EFFECT OF SUBSURFACE AND SURFACE TILLAGE ON STRUCTURE AND PERMEABILITY OF SOLONETZIC AND CHERNOZEMIC SOILS OVER TWO YEARS

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INTRODUCTION

- Saskatchewan has ~ 44% of Canada's total cultivated farmland (Statistics Canada, 2012).
- Considering soil physical attributes (permeability, structure & strength) is important: affects root growth, ability to explore for nutrients and water.
- Wheel traffic compaction, dense horizons can negatively affect root zone (Soane et al., 1994).

Tillage is one management strategy to alter water and air permeability, structure and strength, in the root zone.

Introduction (cont'd)

- In Canada, wheel traffic from heavy equipment can lead to compaction, with reduced porosity and permeability & greater resistance to root penetration.

Introduction (cont'd)

- Naturally high Na leads to clay dispersion, formation of dense Solonetzic B horizons that affect productivity.

Subsoiling *(15-30 cm) may improve conditions in compacted, dense subsoils.*

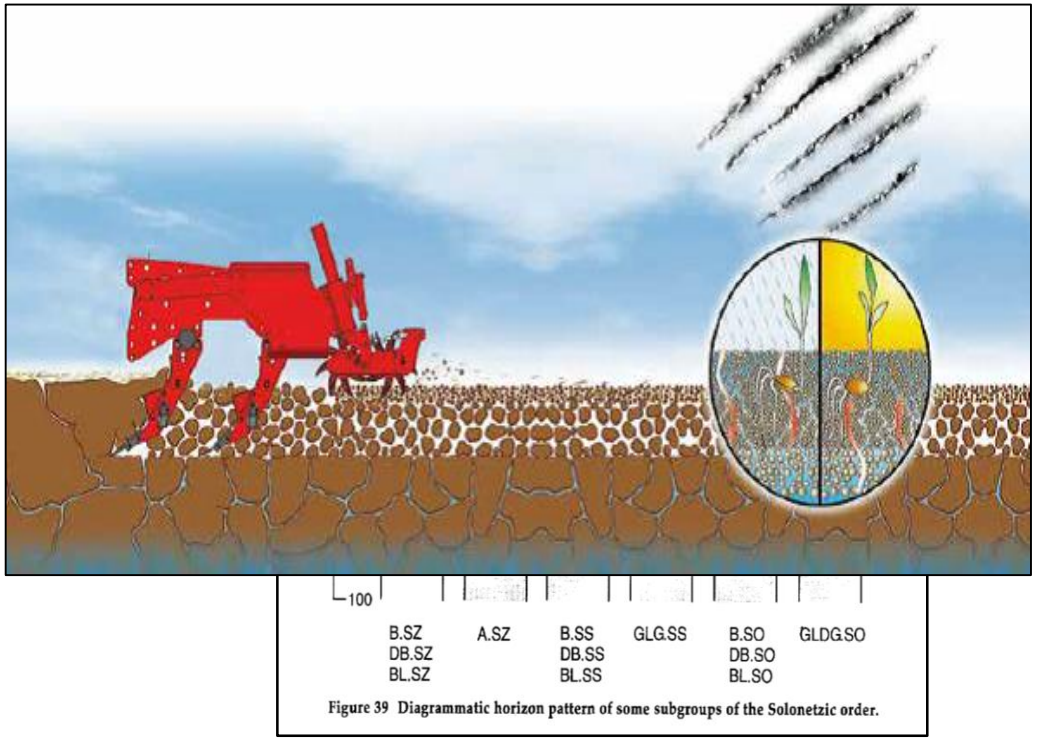

Figure 39 Diagrammatic horizon pattern of some subgroups of the Solonetzic order.

Introduction

- **Surface tillage** (e.g. vertical tillage) is utilized for residue rut management and alters soil conditions mainly at surface.
- **Raking and burning** may also be used for management of difficult crop residues like flax straw.



- Very few recent studies on tillage strategies to address physical limitations in soils of the Northern Great Plains.

STUDY OBJECTIVES

- To assess soil **water infiltration**, **air permeability**, **structural attributes**, as influenced by subsurface and surface tillage treatments in compacted and non-compacted Solonetzic (sodium affected) and Chernozemic soils over two years.
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STUDY LOCATION

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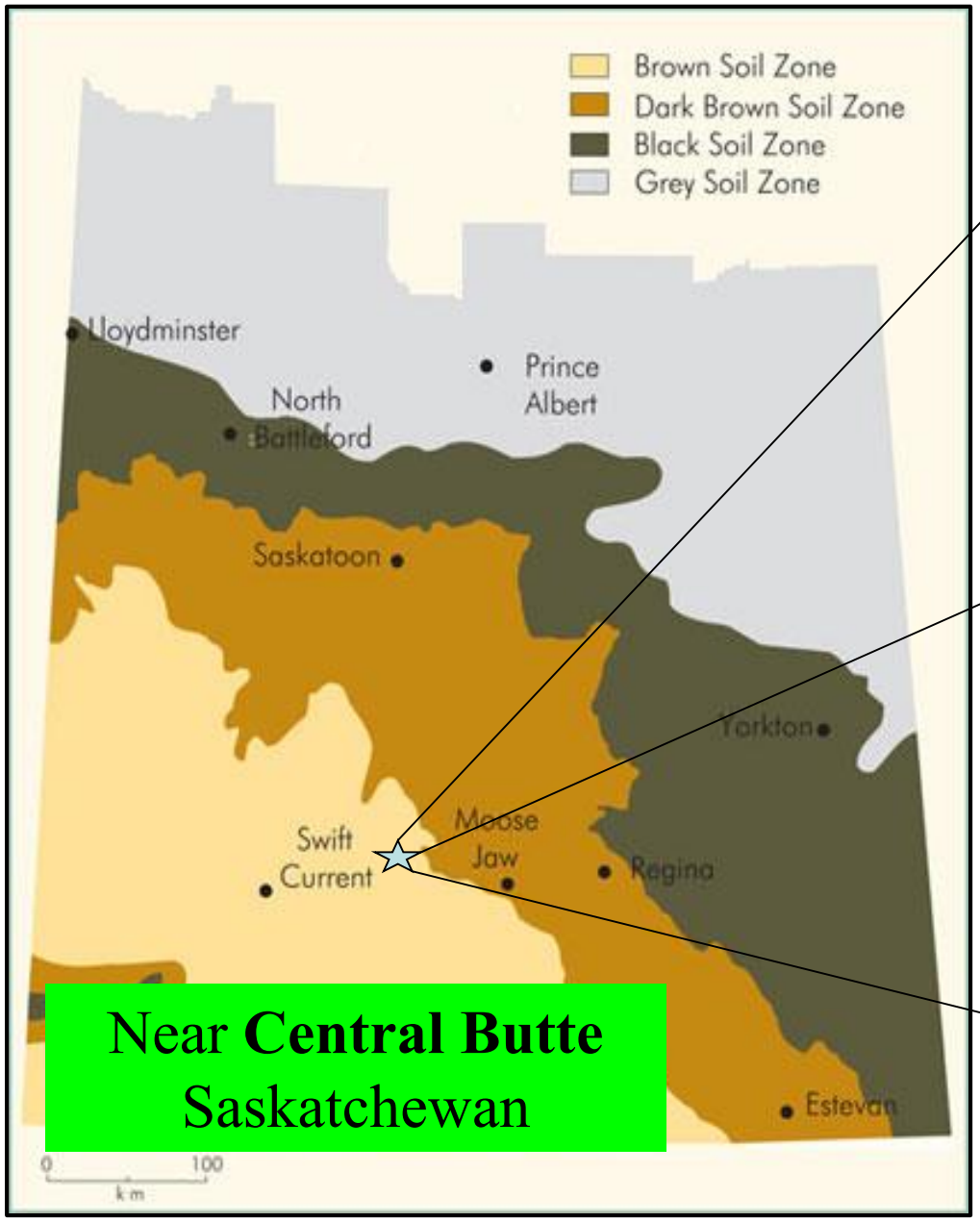


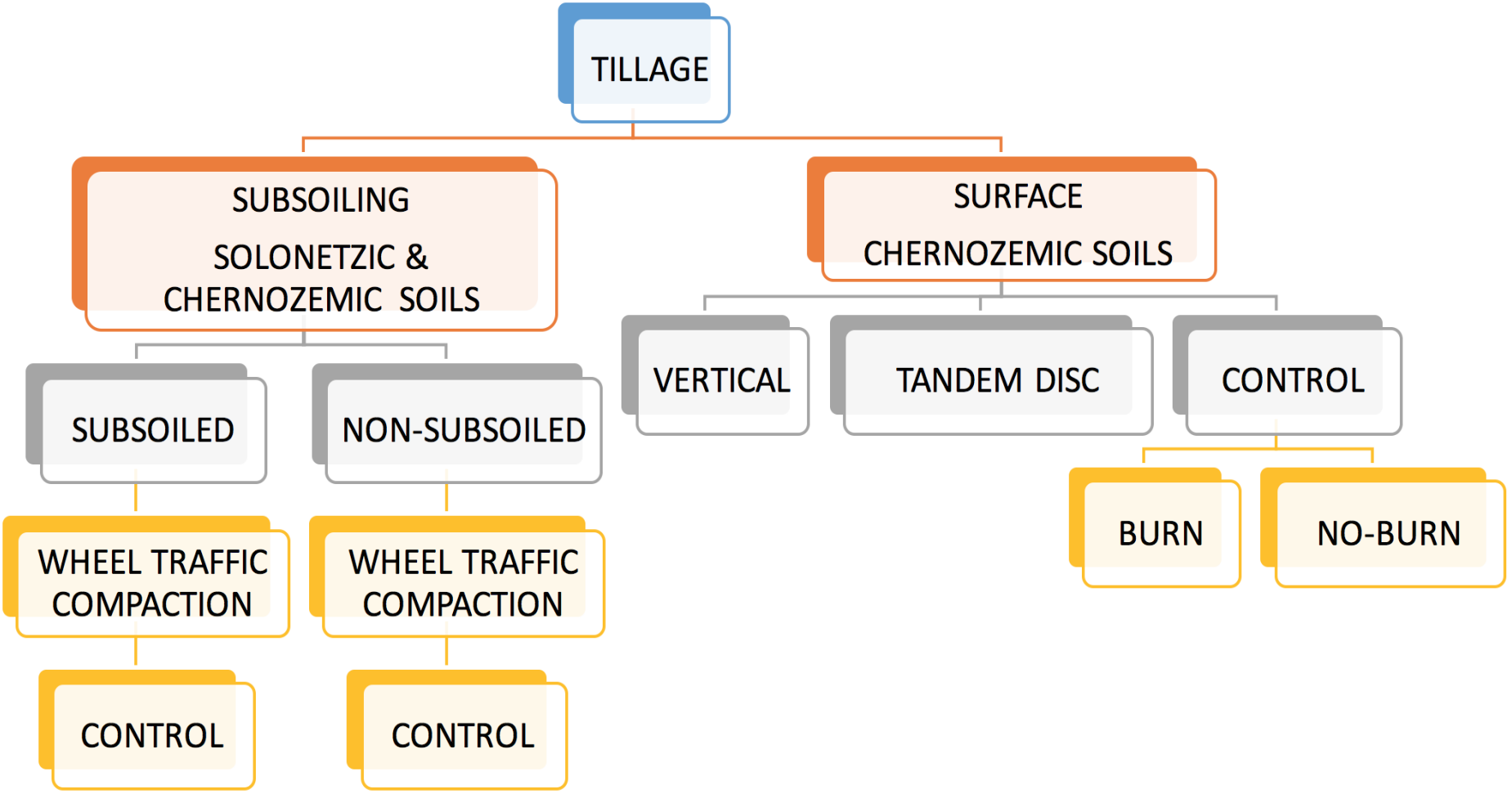
Near **Central Butte** Saskatchewan

Subsoiling Solonetz Site (Echo association)

Subsoiling Chernozem Site 1 (Haverhill association)

Surface Tillage, Rake Burn on Flax Stubble Chernozem Site 2

STUDY DESIGN



Subsoiling Tillage Operation

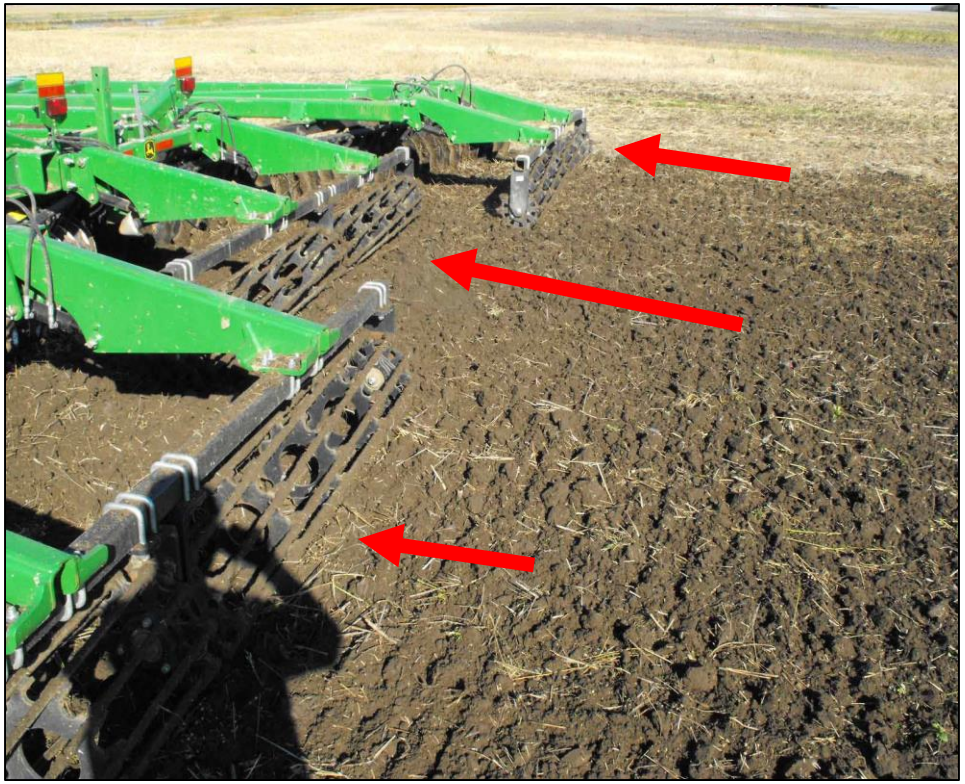
- A John Deere 2100 Minimum-Till subsoiler with five shanks spaced 76.0 cm apart and set to penetrate 30.0 cm into the soil in Fall 2015.

rrow subsoiler shank
eates minimal surface
disturbance

Tandem Disc and Vertical Tillage Operations

- Tandem disc with John Deere Frontier TM5132 to a depth of 8-10 cm in Fall 2015 .

- Vertical Tillage with John Deere 2623VT to a depth of 5 cm in Fall 2015 .



Raked Burn & No-Burn (Flax stubble)

Measurements

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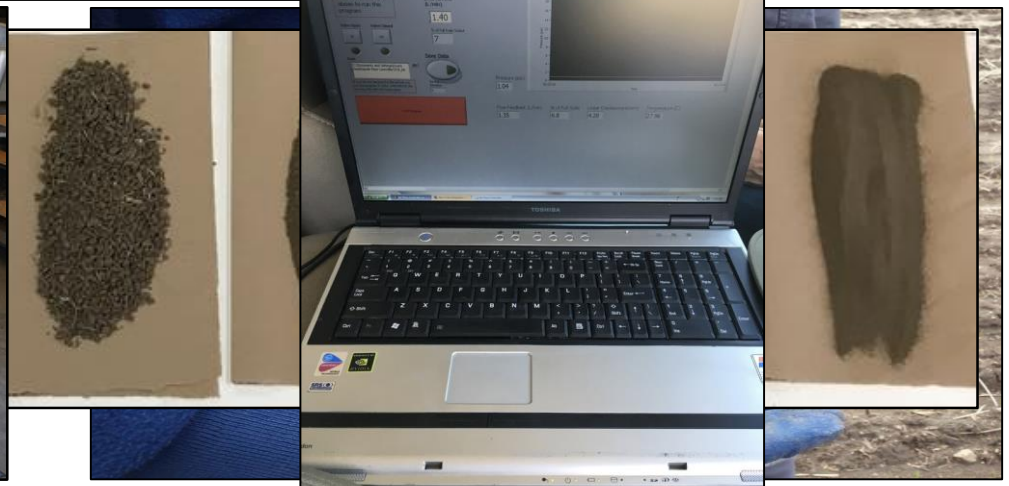
Field Saturated Hydraulic Conductivity

Air Permeability

Aggregate Size



Measurements

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Soil Strength


Results

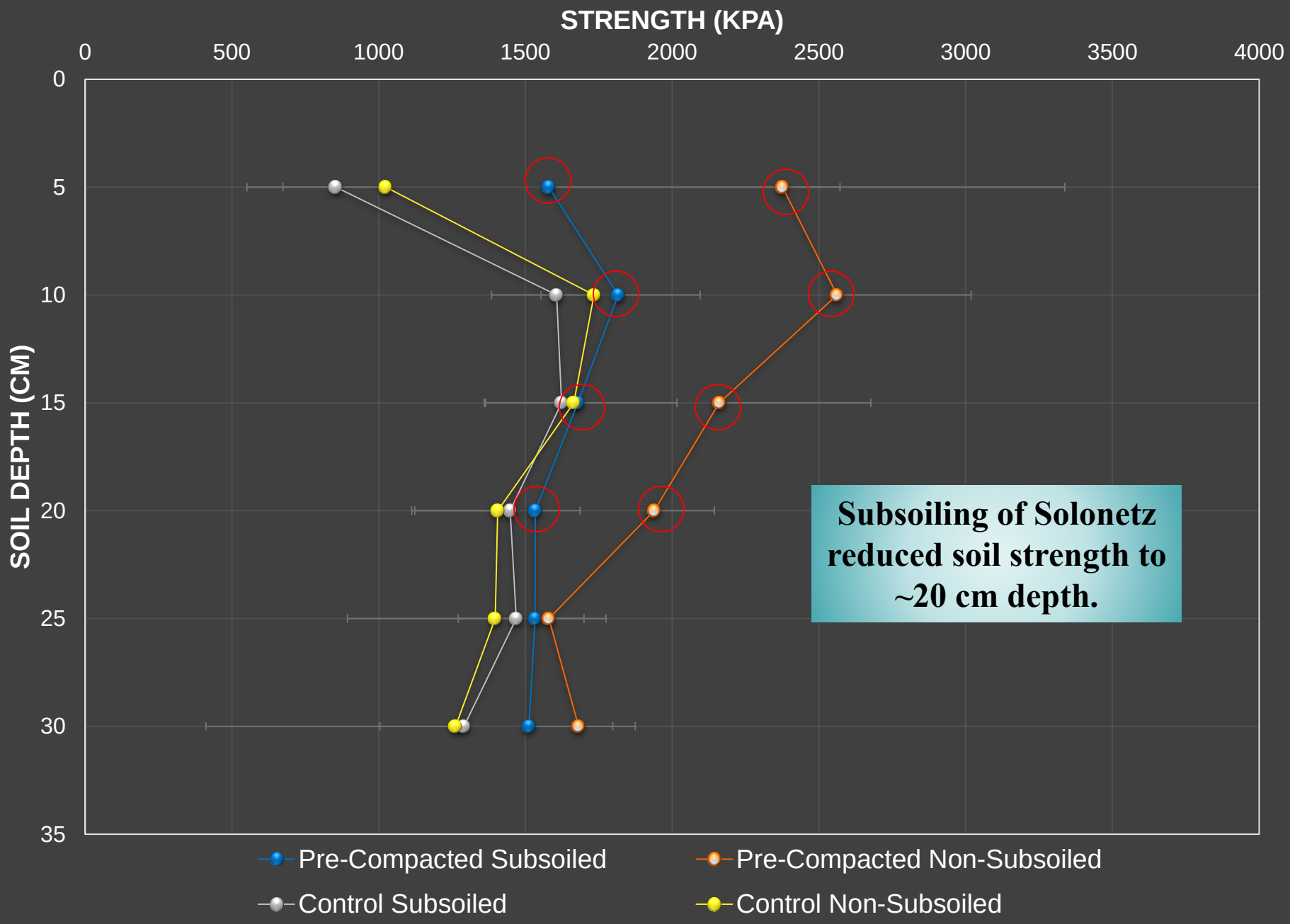
North Central Butte **Solonetzic** Site 2016-2017 **Subsoiling:**

Physical Measurements NCB 2016- 2017.

Treatment		Measurements					
		0-10 cm		0-10 cm		0-10 cm	
		Aggregate Size MWD (mm)		**Air Permeability ($m\ s^{-1}$)**		**Hydraulic Conductivity ($cm\ min^{-1}$)**	
		2016	**2017**	**2016**	**2017**	**2016**	**2017**
Pre-Compacted	**Subsoiled**	12.99	13.66	1.15E-06	1.31E-07	6.32E-02	2.13E-01
	Non-Subsoiled	13.40	13.84	9.78E-07	1.07E-08	1.65E-02	1.67E-01
(P value)		0.7335	0.5940	0.8309	0.3445	0.4622	0.2310
Post-Compacted	**Subsoiled**	12.37	14.41	5.20E-07	1.24E-07	8.32E-03	7.94E-02
	Non-Subsoiled	14.05	13.64	4.15E-07	1.20E-07	5.05E-02	5.73E-02
(P value)		0.4594	0.585	0.6110	0.9537	0.1399	0.9268
Control	**Subsoiled**	10.03	11.65	4.98E-07	2.29E-07	2.86E-02	1.28E-01
	Non-Subsoiled	11.60	13.05	6.40E-07	6.06E-08	6.23E-03	1.17E-01
(P value)		0.1609	0.0990	0.3097	0.0657	0.1474	0.7231
(P value)	**Subsoiled vs Non-Subsoiled**	0.2022	0.7030	0.9125	0.0559	0.0748	0.0632

Subsoiling tended to increase air permeability, hydraulic conductivity ($p<0.10$).

North Central Butte Solonetzic Site Soil Strength (Cone Index) 2016 Subsoiling:



South Central Butte **Chernozemic** Site 1 2016-2017 **Subsoiling:**

Physical Measurements SCB 2016 - 2017.

Treatment		Measurements					
		0-10 cm		0-10 cm		0-10 cm	
		Aggregate Size MWD (mm)		**Air Permeability ($m\ s^{-1}$)**		**Hydraulic Conductivity ($cm\ min^{-1}$)**	
		2016	**2017**	**2016**	**2017**	**2016**	**2017**
Subsoiled	**Compacted**	14.42	11.99	2.87E-06	1.12E-07	4.95E-02	1.20E-01
	Non-Compacted	15.52	12.53	4.15E-06	1.02E-07	7.86E-02	1.42E-01
(P value)		0.0159	0.8013	0.5685	0.8169	0.6127	0.7596
Non-Subsoiled	**Compacted**	15.14	12.62	4.50E-07	2.05E-07	1.58E-02	1.78E-01
	Non-Compacted	14.29	14.42	1.38E-06	1.83E-07	4.77E-02	1.30E-01
(P value)		0.6037	0.1484	0.0650	0.6347	0.1748	0.2342
(P value)	**Subsoiled vs Non-Subsoiled**	0.7413	0.5766	0.0315	0.0745	0.2055	0.5142
	Compaction	0.6558	0.2678	0.0007	0.2688	0.2803	0.6157

Air permeability increased in 1st year by subsoiling of wheel traffic compacted areas

Vertical Tillage **Chernozemic** Site 2 2016-2017:

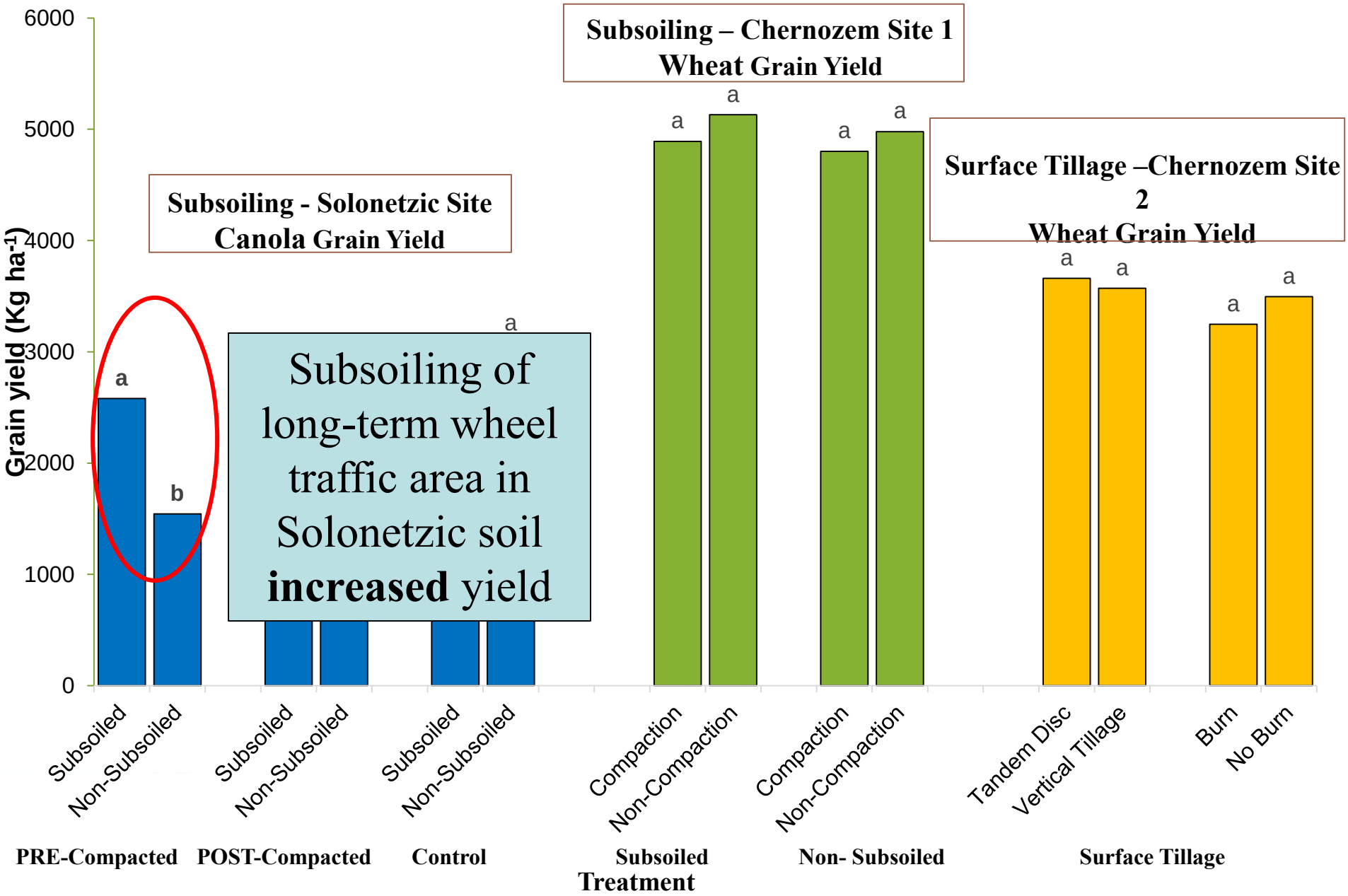
Physical Measurements VT 2016 - 2017.

Treatment		Measurements					
		0-10 cm		0-10 cm		0-10 cm	
		Aggregate Size MWD (mm)		**Air Permeability ($m\ s^{-1}$)**		**Hydraulic Conductivity ($cm\ min^{-1}$)**	
		2016	**2017**	**2016**	**2017**	**2016**	**2017**
Till	**Tandem Disc**	12.67	12.58	1.95E-06	2.24E-07	1.09E-01	6.03E-02
	Vertical	11.61	13.29	6.09E-07	1.31E-07	6.02E-02	8.60E-02
(P value)		0.2439	0.7034	0.0837	0.1406	0.2140	0.1190
No-Till	**Burn**	12.43	13.26	2.61E-06	3.49E-07	5.37E-02	6.88E-02
	No Burn	12.58	12.30	3.99E-06	1.21E-07	6.91E-02	7.52E-02
(P value)		0.9216	0.6167	0.3446	0.2410	0.6967	0.7523
(P value)	**Till vs No Till**	0.6672	0.9007	0.0249	0.5817	0.3853	0.9304

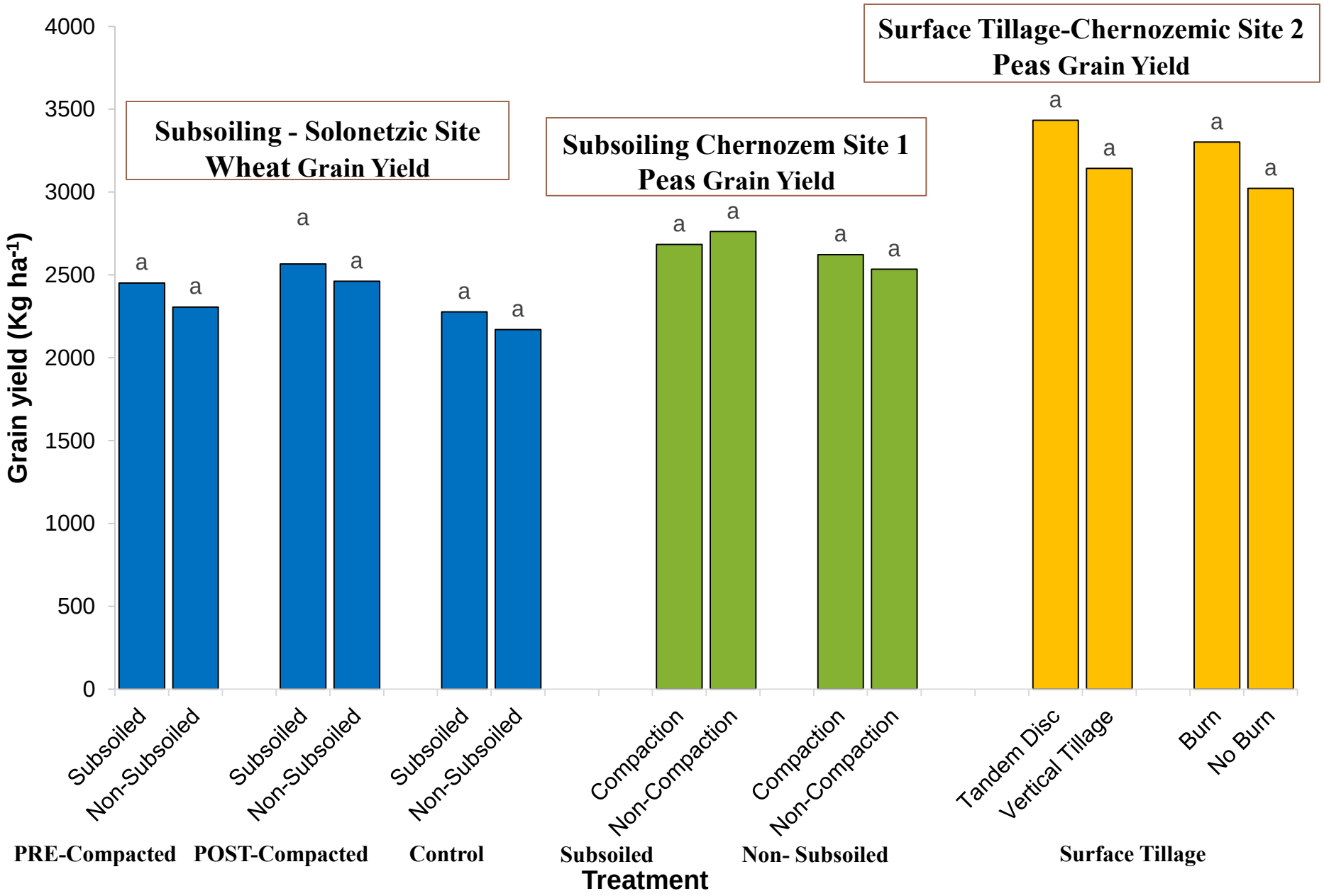
Vertical tillage decreased air permeability in first year vs untilled and tandem disc:
Action of baskets increases proportion of fine pores


But what about
the yield?????

Crop Yield 2016



Crop Yield 2017



Summary & Conclusions

- **Subsoiling** results in increased air permeability, hydraulic conductivity, no effect on aggregate size.
- **Subsoiling** reduces soil strength.
- **Subsoiling** of compacted Solonetz increased canola yield in 2016, but no benefit to wheat yield on Chernozem.
- **Vertical tillage** decreased air permeability in first year.
- No effect of **vertical or tandem disc or burning** in fall of 2015 on the 2016 wheat yield or 2017 pea yield.

Most beneficial tillage strategy: subsoiling of long-term wheel traffic compacted sodium-affected (solonetzic) soils.

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