Effect of Subsoiling on Soil Properties and Crop Yield in a Solonetzic Soil

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Introduction

- Solonetzic soils have inherent structural limitations that include dense sodium and clay enriched B-horizons, that impede plant growth. These soils are also susceptible to compaction by repeated wheel traffic.
- Subsoiling is a form of deep tillage that lifts and loosens the soil at depth with minimum surface disturbance, and may be used to remedy physical limitations and address soil issues from wheel traffic.

Study Objectives

- To evaluate the effect of subsoiling of a Saskatchewan Solonetzic soil on aggregate size, hydraulic conductivity, air permeability, soil resistance and crop yields without and with wheel traffic compaction.

Materials and Methods

- **Study Site:**

  Solodized Solonetz (Echo Association) loam textured soil located in the Brown soil zone 1.6 km north of Central Butte, SK.

  ➢ Soil at this site is predominantly solonetzic with a dense hard B horizon restricting rooting volume and limiting water infiltration.
- **Subsoiling Treatment:**

  Subsoiling imposed in October of 2015:

  ➢ Two treatments replicated four times: a control treatment with no subsoiling tillage, and a subsoiled treatment using a John Deere 2100 minimum tillage subsoiler with five shanks spaced 78.0 cm apart and operated at a 30.0 cm depth (Fig. 1).
- **Induced Soil Compaction Treatment:**

❑ *Three sampling transects established in subsoiling treatments:*

  ➢PRE-Subsoiling Compaction (PRE-Comp) transect: Heavy vehicle and farm machinery wheel traffic over multiple years.

  ➢POST-Subsoiling Compaction (POST-Comp) transect: In the March of 2016, a one ton truck and livestock trailer travelled over the subsoiling treatment area three times.

  ➢No wheel traffic (control) transect.
- **Soil and Crop Measurements:**

  Aggregate size, hydraulic conductivity, air permeability, soil resistance (soil strength) (Fig. 2) and canola crop biomass samples collected in 2016 crop year for analysis.

Fig. 1. John Deere 2100 minimum tillage subsoiler operated at 30.0 cm depth.

Fig. 2. Hydraulic conductivity (a) , air permeability (b) and soil resistance (c) measurements in compacted and subsoiled treatment plots at the North Central Butte (NCB) Solonetzic site in June 2016.

Table 1. Aggregate size, hydraulic conductivity and air permeability measurements taken in June 2016 at the North Central Butte (NCB) Solonetzic site. Pre-compacted indicates compaction induced by wheel traffic prior to subsoiling and Post- compacted indicates compaction induced by wheel traffic post-subsoiling.

		Measurements		
Subsoiling Treatment	Compaction Treatment	Aggregate Size MWD (mm)	Hydraulic Conductivity (cm min^{-1})	Air Permeability (m s^{-1})
Subsoiled	Pre-Compaction†	12.01	6.32E-02	1.15E-6a¶
	Post-Compaction‡	12.37	5.05E-02	5.20E-7b
	Control§	10.03	2.86E-02	4.67E-7c
Non-Subsoiled	Pre-Compaction	12.51	1.65E-02	9.78E-7d
	Post-Compaction	14.05	8.32E-02	4.15E-7e
	Control	10.72	6.23E-03	6.40E-7f
	Subsoiled Effects	0.3578	0.0857	<0.001
P Value	Compaction Effects	0.969	0.6738	<0.001
	Subsoiled*Compaction	0.8793	0.875	<0.001

†Pre-Compaction is vehicle traffic induced soil compaction treatment occuring prior to subsoiling treatment being imposed at the North Central Butte (NCB) site in Oct. 2015.
‡Post-Compaction is vehicle traffic induced soil compaction treatment occuring in April 2016 after subsoiling treatment being imposed at the North Central Butte (NCB) site in Oct. 2015.
§ No vehicle traffic induced soil compaction treatment.
¶Means followed by the same letter are not significantly different at $P \leq 0.10$.

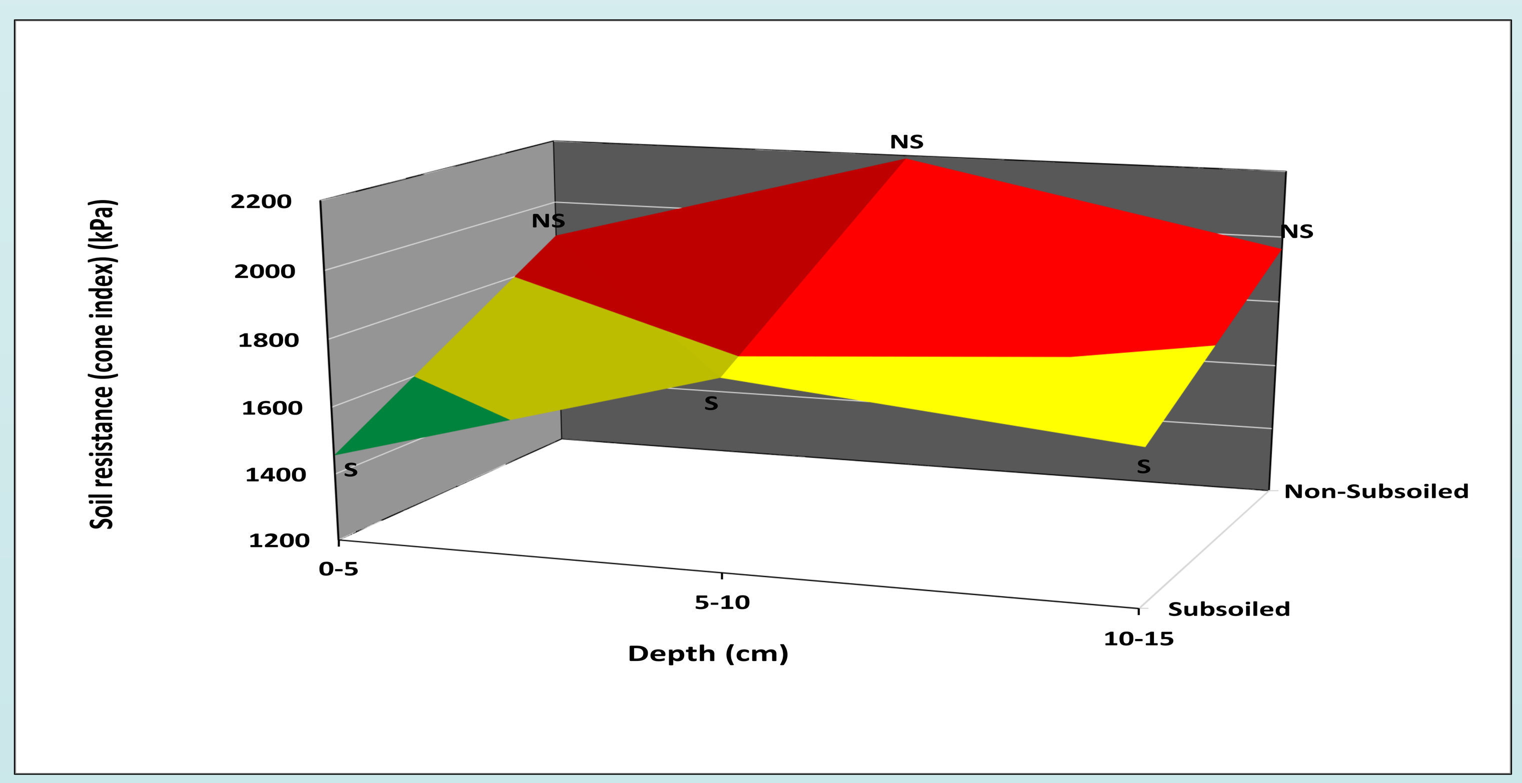

Fig. 3. Soil resistance (strength, kPa) in the 0-15 cm depth in subsoiled (S) and non-subsoiled (NS) treatment points at North Central Butte (NCB) Solonetzic site in May 2016.

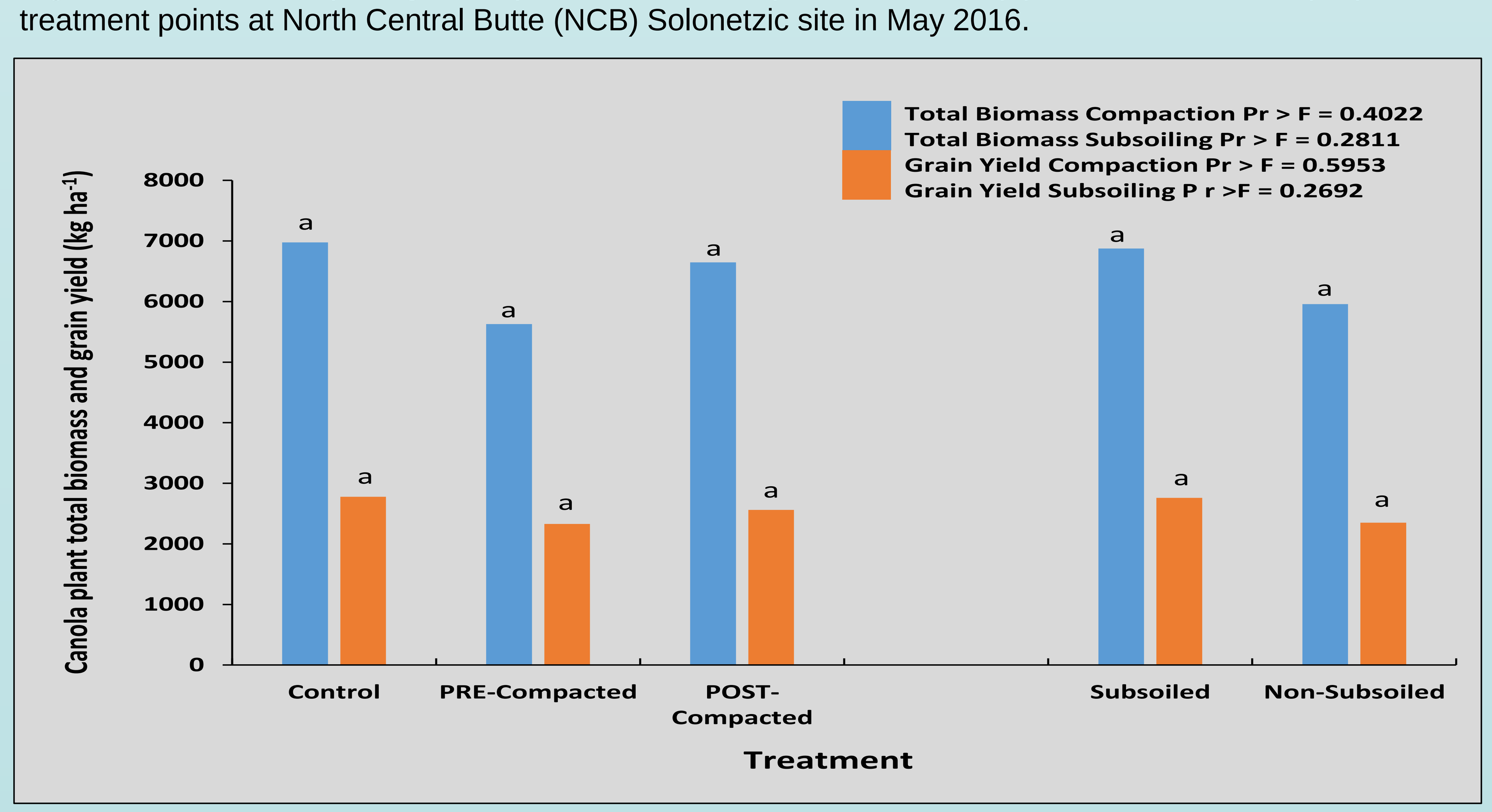

Fig. 4. Canola total above-ground biomass and grain yields (kg ha^{-1}) in control (no wheel traffic), pre-subsoiling compaction, post-subsoiling compaction treatment transect points at the North Central Butte Solonetz site in August 2016.

Results and Discussion

- Subsoiling did not have a significant effect on aggregate size in the subsoiled or wheel traffic compacted treatments (Table 1), however, aggregate size was greater in wheel traffic compacted areas due to creation of massive structure.
- Subsoiling tended to increase water and especially air permeability (Table 1).
- Soil resistance (strength) in the 0-15 cm depth was significantly greater in wheel traffic affected soils compared to control (no wheel traffic).
- Subsoiling significantly lowered soil strength (Fig. 3) and bulk density (data not shown) in all treatments.
- The lifting and shattering action of the subsoiler openers provides soil loosening to decrease soil strength.
- Compaction and subsoiling treatments did not significantly affect canola yield in 2016 (Fig. 4), which may be explained by ample moisture received during the 2016 growing season at this site.
- There was a trend for canola yield to be higher in subsoiled treatments and where there was no history of wheel traffic.

Conclusions

- Lifting and shattering action of the subsoiler implement loosened soil to generally improve permeability and reduce strength and density in wheel traffic compacted and non-compacted Solonetzic soil.
- The effect of subsoiling on crop yield was small in this study, similar to previous studies with Chernozems and Vertisols (Ewen, 2015).
- Effects on soil properties and wheat yield in the second year will be determined in 2017.

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