased soil organic matter (Hamza and Anderson, 2005), which has been previously documented through soil C increases for this rotation (Mitchell et al., 2008).

- Although irrigation was part of the treatment structure, irrigation did not affect measurements because plots were last irrigated on Aug. 2014. Gravimetric water contents were consistent across rotations, but the 15-30 cm depth was 56% wetter than the 0-15 cm depth (data not shown).

- The Old Rotation was established prior to R.A. Fisher's first publication related to modern statistics in 1925 (Steel and Torrie, 1960), which does not allow a traditional statistical analysis to be performed.

CONSIDERATIONS FOR THIS NEW METHOD

- The magnitude of the $AUC_{C.I.}$ values are only important to compare treatments (rotations in this example) in the same experiment to determine how soil strength from one treatment compares to other treatments collected under identical soil conditions.

- An advantage is integrating all soil strength values from each row position (x-value) and depth (y-position) depicted in contour graphs into a single value to simplify interpretation.

- However, the single $AUC_{C.I.}$ value alone can be a disadvantage because it does not identify where areas of elevated soil strength occurs across the measurement area. Contour graphs can easily depict these differences (Fig. 3).

- Analyzing $AUC_{C.I.}$ values for each experimental unit from any field experiment is analogues to analyzing other field data such as yield, which simplifies initial soil strength analyses among treatments.

CONCLUSION

- The proposed method demonstrated an approach to simplify soil strength comparisons among treatments in a non-replicated field experiment to aid in interpretation of soil strength data.

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