Occasional and strategic tillage effects on weeds, crop yield and soil health in dryland cropping systems

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Introduction

- NT adoption benefits includes
  - reduce soil erosion
  - improve soil structure
  - Improve SOM
  - increase soil water storage
- Some challenges in long term NT
  - stratification of pH
  - effective control of perennial grass weeds (windmill grass)
  - herbicide resistance weeds
  - Some producers reverting to intensive tillage to manage weeds

Herbicide resistant weeds

Research objectives

- Determine
  I. Effectiveness of strategic or occasional tillage to control perennial grass and herbicide resistant weeds
  II. Tillage effects on crop yields and soil properties

Definitions

- **Strategic tillage** is defined as a one-time tillage operation in an otherwise NT cropping system to correct a resource concern (e.g. HR weeds) after which the field is returned to NT
- **Occasional tillage** is defined as one or two tillage operations every three or more years to manage challenges of NT.
- Occasional tillage is on a fixed schedule as part of the production system, while strategic tillage is a one-time corrective measure with tillage.

Methods-Strategic tillage

- Used Long-term plots established in 1976

  Main plots

  crop rotation (WF, WSF, WW, SS and SF)

- Subplots –Tillage treatments

  Reduced tillage

  continuous NT,

- Modified in July 2016 with one-time strategic tillage of NT to control grass weeds (three-awn and tumble windmills grass by splitting the NT plots into two equal plots

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Methods-strategic tillage

- Tillage for ST plots in 2016
  - Pass #1: Premier Tillage Minimizer at 7.5 cm depth
  - Pass #2: Quinstar Fallow Master sweep plow at 15 cm depth
- Tillage for RT plots
  - 2 to 3 tillage operations with V blade implement and Fallow Master sweep plow
- Tillage occurred in July before winter wheat planting or May ahead of sorghum planting in June

Strategic tillage vs NT plot

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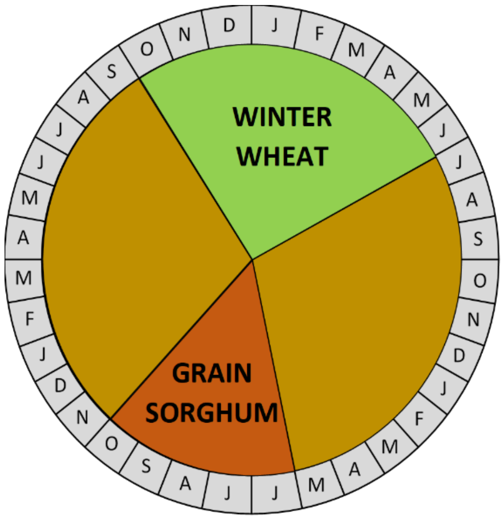
Methods-Occasional tillage

- Wheat-sorghum-fallow (W-S-F) rotation in Hays, Garden City and Tribune
- Split plot treatment structure
  – Main plot: crop phase in W-S-F rotation
    - Every phase present every year
  – Sub plot: 5 tillage treatments
  – 4 replications at Garden City & Tribune
  – 3 replications at Hays



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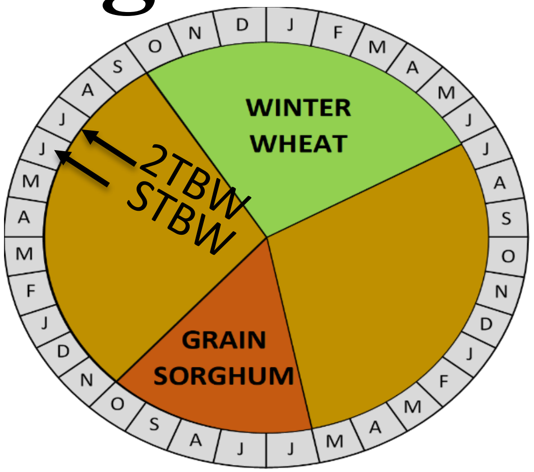
Methods-Occasional tillage



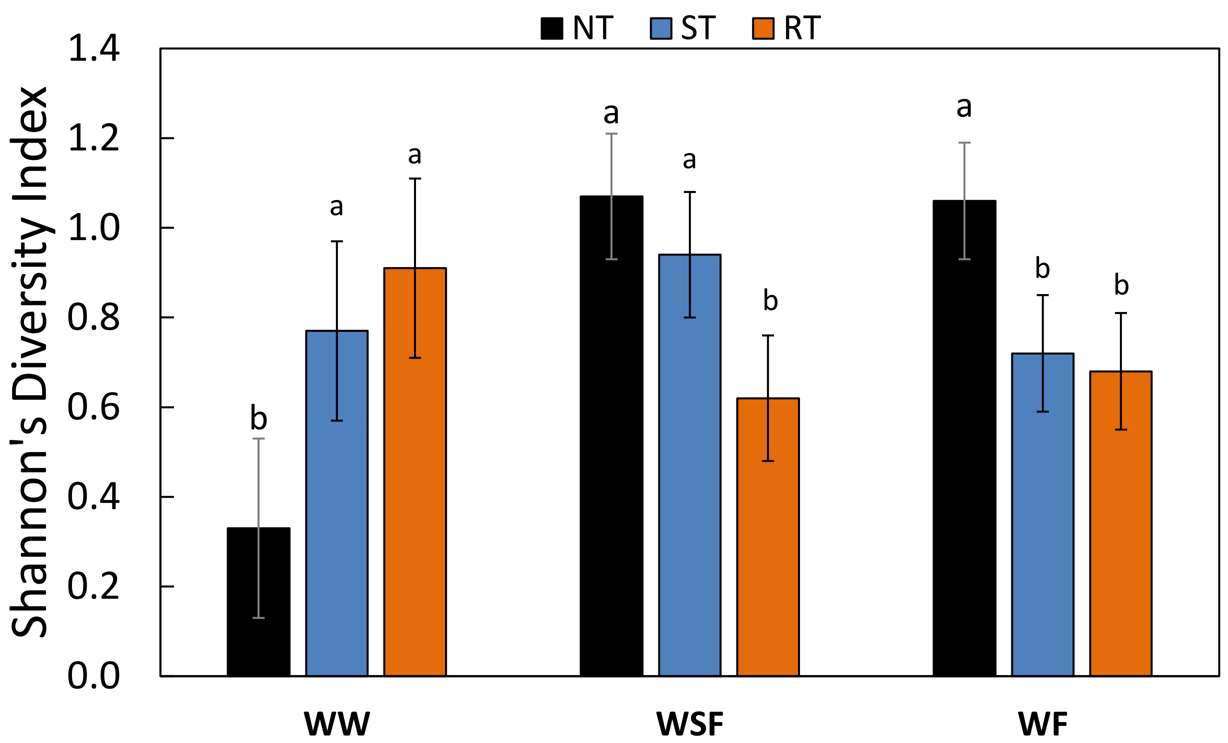
- 5 treatments since 2016
  - o No-tillage (NT)
  - o Single tillage before wheat (STBW)
  - o Two tillage passes before wheat (2TBW)
  - o Single tillage after wheat harvest (STAW)
  - o Single tillage after wheat plus another tillage during fallow (2TAW)
- Tillage operations completed with a sweep plow every year
  - STBW: pass in June
  - 2TBW: pass in June & pass in July

Data collected

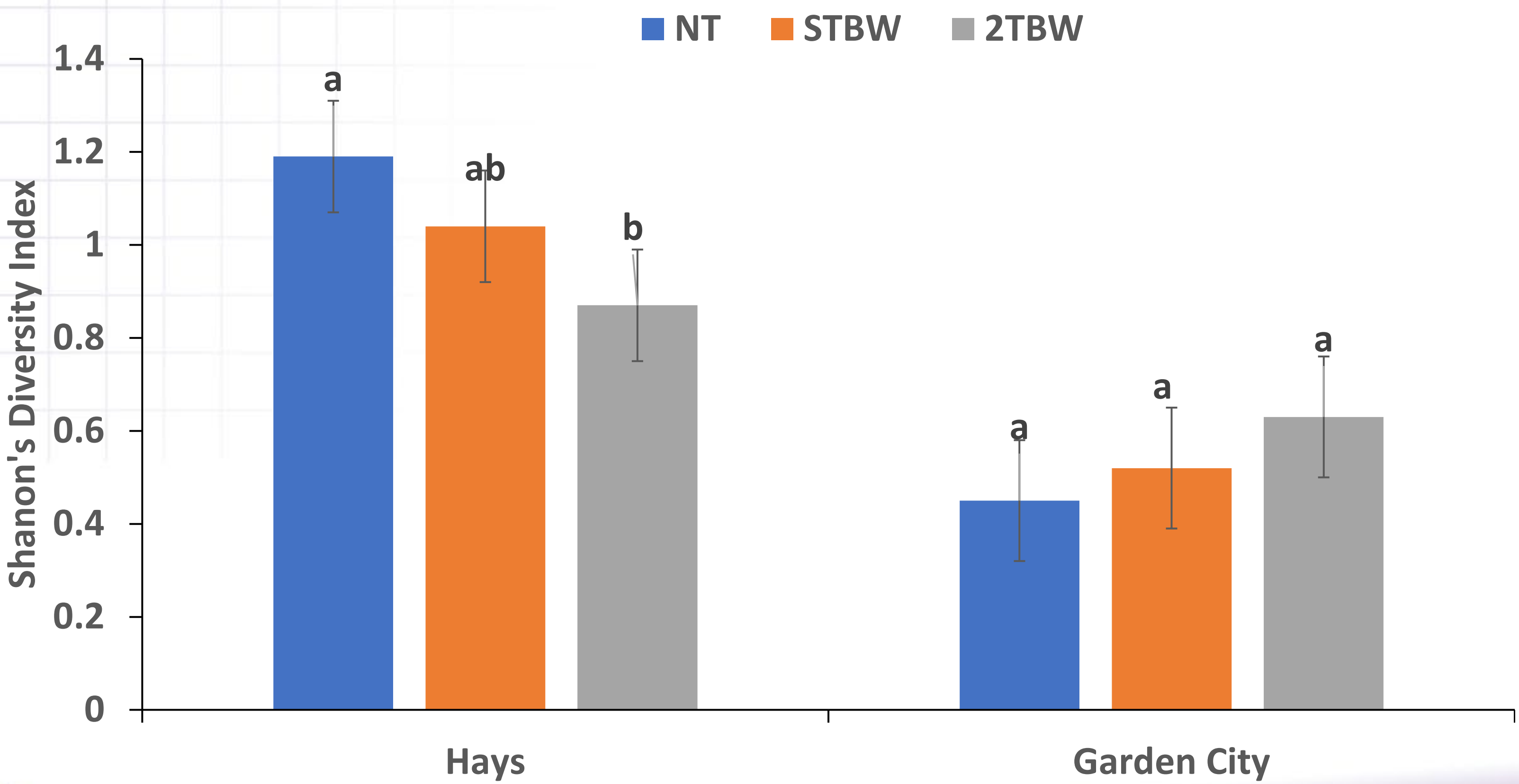
- 0-5cm depth
  - Aggregate stability
    - Mean Weight Diameter-wet (MWD)
    - Wind Erodible Fraction (WEF)
- Wheat and sorghum yield crop yields from 2017 to 2023

- Soil sampling at 0-5, 5 to 15, & 15 to 30 cm depth
  - Soil Organic Carbon
  - pH
  - Nutrients: N, P, K, Ca, MG, Fe, Mn, Zn
  - Bulk Density
- Weed counts
  - June 2022 and 2023

Weed diversity in 2023-Strategic tillage study



Weed Diversity measured in 2022 & 2023-Occasional tillage



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Occasional tillage study

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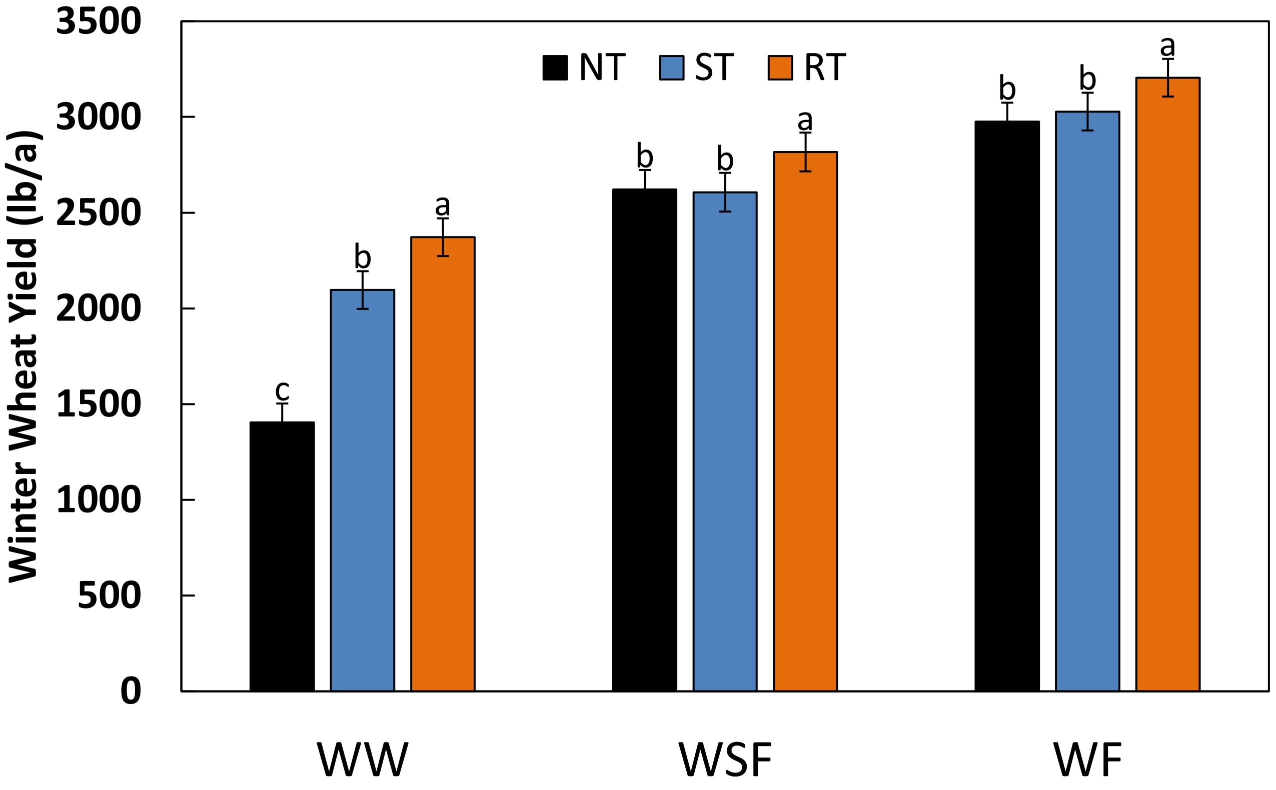
Tillage by crop rotation effects on wheat yields across years



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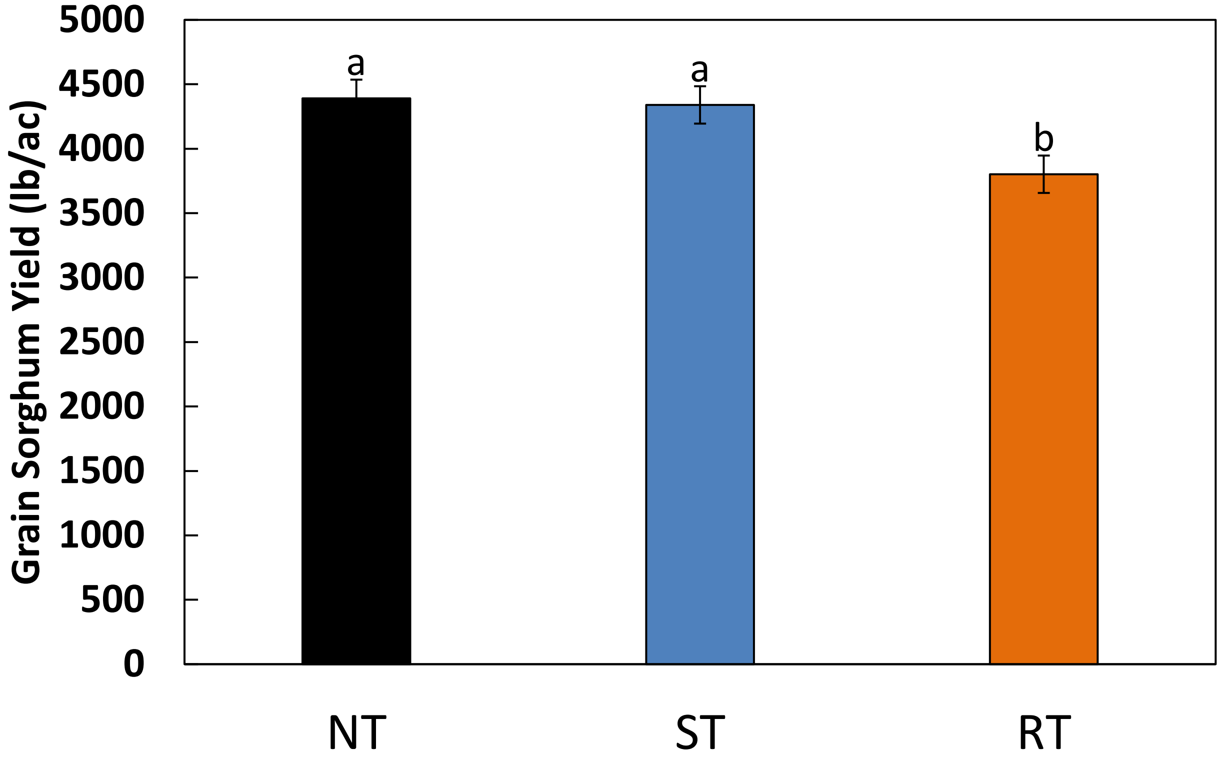
Strategic tillage vs NT continuous wheat

Continuous wheat ST

Continuous wheat NT

Strategic tillage effects on sorghum yield



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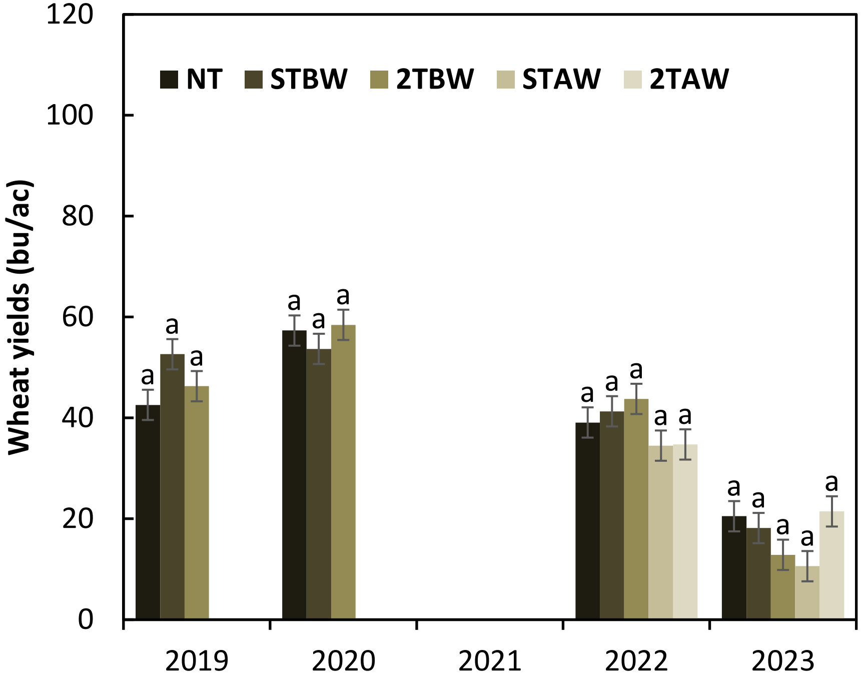
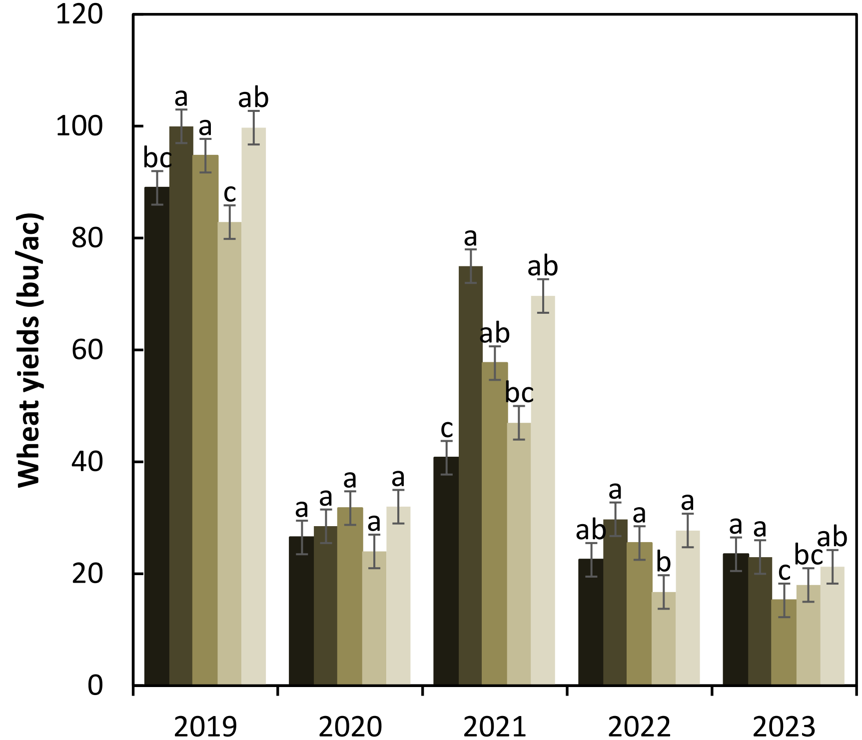
Occasional tillage effect on wheat yield

Hays



Garden City



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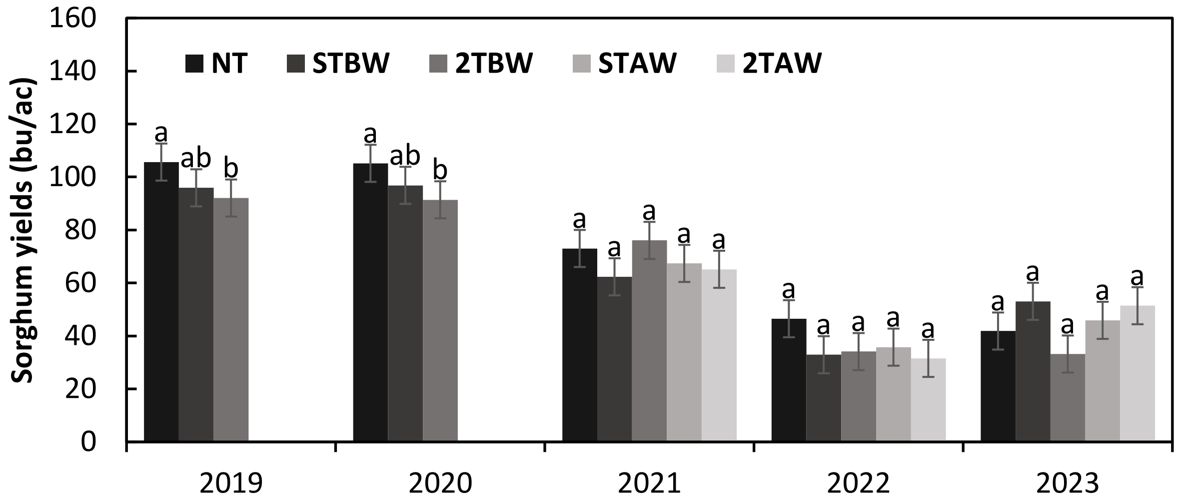
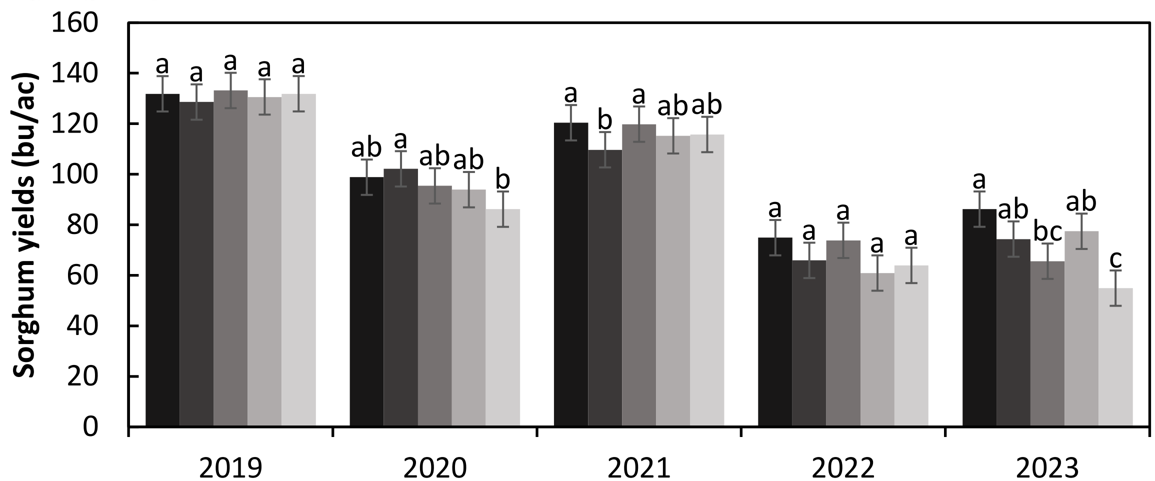
Grain sorghum yields





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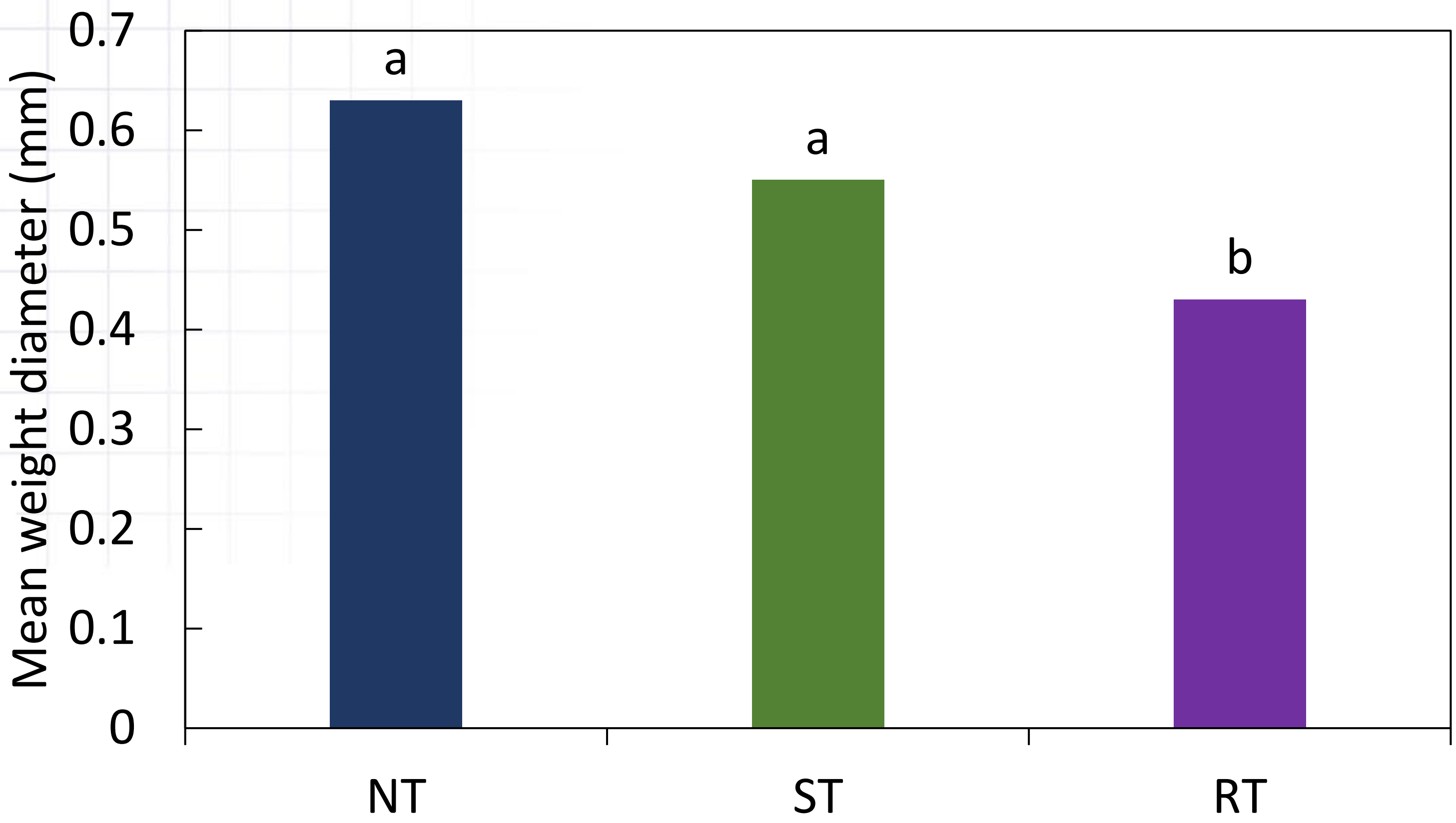
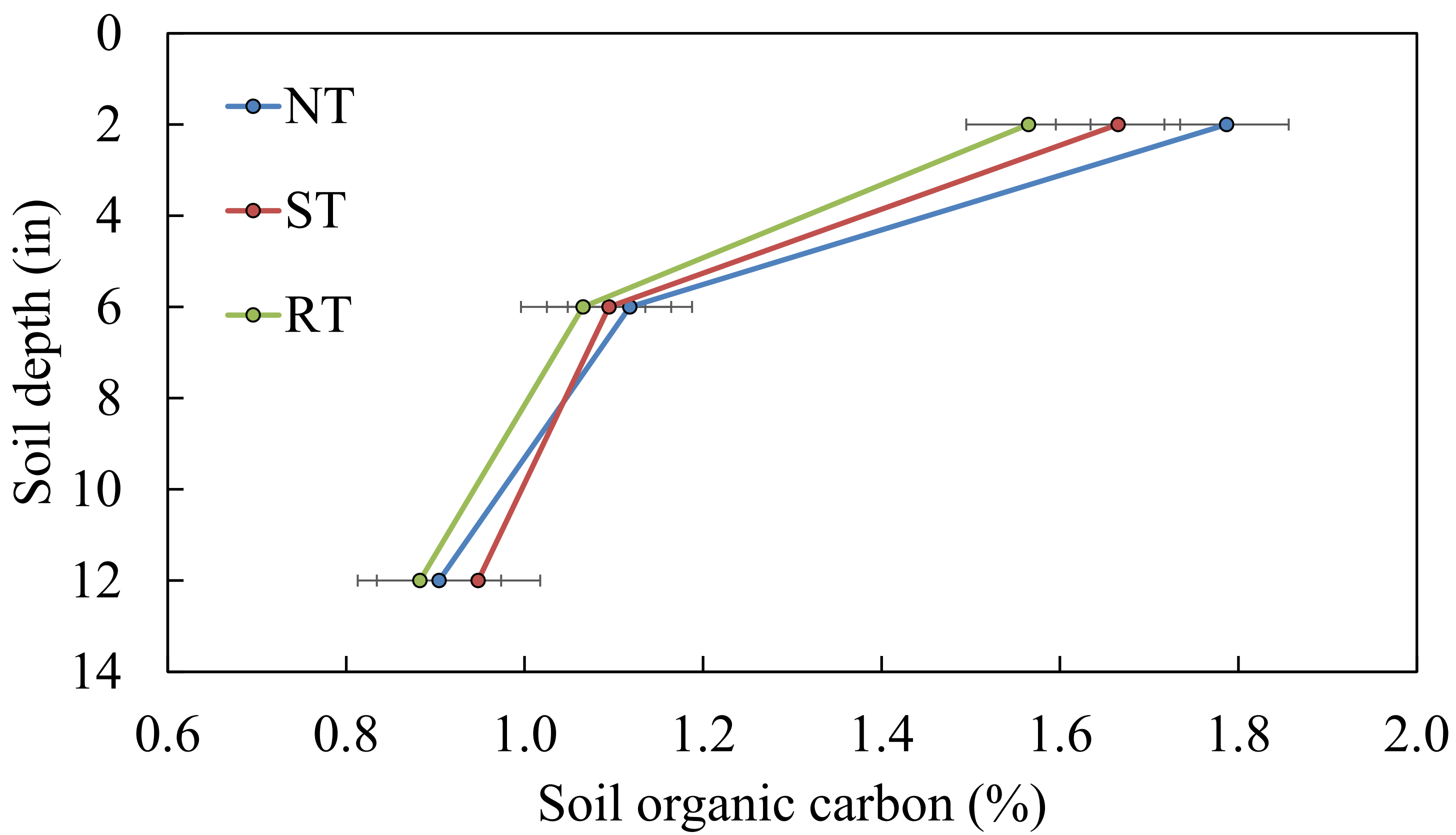
Tillage effect on aggregate stability measured in 2022



Strategic tillage effect on SOC measured in 2022



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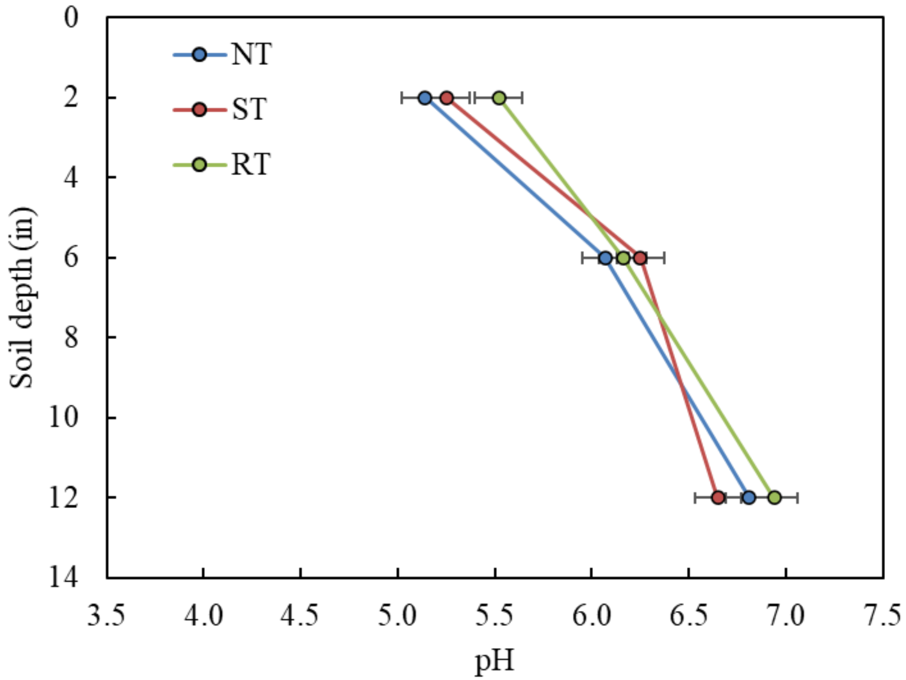
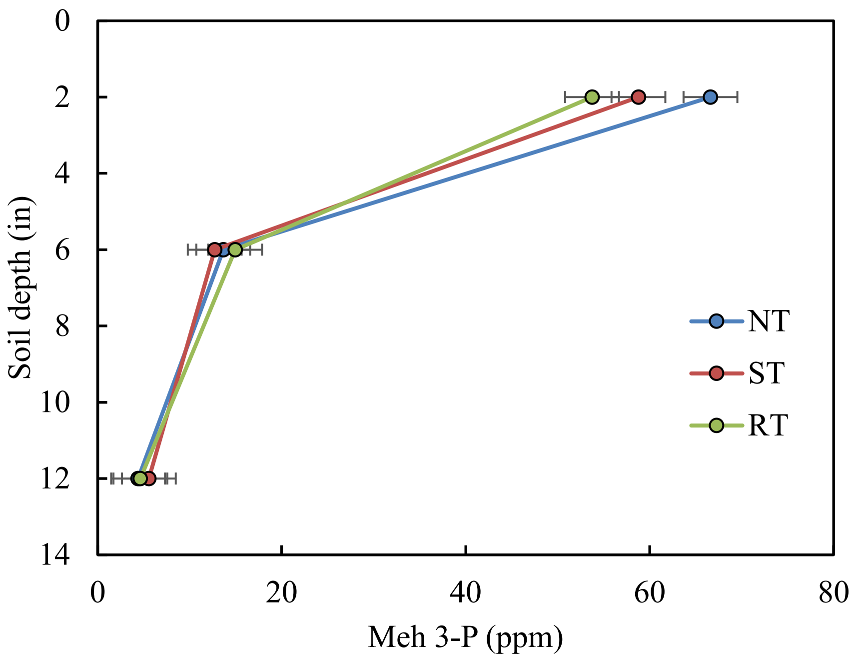
Tillage effects on pH and soil Phosphorus



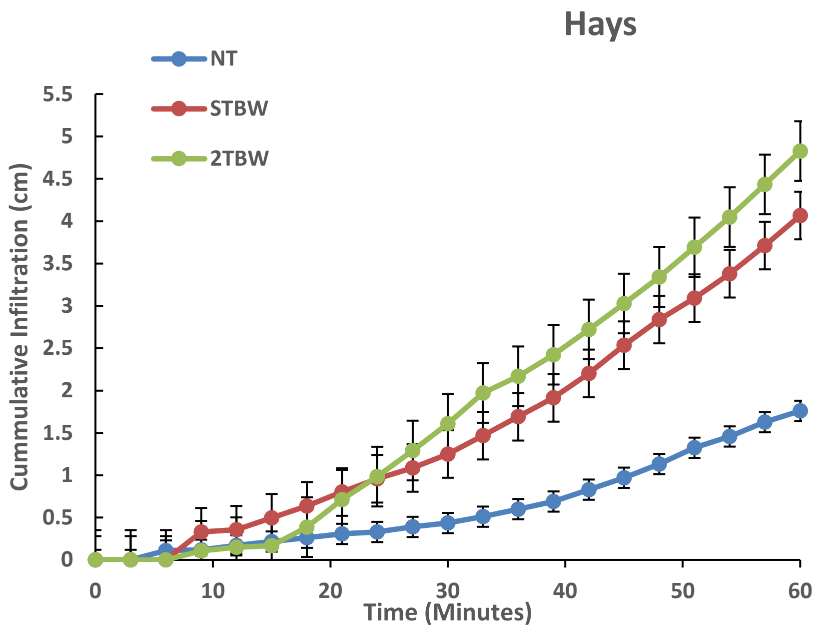


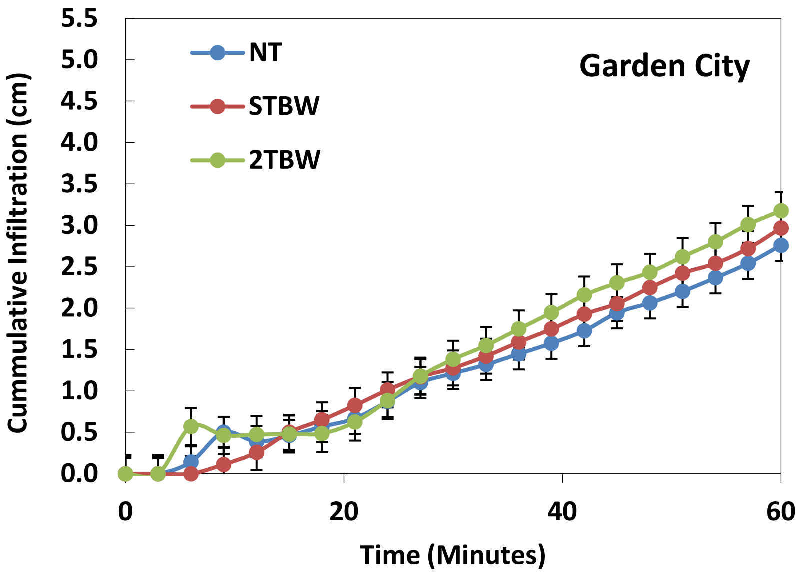
Tillage effects on soil properties across location within 0-15 cm depth

Treatments	SOC	BD	MWD	WEF	PR
	%	g cm^{-3}	mm	%	MPa
Tillage					
No-tillage	1.27	1.32a†	0.53a	27.6a	1.26a
STBW	1.22	1.30a	0.46a	25.5a	1.13b
2TBW	1.25	1.30a	0.47a	25.5a	1.11b

Means followed by the same lower-case letter within the same column are not significantly different (α = 0.05) among treatments

Water infiltration in 2023





Conclusions

- Strategic tillage (ST) of an otherwise long-term NT was effective at controlling weeds and had no negative effects on wheat or grain sorghum yields or soil properties
- Strategic tillage reduced stratification of pH, P and micronutrients concentrations
- Occasional tillage reduced weed density and had no effect on wheat yields
- Occasional tillage reduce penetration resistance and had no effect on SOC or aggregate stability.
- However, tillage reduced sorghum yields in some years of the study

Conclusions

- Occasional tillage could be an effective tool for farmers to manage difficult-to-control and HR weeds
- Tillage should be timed in hot summer days, implemented at shallow depth
- Frequency of strategic tillage will depend on crop rotation as well length of time issues resurges after returning to NT

Shallow tillage in the summer required to control windmill grass

Funding and Contact Info

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