Dryland Soil Chemical Properties and Crop Yields Affected by Long-term Tillage and Cropping Sequence

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Introduction

- Long-term sustainability of dryland farming systems depends on soil quality and fertility.
- In the northern Great Plains, spring wheat-fallow has been used as the traditional practice in the last century. Fallowing, however, can reduce soil quality and fertility by increasing organic matter mineralization and erosion and decreasing crop yields by the absence of crops during the fallow period.
- Little is known about the long-term (30 yr) impact of tillage and cropping sequence combination on soil nutrients and chemical properties under dryland cropping systems in the northern Great Plains.

Objectives

- Evaluate the 30-yr influence of tillage and cropping sequence combination on dryland annualized crop yield and soil Olsen-P, K, Ca, Mg, Na, SO_4-S, and Zn concentrations and pH, buffer pH, cation exchange capacity (CEC), and electrical conductivity (EC) at the 0-120 cm depth under dryland cropping systems in eastern Montana and
- Identify a management practice that can enhance long-term sustainability of soil fertility and crop yields in the northern Great Plains.

Sites / Treatments

Wheat

Barley

Pea

Fallow

No till Conventional till

Soil sampling

Location: Sidney, MT

Duration: 1984-2013

Treatments

NTCW = No-till continuous spring wheat

STCW = Spring till continuous spring wheat

FSTCW = Fall and spring till continuous spring wheat

FSTW-B/P = Fall and spring till spring wheat-barley (1984-1999), followed by spring wheat-pea (2000-2013)

STW-F = Spring till spring wheat-fallow (traditional system)

Design: Randomized complete block

Replication: 4

Conclusions / Recommendations

- No-tillage with legume-nonlegume crop rotation may be used as a viable management practice to sustain the long-term dryland soil fertility and crop yields with reduced chemical and energy inputs.
- Because of increased residual soil P and K concentrations, P and K fertilization rates can either be reduced or suspended for several years until their concentrations falls near the critical levels.

Results / Discussion

- Annualized crop yield was lower in STW-F than the other treatments (***Fig. 1***).
- At 0-7.5 cm, soil P, K, Zn, Na, and CEC were greater, but pH, buffer pH, and Ca were lower in NTCW, STCW, and FSTW-B/P than STW-F (***Figs. 2-5***).
- At 7.5-15 cm, K was greater, but pH, buffer pH, and Mg were lower in NTCW, STCW, FSTCW, FSTW-B/P than STW-F (***Figs. 2-5***).
- At 60-120 cm, soil chemical properties varied with treatments (***Figs. 2-5***).
- Soil P, K, and Zn decreased, but Ca, Mg, Na, SO_4-S, CEC, pH, buffer pH, and EC increased with depth.
- Tillage had no effect on soil properties and crop yield, but continuous spring wheat increased P, K, Zn, and CEC and decreased pH, buffer pH, Ca and Mg at the surface soil.
- Absence of crops during fallow reduced annualized crop yield with STW-F compared with other treatments.
- Presence of increased calcite and dolomite probably increased Ca, Mg, Na, SO_4-S, CEC, pH, buffer pH, and EC with depth in all treatments.
- Continuous N fertilization probably reduced soil pH, Ca, and Mg, but greater crop residue returned to the soil increased P, K, Na, Zn, and CEC in NTCW and STCW compared with STW-F at the surface soil.

ALL FIGURES. *Tillage and cropping sequence combinations are:*

NTCW: *no-till continuous spring wheat*

STCW: *spring till continuous spring wheat*

FSTCW: *fall and spring till continuous spring wheat*

FSTW-B/P: *fall and spring till spring wheat-barley (1984-1999) followed by spring wheat-pea (2000-2013)*

STW-F: *and spring till spring wheat-fallow*

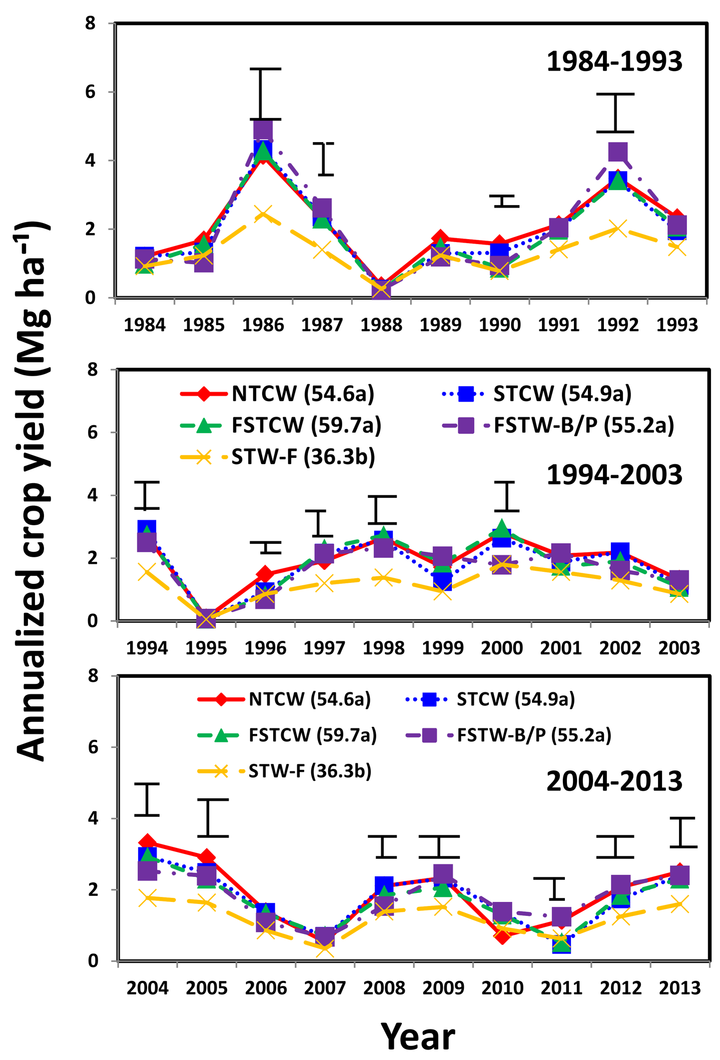

Fig. 1. *Annualized crop yield from 1984 to 2013 as affected by tillage and cropping sequence combination. Values inside the parenthesis in the legend are mean annualized crop yield across years.*

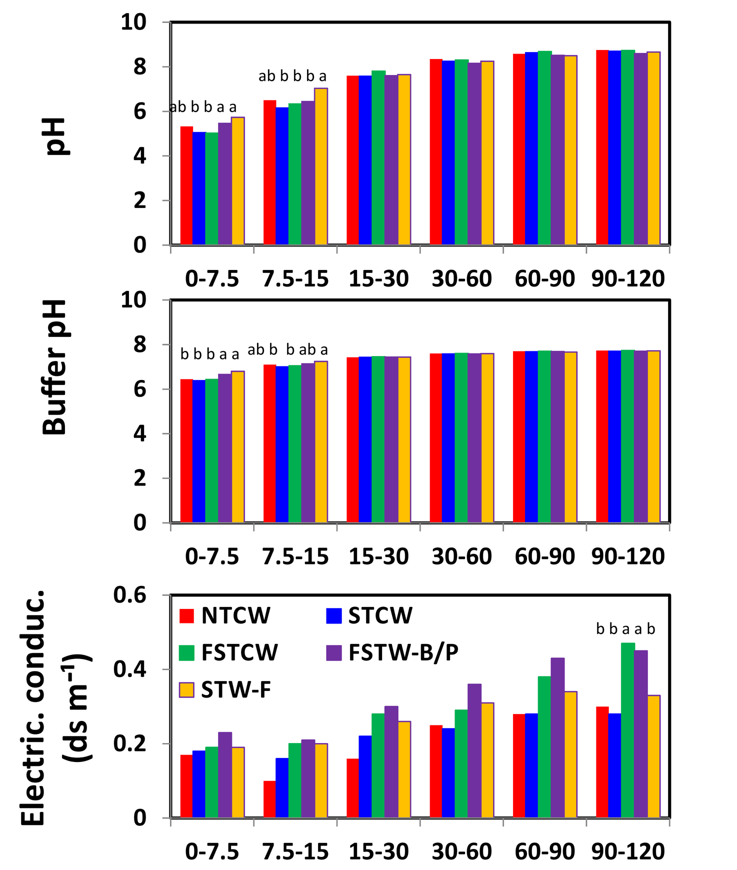

Fig. 2. *Soil pH, buffer pH, and electrical conductivity as affected by tillage and cropping sequence combination.*

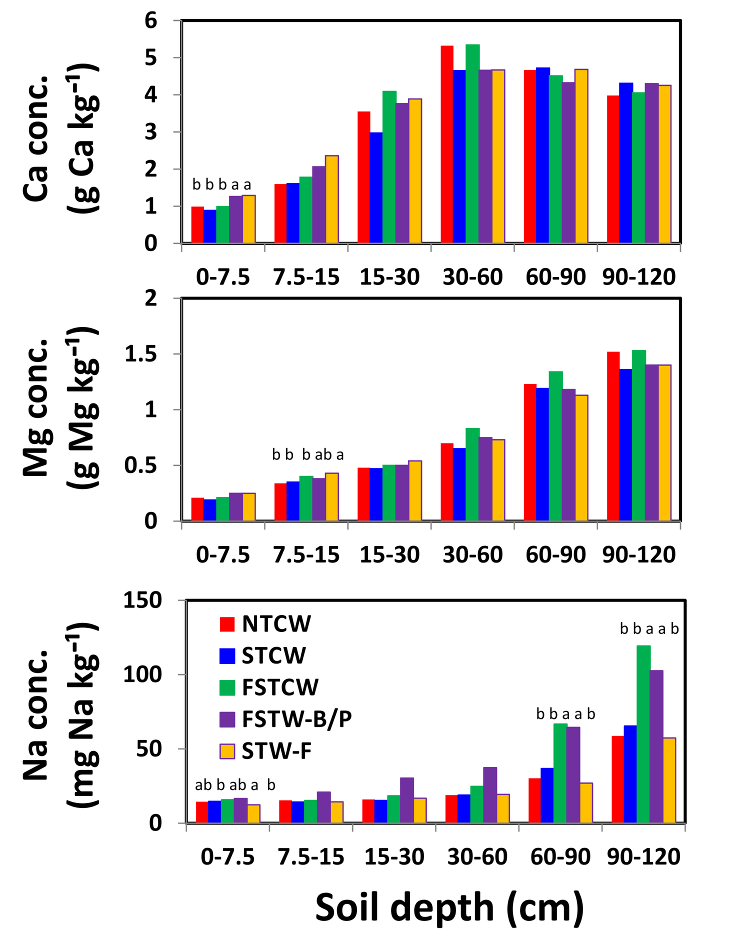

Fig. 4. *Soil Ca, Mg, and Na concentrations as affected by tillage and cropping sequence combination.*

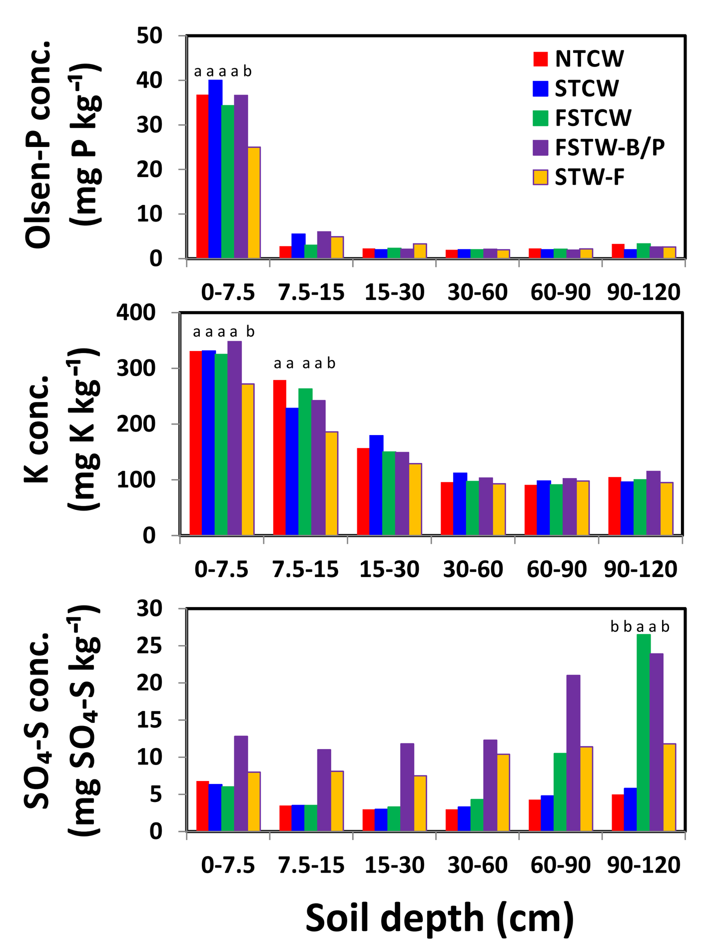

Fig. 3. *Soil Olsen-P, exchangeable K, and SO_4-S concentrations as affected by tillage and cropping sequence combination.*

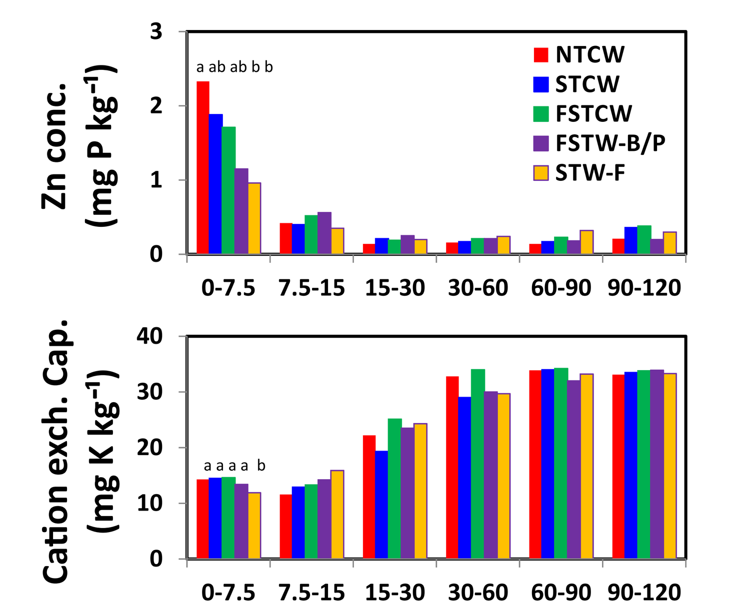

Fig. 5. *Soil Zn concentration and cation exchange capacity as affected by tillage and cropping sequence combination.*