SHORT TERM EFFECT OF DOUBLE CROPPING AND COVER CROPPING ON SOIL PHYSICAL PROPERTIES

F. Sheikhi Shahrivar[1], O, Ola[1], O, Guzel[1], K. L. Gage[1], K, W. J. Williard[2], J. E. Schoonover[2], S. Mueller[3], A. Sadeghpour[1,4]
[1]School of Agricultural Sciences, Crop, Soil, and Environmental Program, Southern Illinois University
[2]School of Agricultural Sciences, Forestry and Horticulture Program, Southern Illinois University
[3]Energy Resources Center, University of Illinois Chicago
[4]Adaptive Cropping System Laboratory, USDA-ARS Beltsville Area Research Center-West

ABSTRACT

Integrating cover crops into corn (*Zea mays* L.)-soybean (*Glycine max* L.) rotation has been promoted as a sustainable practice to reduce soil erosion, enhance soil health, and improve agricultural sustainability. However, growers are less inclined to include cover crops into their cash crop rotations especially winter cereals such as winter rye (*Secale cereale* L.) behind corn. One strategy to minimize the fallow period in corn-soybean rotation is by intensifying the corn-soybean rotation using winter wheat (*Triticum aestivum* L.) as a double crop. This study investigates the short-term impact of double cropping and cover cropping on key soil physical properties including bulk density, aggregate size distribution and stability, soil compaction, saturated hydraulic conductivity, and soil porosity at two different soil depths (0-5 and 5-20 cm). A three-year field trial was conducted at the Agronomy Research Farm in Carbondale, Illinois, with four treatments: (1) corn-soybean rotation with no cover crop (CNSN), (2) corn-rye-soybean-rye rotation (CRSR), (3) corn-wheat-soybean cash crop rotation without cover crops (CWSN), and (4) corn-wheat-soybean cash crop rotation with a rye cover crop (CWSR). Results indicated that the influence of cover crops and double cropping systems on soil physical properties was more pronounced at the 0-5 cm depth compared to the 5-20 cm depth. No significant treatment effects were observed at the 5-20 cm depth, suggesting that the impact of these practices is limited to the surface soil layer in the short term. The findings suggest that the observable benefits of these practices on soil physical properties may require a longer duration of implementation to manifest. This study provides insights into the early-stage effects of cover cropping and double cropping systems, contributing to the understanding of soil health dynamics in sustainable agricultural systems.

INTRODUCTION

Cover cropping and double cropping systems are increasingly recognized for their potential to improve soil health by mitigating the negative impacts of intensive agriculture. Cover crops, like Winter rye, improve soil physical properties by reducing erosion, enhancing porosity, and increasing soil carbon (Kaspar & Singer, 2011; Blanco-Canqui & Ruis, 2020). While the benefits of cover crops, over time, are well-known, the short-term effects of double cropping on soil, especially in rotations with corn and

soybean, remain less explored (Sadeghpour et al., 2021; Wang et al., 2022). This study aims to evaluate the impacts of cover and double cropping systems on key soil physical properties, including aggregate stability, bulk density, compaction, and organic matter.

MATERIAL AND METHODS

Field trials were conducted at Southern Illinois University's Agronomy Research Farm in a randomized complete block design with four replications. Treatments included: (1) corn-soybean rotation without cover crops (CNSN), (2) corn-rye-soybean-rye rotation (CRSR), (3) corn-wheat-soybean cash crop rotation without cover crops, and (4) corn-wheat-soybean cash crop rotation with a rye cover crop. Wheat received 150 lbs DAP in fall and 70 lbs/acre UAN at each tillering and jointing, following discussions with growers in the region. Soil samples per plot were collected at 0-5 cm depth. Dried samples were analyzed for aggregate size distribution per Weidhuner et al. (2021). Compaction was also measured by a digital penetrometer in pounds per square inch (psi) (Herrick and Jones, 2002). Compaction depths were 0-10, 10-20, 20-30, and 30-40 cm depths. ANOVA (PROC MIXED) assessed treatment, depth, and their interactions as main effects, and block as random effect. For the compaction readings, PROC MIXED in SAS was used with treatment, depth, and their interactions as main effects. Sampling depth was considered as a repeated measure with AR1 as covariate structure.

RESULT AND DISCUSSION

Aggregate size distribution

Figure 1 shows the soil aggregate distribution at the 0-5 cm depth under four cropping treatments: CNSN, CRSR, CWSN, and CWSR. Treatments significantly impacted the 1-2 mm and 0.5-1 mm aggregates, with CRSR, CWSN, and CWSR showing increases in these sizes compared to CNSN by over 25% and 33%, respectively.

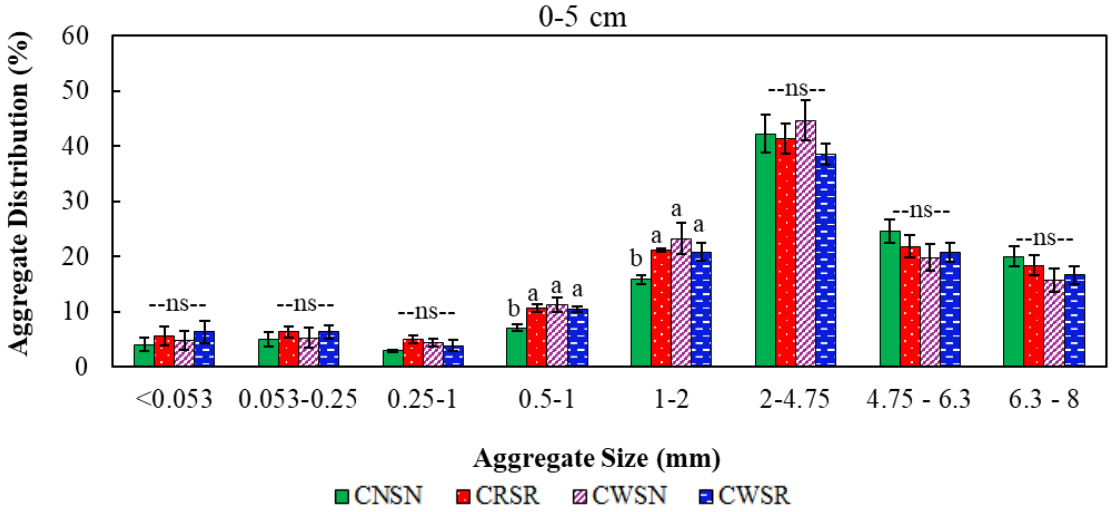

Fig 1. Effect of cropping system on dry aggregate size distribution (%) at a) 0-5 cm. Treatments include CNSN (Corn-Soybean Rotation with No Cover Crop), CRSR (Corn-Rye-Soybean-Rye Rotation), CWSN (Corn-Wheat-Soybean Rotation with No Cover Crop), and CWSR (Corn-Wheat-Soybean Rotation with Rye Cover Crop). Same letters within each aggregate size class indicate no significant differences ($P < 0.05$), while 'ns' denotes non-significant differences among treatments.

Compaction

Figure 2 indicates the effect of the cropping system on soil compaction (PSI) across different depths. The analysis indicates that soil compaction was only influenced by depth and there were no significant differences in compaction between treatments (denoted as 'ns'). The same letters within each aggregate size class suggest no significant differences ($P < 0.05$).

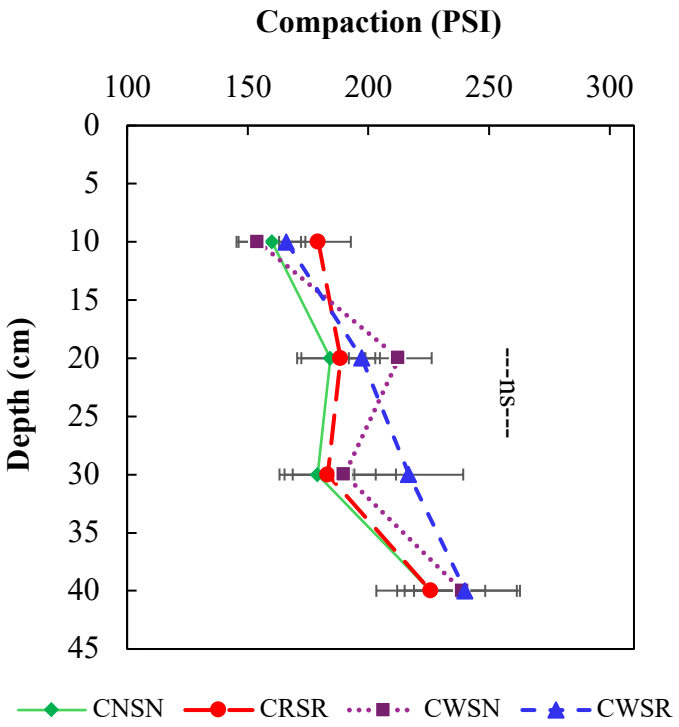

Fig 2. Effect of cropping system on soil compaction (PSI) at different sampling depths. Treatments include CNSN (Corn-Soybean Rotation with No Cover Crop), CRSR (Corn-Rye-Soybean-Rye Rotation), CWSN (Corn-Wheat-Soybean Rotation with No Cover Crop), and CWSR (Corn-Wheat-Soybean Rotation with Rye Cover Crop). Same letters within each aggregate size class indicate no significant differences ($P < 0.05$), while 'ns' denotes non-significant differences among treatments.

CONCLUSION

Cover cropping (rye-cash crop) and double cropping (wheat-soybean), enhanced medium-sized aggregate formation in surface soil, improving short-term soil structure with no effect on soil compaction. This suggests that soil aggregation can be improved

over time by cover crop and double cropping but long-term research is needed to see greater benefits.

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