EVALUATION OF SOIL COMPACTION IN CORN GROWN UNDER DIFFERENT TILLAGE SYSTEMS AND SOIL ZONES

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SUMMARY

Determination of soil compaction under different soil zones and tillage systems can help to improve soil management. The objective of this study was to evaluate soil compaction under different soil textures, based on the soil electric conductivity (EC) measurements, and tillage systems in dryland corn (*Zea mays* L.). The research project was initiated with planting wheat (*Triticum aestivum* L.) cover crop at Clemson University, Edisto Research and Education Center near Blackville, SC in the fall of 2006. A commercially available soil electric conductivity (EC) measurement system (Veris Technologies 3100) was used to identify variations in soil texture across the fields prior to planting wheat cover crop and create soil zone maps using global positioning system (GPS) and geographical information system (GIS). Corn was planted across four different soil zones (based on soil EC measurements and ranging from 1 - sandy soils to 4 – clay soils) and under three tillage systems (no-till, conventional, and strip-till). Soil compaction was measured within corn rows using a CP40II cone penetrometer during corn vegetation. The results show that soil compaction can be influenced not only by tillage, but also soil texture. Generally, soil compaction varied from year to year creating different conditions for plant growth and development, and significant differences between soil zones were observed at some depths within the top 12 inches under conventional tillage and strip-till in 2007, and under no-till and strip-till in 2008.

INTRODUCTION

Greater understanding of spatial-variability due to soil texture, tillage systems, and nitrogen application on crop production under dryland conditions can help to obtain optimum yields. Tillage systems are among the many factors that affect soil productivity (Licht and Al-Kaisi, 2005). Tarkalson et al. (2006) noted that tillage systems and nutrient management influence soil chemical properties that can impact the long-term sustainability of dryland production systems. Also, previous research has shown that nitrogen (N) availability depends on seasonal changes in soil structure (Radke et al., 1985; Johnson and Lowery, 1985; Wagger, 1989; Ranells and Wagger, 1992). Nitrogen mineralization and availability may be reduced due to soil compaction (Hassink, 1995) and low temperature, as a result of reduced air flow in conservation tillage (Johnson and Lowery, 1985). However, frequent soil movement in conventional tillage (CT) may increase the N mineralization process (Grace et al., 1993). Azam et al. (1988) and Grace et al. (1993) noted that N fertilization not only increases ammonium N, but also N mineralization in the soil. The synchrony of N supply with crop demand is essential in order to ensure adequate nitrogen utilization and optimum yield in the economically sustainable crop production (Fageria and Baligar, 2005).

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A commercially available soil electrical conductivity (EC) measurement system (Veris Technologies 3100) helps to identify variations in soil texture across the field and create soil zone maps using global positioning system (GPS) and geographic information systems (GIS).

More in depth evaluation of soil compaction under different soil zones and tillage systems may help to improve soil management. Therefore, the objective of this study was to evaluate soil compaction under different soil textures, based on the soil electric conductivity (EC) measurements, and tillage systems in dryland corn.

METHODS AND MATERIALS

The study was initiated on Dothan loamy sand (fine loamy, kaolinitic, thermic Plinthic Kandiudult) at Clemson University, Edisto Research and Education Center near Blackville, SC in the fall of 2006. Prior to planting wheat cover crop in 2006, soil electrical conductivity (EC) measurement system (Veris Technologies 3100) was used to identify variations in soil texture across the field and create soil zone maps using global positioning system (GPS) and geographic information systems (GIS). Feed wheat planted in early December of 2006 and Pioneer 26R12 wheat planted on 21 November 2007 were killed on 26 February 2007 and 6 March 2008, respectively. Field was divided into 4 different soil zone areas based on the soil EC readings. Each soil zone area was split into three tillage systems (conventional, strip-till, and no-till). Due to high soil variability, each tillage system was split into four soil zones based on average soil EC for each plot. Great Plains Turbo Till was used in the no-till (NT) sections and worksaver following disk was used in the conventional (CV) sections of the study on 12 March 2007 and 17 March 2008.

Pioneer 31G65 corn was planted at aproximately 28,000 seeds/acre in CV and NT sections using a John Deere 7300 MaxEmerge II Vaccum planter on 13 March 2007 and strip-till (ST) sections were planted on 14 March 2007 using a Univerferth Ripper-Stripper (Unverferth Mtg. Co., Inc., Falida, OH) and John Deere 1700 MaxEmerge XP Vaccum planters. In 2008, the Univerferth Ripper-stripper implement was used in ST and Pioneer 31G65 corn was planted in all plots, at the same rate as 2007, using a John Deere 7300 MaxEmerge II Vaccum planter on 18 March 2008. Weed control was based on the South Carolina Extension recommendations.

Soil compaction was measured within corn rows using a CP40II cone penetrometer with a 0.2 sq. inch cone during corn vegetation on 13 and 24 June in 2007 and 2008, respectively.

The experimental design was a split-plot with four replications. Tillage systems were considered the main plots and soil zones were subplots. The PROC GLM (SAS, 1999) was used to compare soil zones under different tillage systems. The difference between soil zones was considered significant at $P \leq 0.05$.

RESULTS AND DISCUSSION

Soil compaction was influenced by soil zones under convetional tillage, no-till, and strip-till in 2007 and 2008 (Fig. 1 - 6). Under conventional tillage, significantly higher soil compaction was observed on soil zone 4 (clay soils) compared to soil zone 1 (sandy soils) at 5-8, 19 and 20 inch soil depth in 2007 (Fig. 1). In 2008, soil zone 4 had higher compaction at 13-19 inch soil depth compared to soil zone 1 (Fig. 2). There was no significant difference across soil zones at 1-4 and 9-18 inch soil depth in 2007, and 1-12, and 20 inch soil depth in 2008.

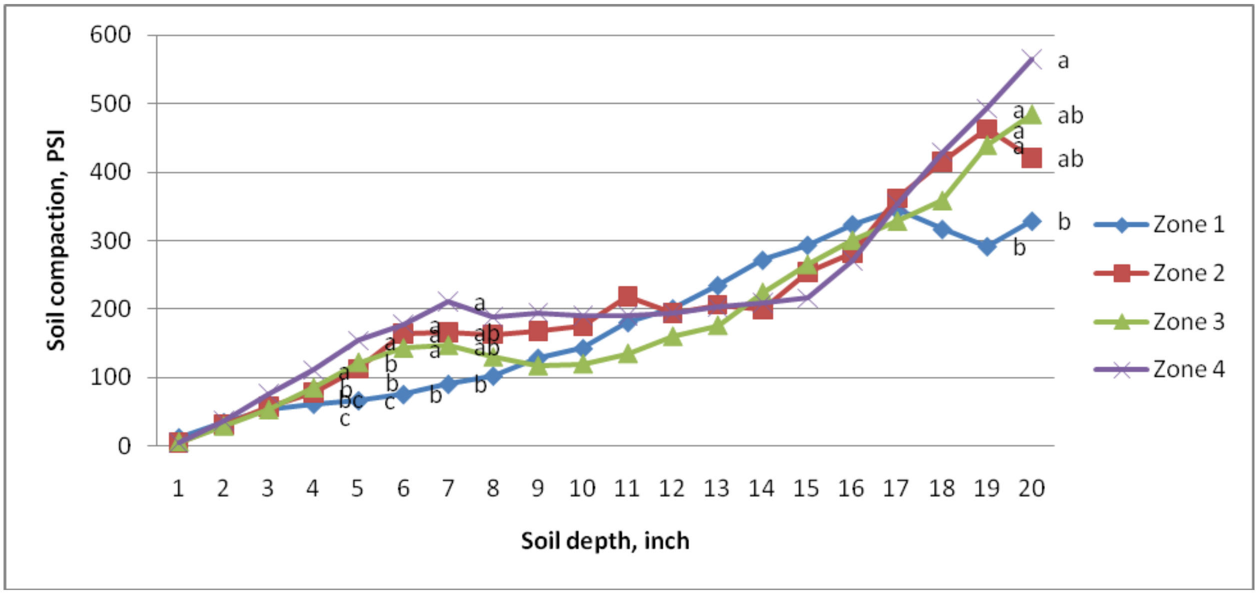

Fig. 1. Soil compaction across different soil zones (based on soil electric conductivity) under convetional tillage in 2007. Letter separation for each soil depth indicates significant difference at *P*≤0.05.

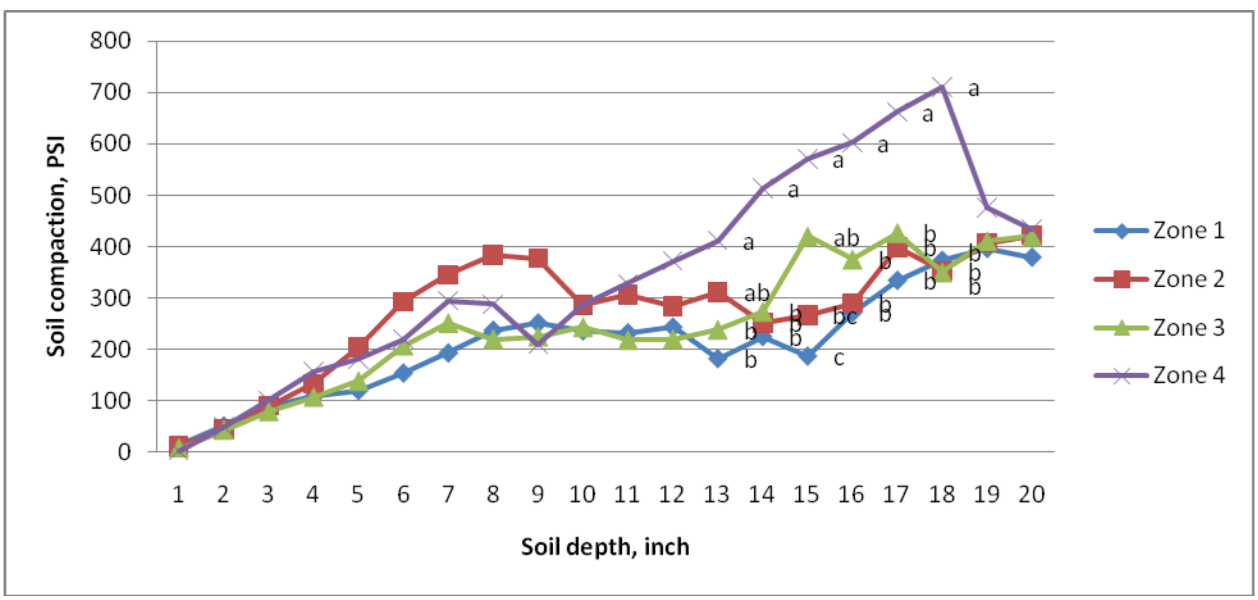

Fig. 2. Soil compaction across different soil zones (based on soil electric conductivity) under convetional tillage in 2008. Letter separation for each soil depth indicates significant difference at *P*≤0.05.

As for no-till, highest soil compaction was noted for soil zones 4 and 3 at 14-20 inch depth in 2007 (Fig. 3). For the same year, lowest soil compaction was observed for zone 2 at 15, 16, and 17 inch soil depth, and lowest for zone 1 at 18, 19, and 20 inch soil depth. In 2008, highest soil compaction was noted for zone 3 and 4 at 7 inch soil depth, and soil zone 2 at 8 inch depth (Fig. 4). For soil depth 17-20, significantly lower compaction was noted for zone 1 compared to other zones. For the same depths, there was no significant difference observed between zones 2, 3, and 4. Difference between zones was not significant at 1-13 inch soil depth in 2007 and 1-2, 5, and 9-16 inch soil depth in 2008.

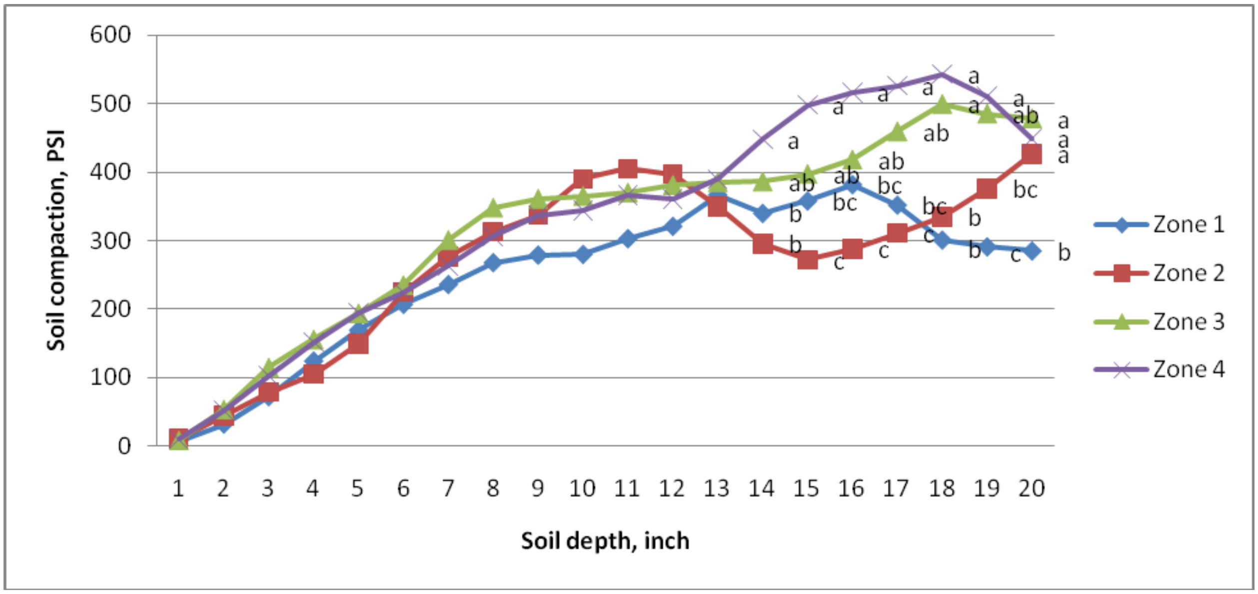

Fig. 3. Soil compaction across different soil zones (based on soil electric conductivity) under no-till in 2007. Letter separation for each soil depth indicates significant difference at $P \leq 0.05$.

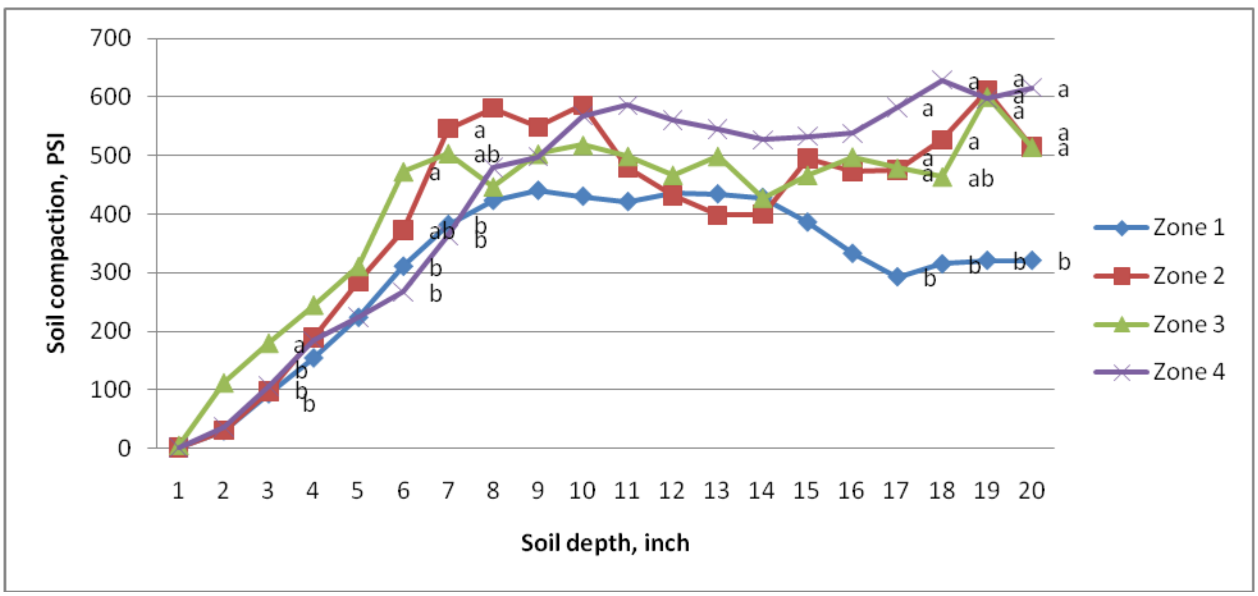

Fig. 4. Soil compaction across different soil zones (based on soil electric conductivity) under no-till in 2008. Letter separation for each soil depth indicates significant difference at $P \leq 0.05$.

Under strip-till, soil compaction was highest for soil zone 4 at 8-14 and 20 inch depth, and higher for zones 1, 3, and 4 than zone 2 at 15, 16, and 17 inch depth in 2007. In 2008, higher soil compaction was noted for zone 4 and 2 at 6-8 inch soil depth, and zone 4 and 3 at 17 inch depth. There was no significant difference between soil zones at 1-7 and 19 inch soil depth in 2007, and 1-4, 10-16, and 19-20 inch soil depth in 2008.

Generally, the differences for soil compaction close the soil surface were very small. However, compaction changed at lower soil depths with higher compaction usually observed for soil zone 4, which is characterized by highest soil EC values due to clay content.

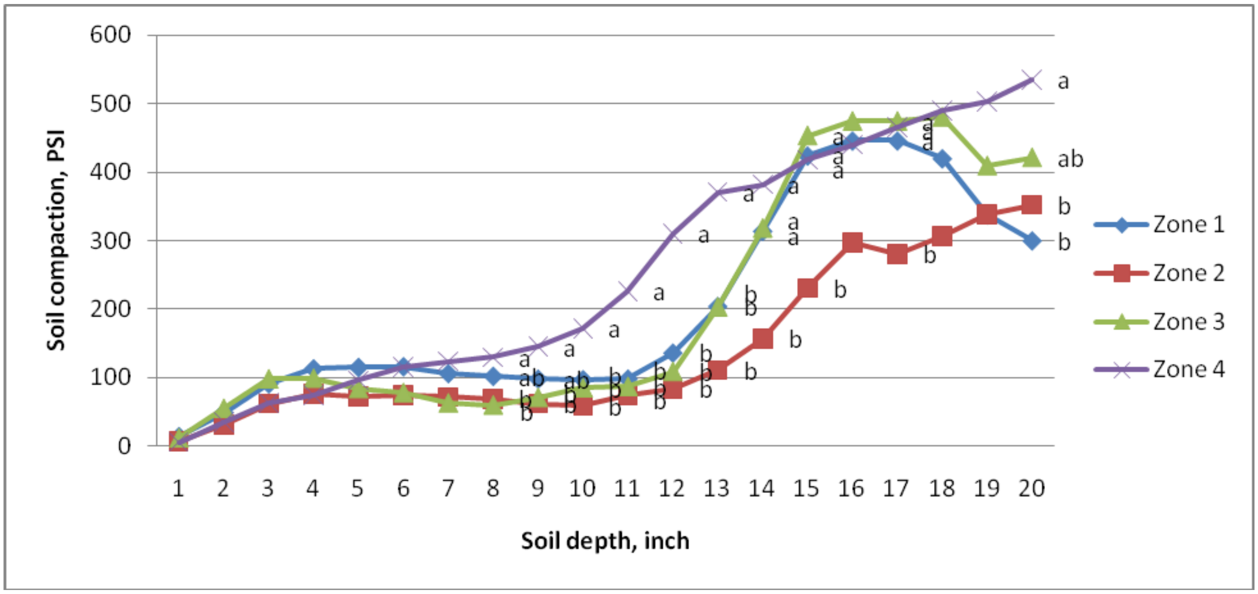

Fig. 5. Soil compaction across different soil zones (based on soil electric conductivity) under strip-till in 2007. Letter separation for each soil depth indicates significant difference at $P \leq 0.05$.

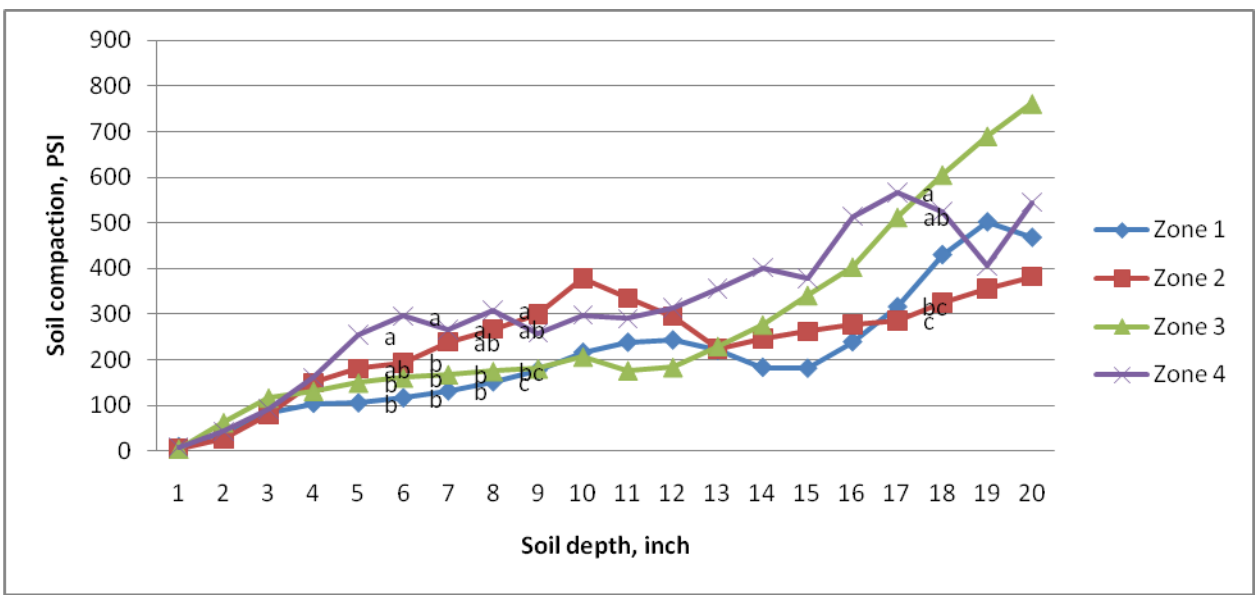

Fig. 6. Soil compaction across different soil zones (based on soil electric conductivity) under strip-till in 2008. Letter separation for each soil depth indicates significant difference at $P \leq 0.05$.

CONCLUSION

Soil EC can be successfully used to map fields for soil texture changes. Generally, higher EC indicate heavier soils and lower EC indicate sandier soils. The soil compaction results show that soil compaction varied from year to year creating different conditions for plant growth and development. Within the top 12 inches, significant differences between soil zones were observed at some depths under conventional tillage and strip till in 2007, and under no-till and strip-till in 2008.

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DISCLAIMER

Any opinions, findings, conclusions or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the USDA.

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