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

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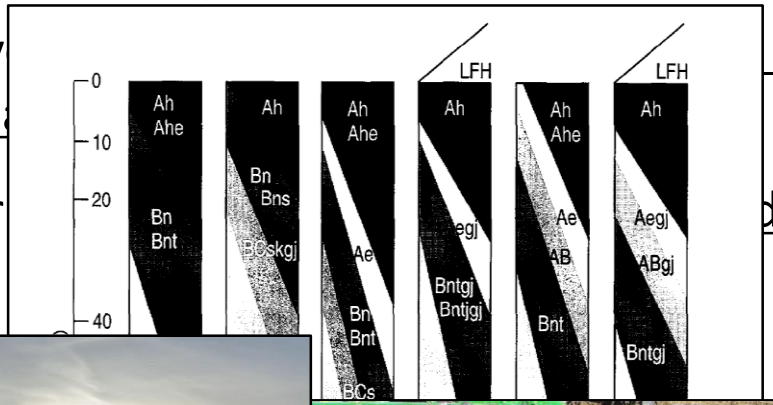
INTRODUCTION

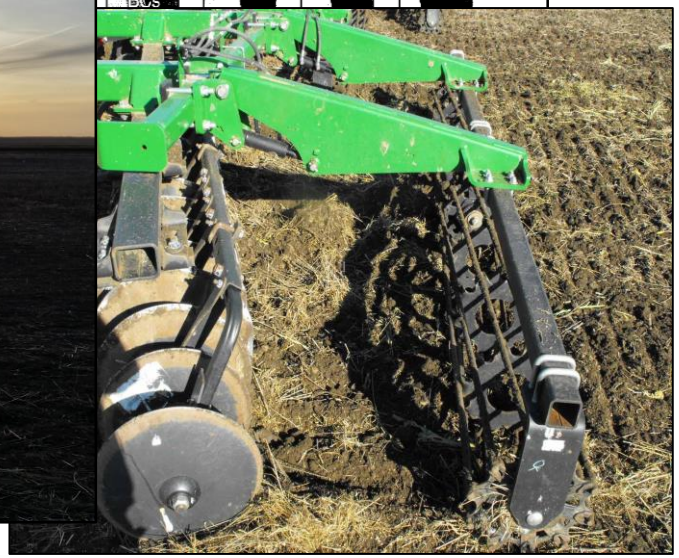
- Saskatchewan, has ~ 44% of Canada's total cultivated farmland (Statistics Canada, 2012).
- Considering soil physical attributes (structure, permeability) is important: affects root growth, exploration volume, nutrient and water acquisition.
- Wheel traffic compaction and natural dense horizons can negatively affect the root zone (Soane et al., 1994).

Tillage is one management strategy to alter structure, water and air permeability

INTRODUCTION

- High concentrations of Na lead to clay dispersion, formation of dense Solonetzic B horizons that affect productivity and workability.
- **Subsoiling** at depth (15-30cm) may improve conditions in compacted, dense subsoils.
- **S** basket (v and
  r nditions
- **R** used for dues
  li





- 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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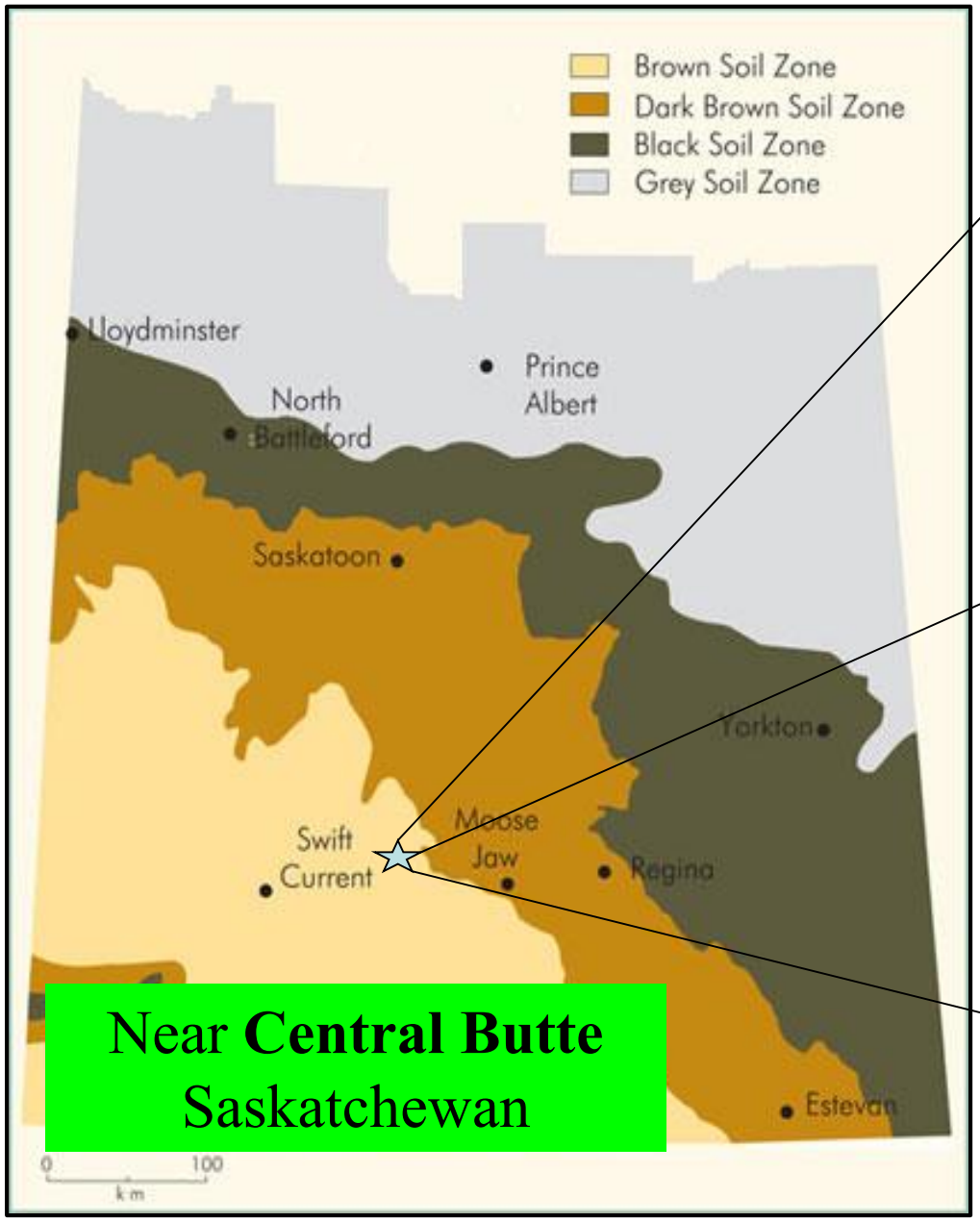
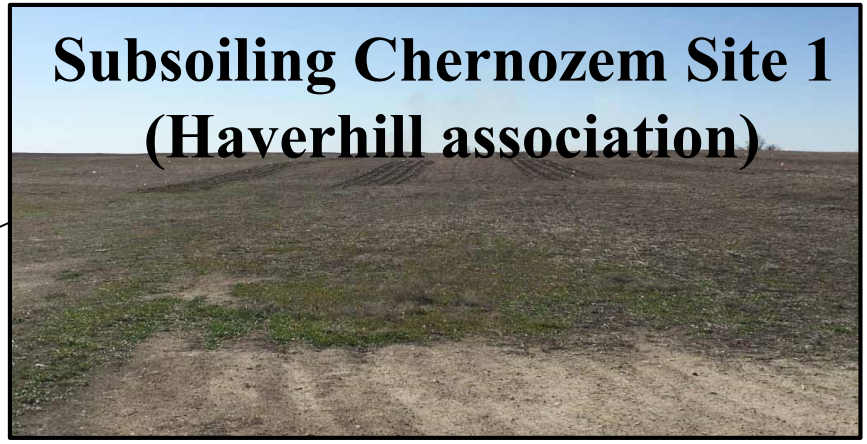
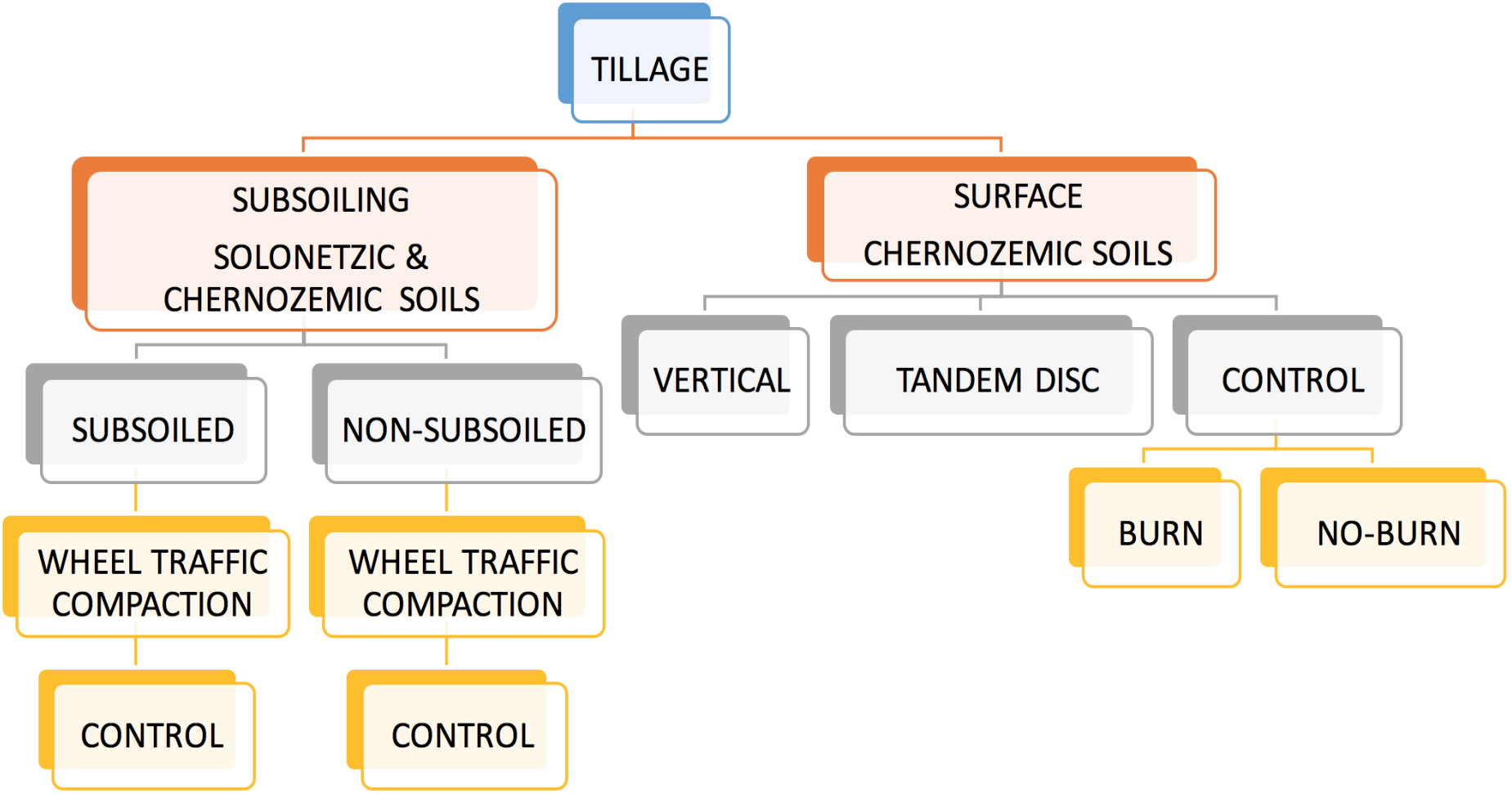
STUDY LOCATION



Near **Central Butte** Saskatchewan



STUDY DESIGN



Subsoiling Tillage Operation

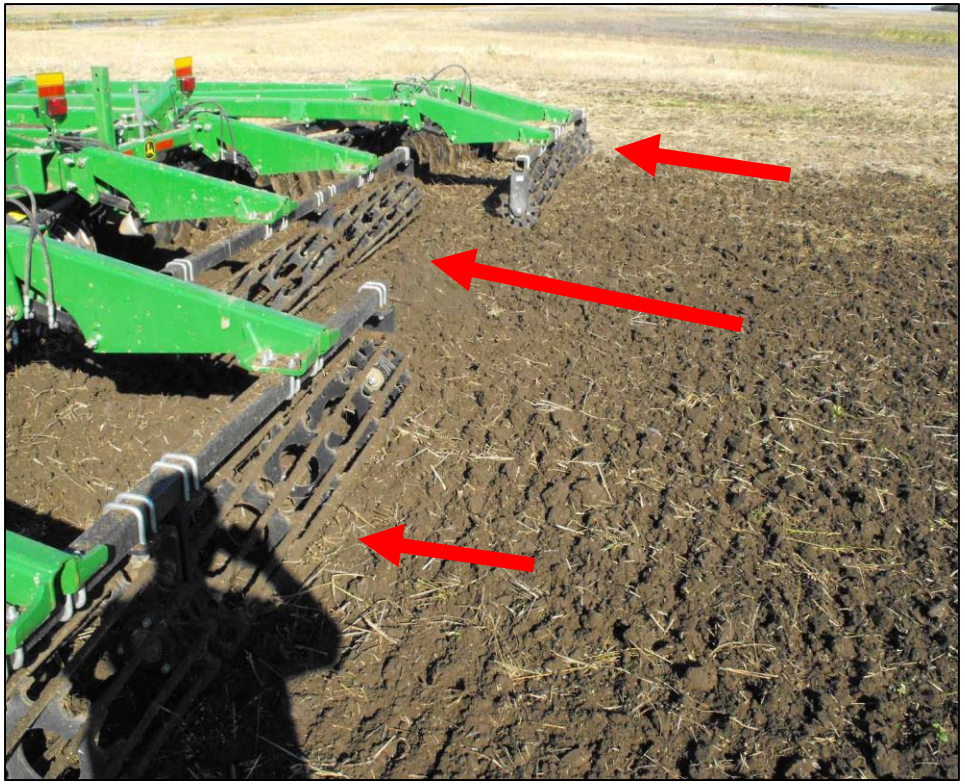
- A John Deere 2100 Minimum-Till subsoiler with five shanks spaced 76.0 cm apart and set to penetrate 30.0 cm into the soil in Fall 2015.

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)

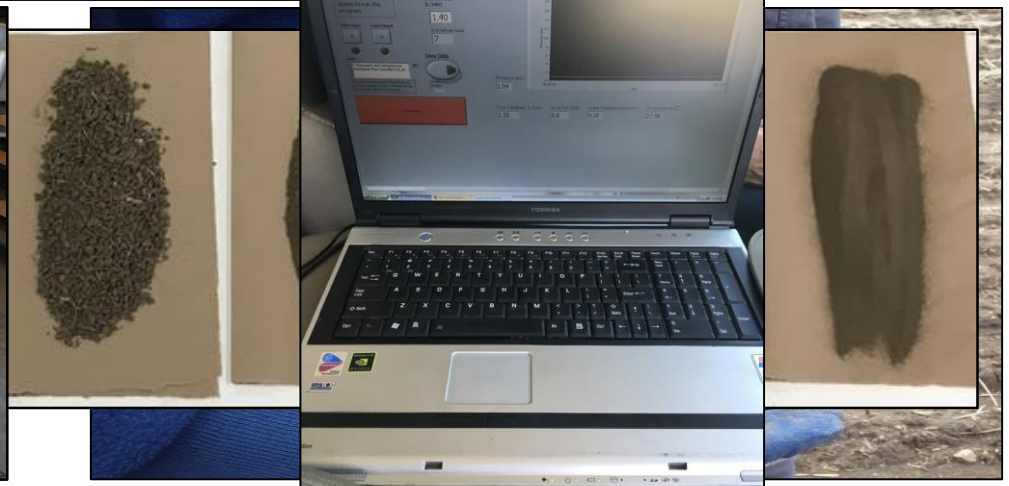
Measurements

UNIVERSITY OF SASKATCHEWAN

Field Saturated Hydraulic Conductivity

Air Permeability

Aggregate Size



Measurements

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Soil Strength


Results

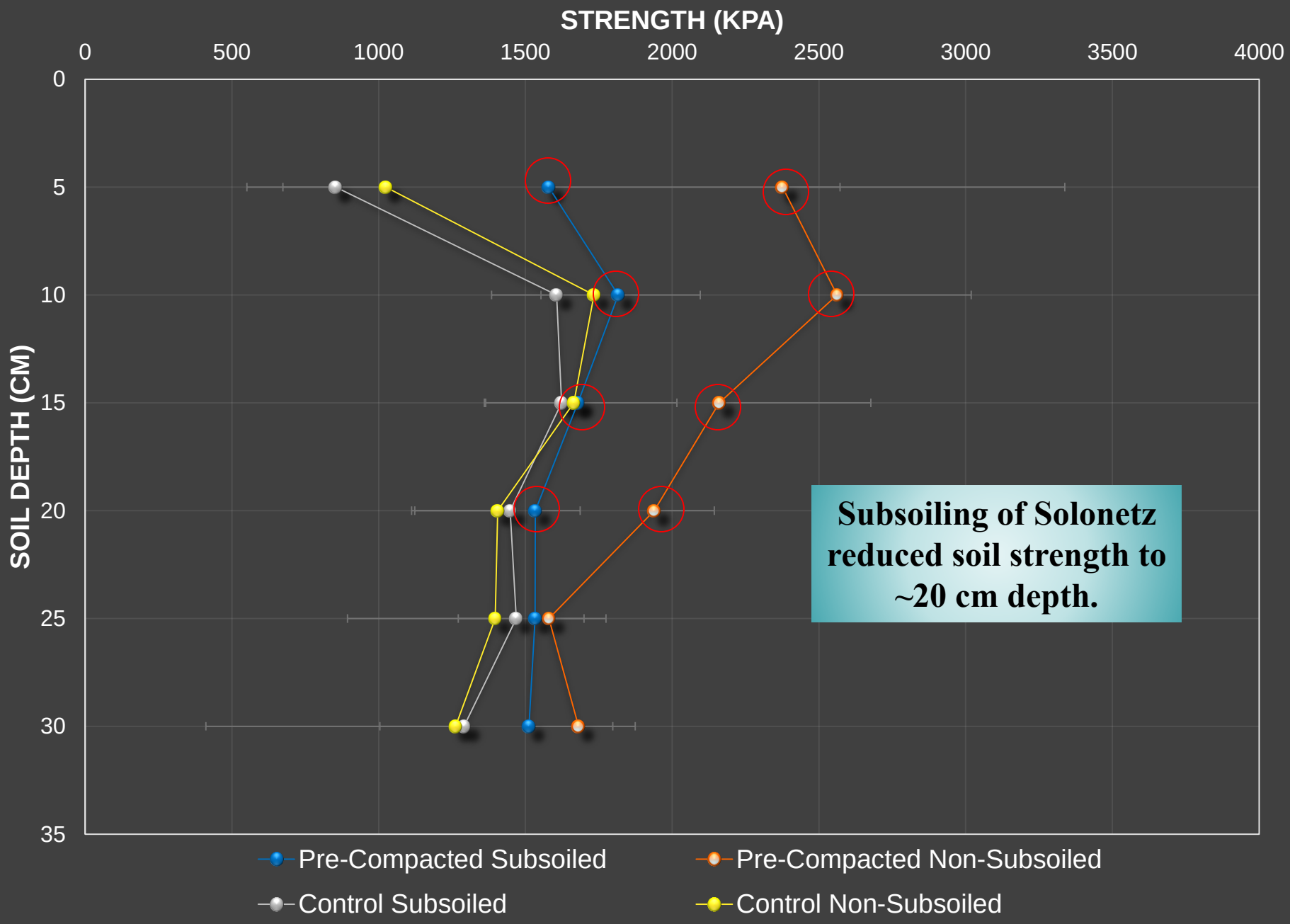
North Central Butte **Solonetzic** Site 2016-2017 **Subsoiling:**

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

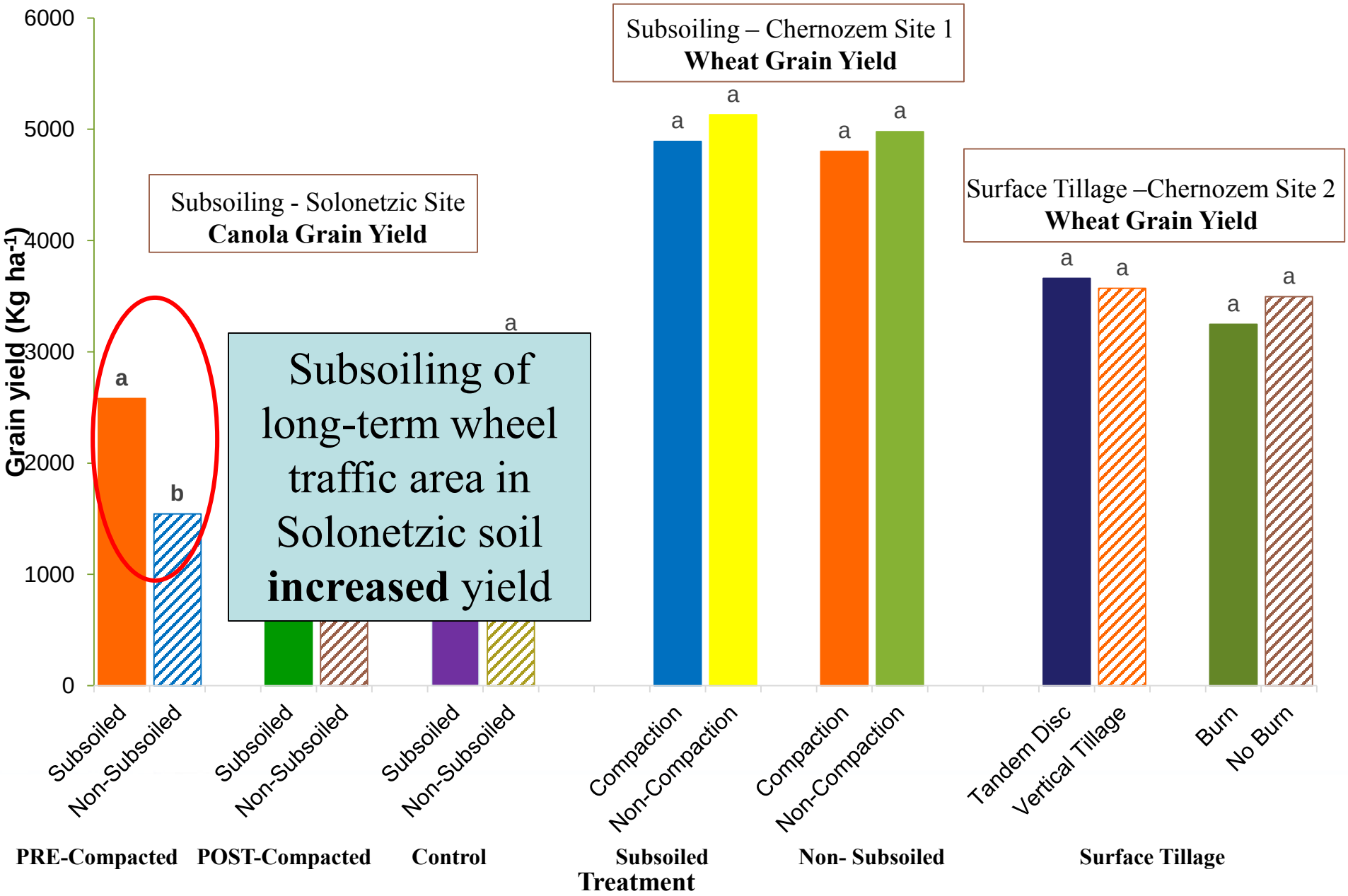
Vertical Tillage **Chernozemic** Site 2 2016-2017:

Physical Measurements VT 2016 - 2017.

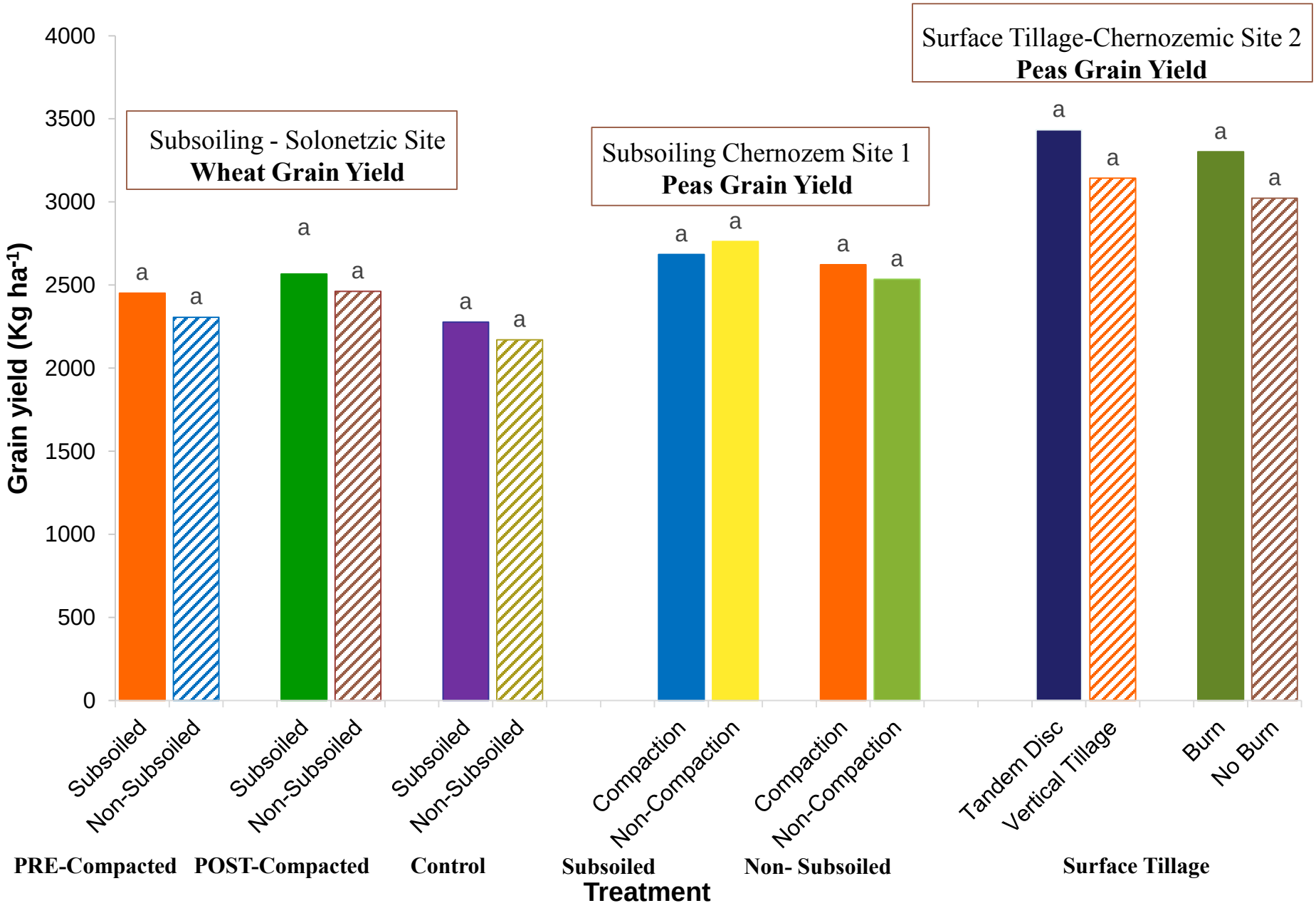
Treatment		Measurements					
		0-10 cm		0-10 cm		0-10 cm	
		Aggregate Size MWD (mm)		Air Permeability ($m\ s^{-1}$)		Hydraulic Conductivity ($cm\ min^{-1}$)	
		2016	2017	2016	2017	2016	2017
Till	Tandem Disc	12.67	12.58	1.95E-06	2.24E-07	1.09E-01	6.03E-02
	Vertical	11.61	13.29	6.09E-07	1.31E-07	6.02E-02	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

Crop Yield 2016



Crop Yield 2017



Conclusions

- Subsoiling results in increased air permeability, hydraulic conductivity, no effect on aggregate size.
- Subsoiling reduces penetration resistance.
- 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

Acknowledgements

- ***Assistance lab and field:***

  - C. Fatteicher, B. Ewen, R. Kar, J. Wiens, B. Swerhone, S. Froese, N. Rahman, J. Xie, S. Klippenstein, P. Hrycyk, R. Hangs, K. Gudkova, J. Toews.

- **Funding:**
  - Saskatchewan Agriculture Development Fund
  - Saskatchewan Wheat Development Commission
  - Western Grains Research Foundation
  - Sask Pulse Growers

- **Equipment courtesy of:**


Thank you