Reducing winter P losses from dairy agroecosystems through tillage and manure application timing

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Research Motivations

- Logistical and environmental balance Srinivasan et al. (2006)
  - ~75% of annual runoff on frozen soils Good *et al.* (2012)
  - Nutrient losses from unincorporated manure on frozen soil
  - Cost-prohibitive long-term storage, emergency situations
- Updates to manure regulations
- Limited conclusive, mechanistic, or replicated field data
  - Confounding effects from weather, frozen soil complexity
  - Model routines needed for winter conditions

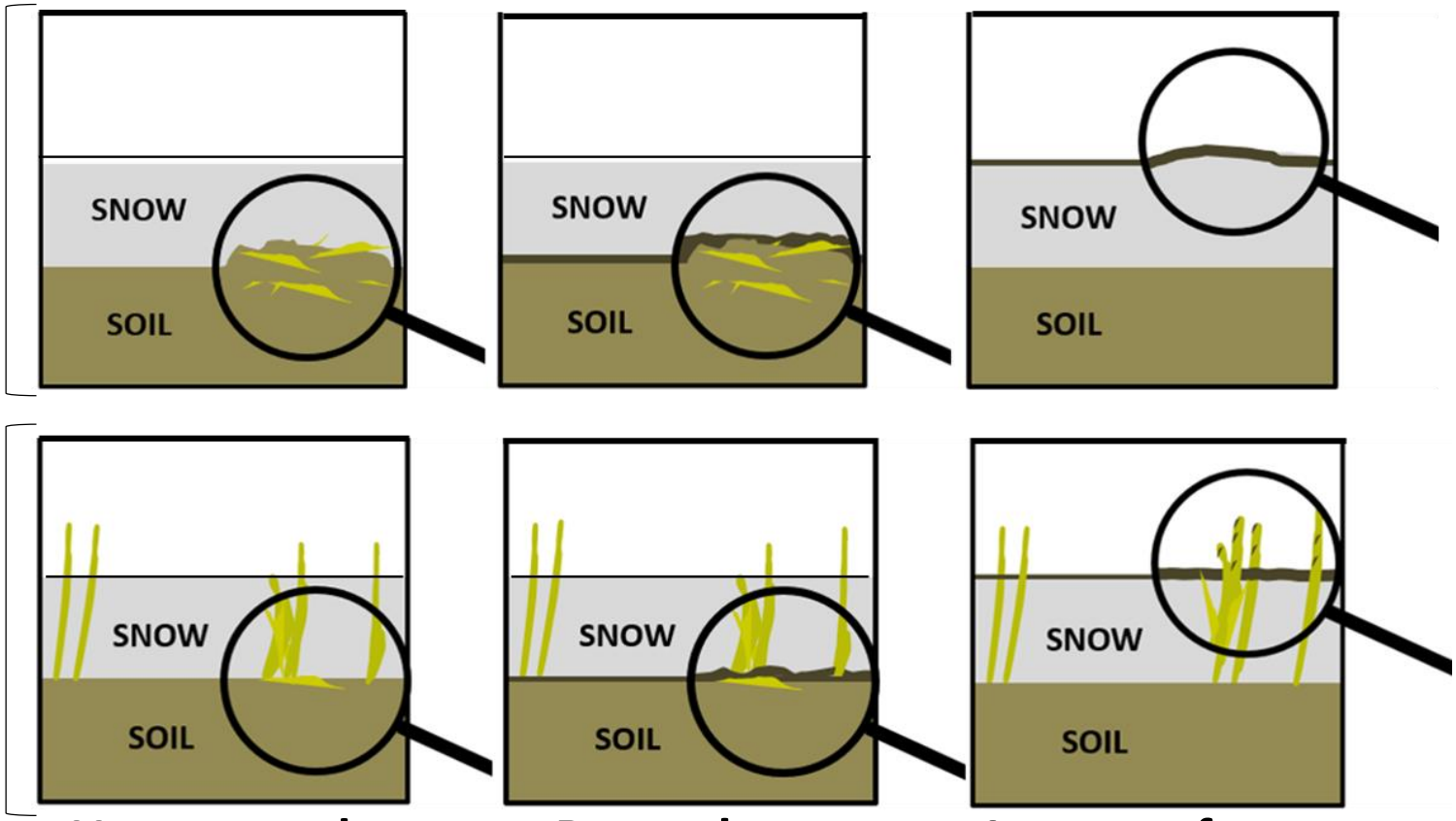
Objectives

- Identify management practices that reduce runoff on frozen soils
  - Conventional fall tillage vs. no-tillage
  - Manure application timing
- Quantify the biochemical and physical processes driving snowmelt, infiltration and runoff, and surface nutrient losses

6 Management Treatments

Conventional Tillage (Chisel)

No-Tillage

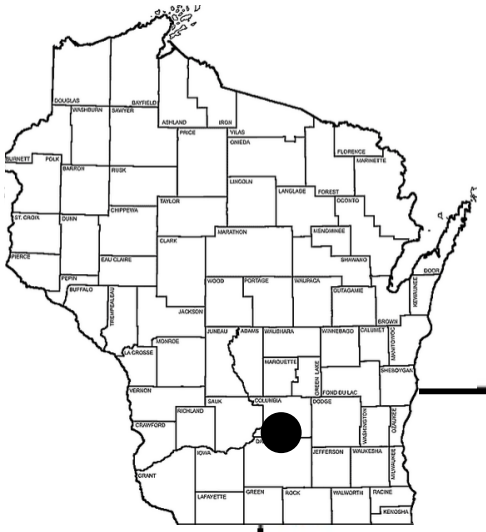


Unmanured Control

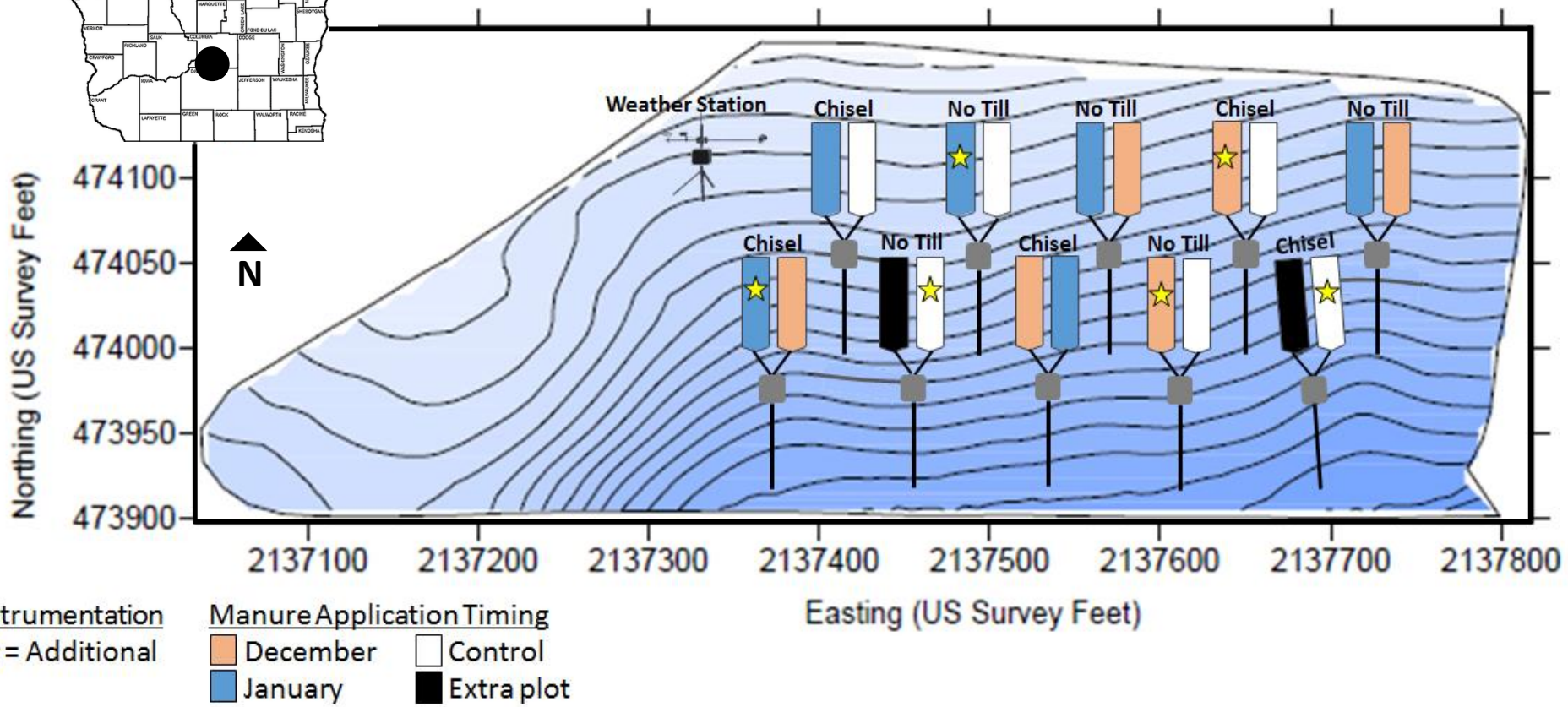
December: less frost, snow

January: frozen, snow-covered soil

Methods: Field Design



- UW Arlington Agricultural Research Station
- Liquid dairy manure, 37.4 kL ha^{-1} (4000 gal ac^{-1})
- Continuous corn for silage 2015-2018
- Silt loams, south-facing 5.9 % slope



Water-Energy Balance

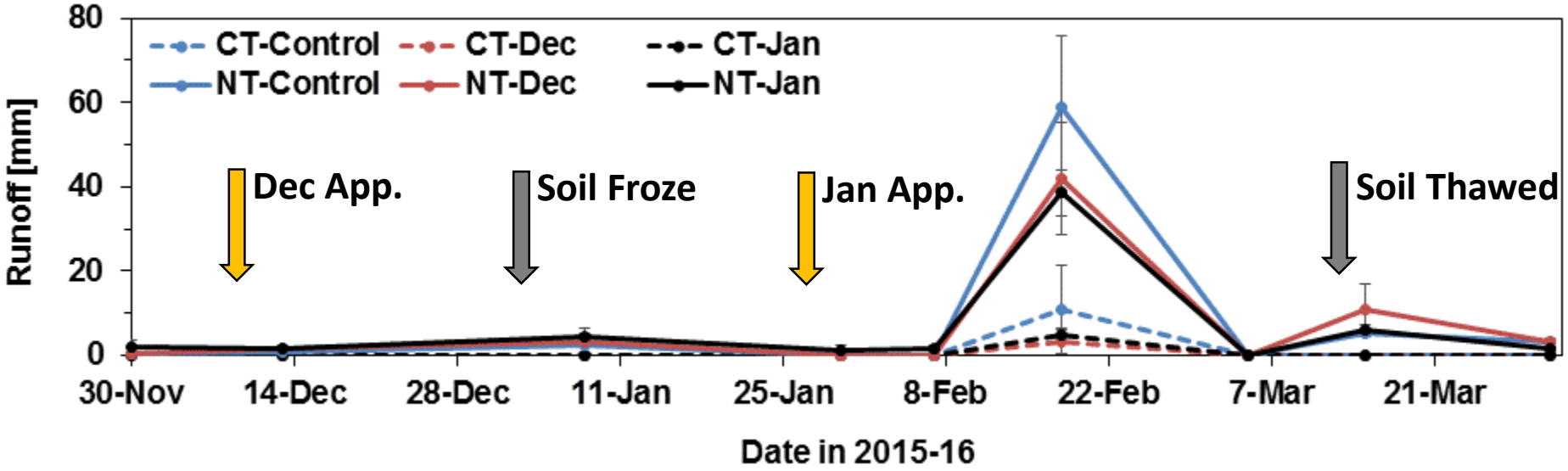
Air Temperature
Vapor Pressure
Wind
Surface Temperature
Snow Depth
Net Radiation
Precipitation
Heat Flux
Frost Depth
Soil Potential
Soil Water Content
Soil Temperature

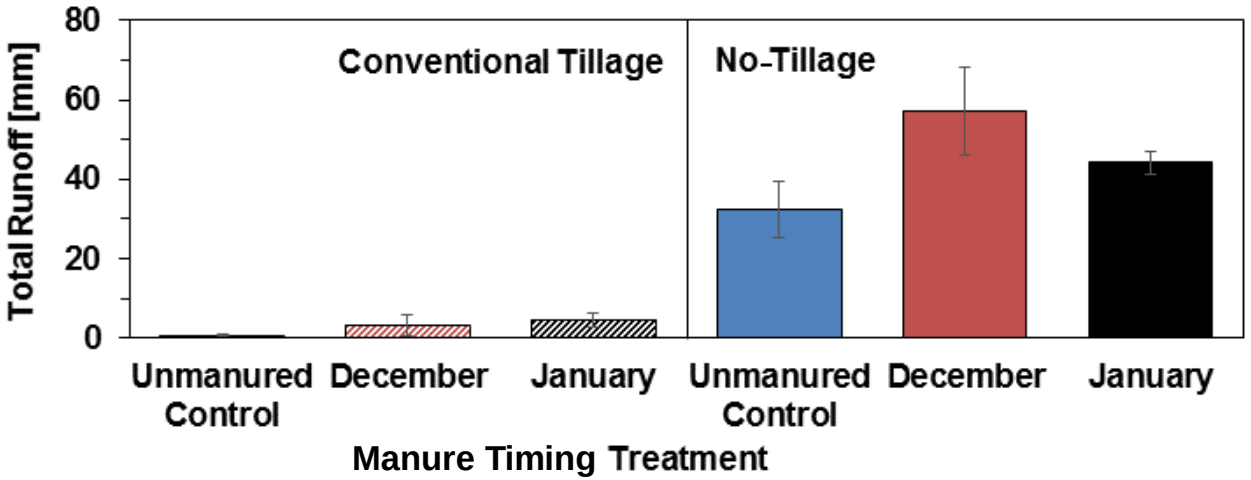
Net Radiation
+
Sensible Heat
+
Latent Heat
+
Snow Storage
+
Ground Heat

Precipitation + Manure =

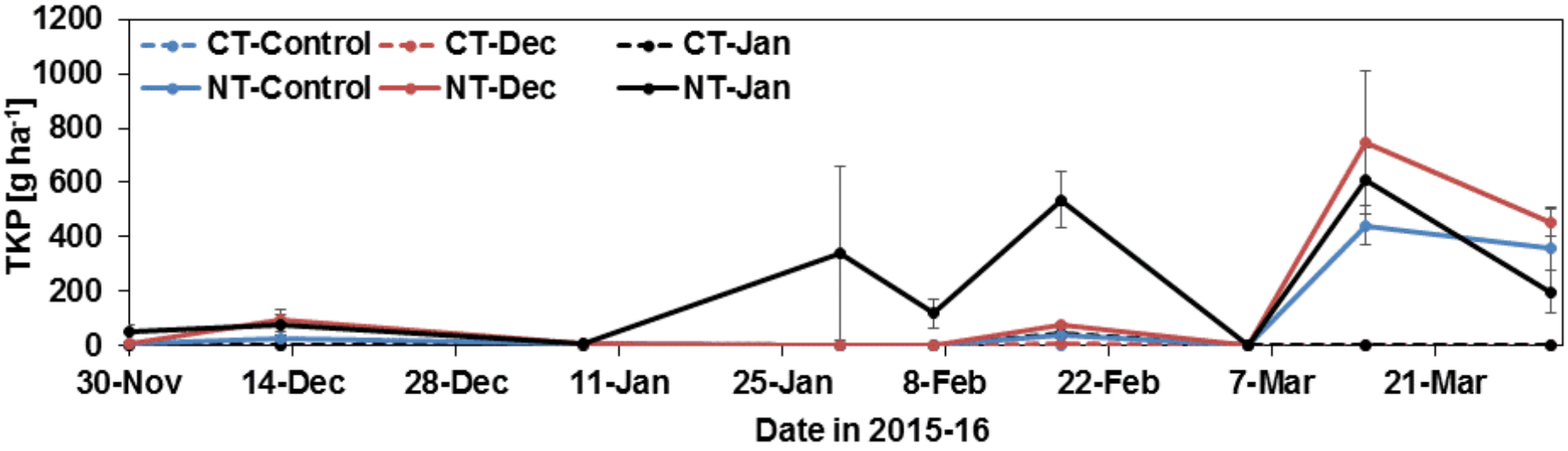
Infiltration + Runoff
=
Snow Storage
+
Soil Storage
+
Soil Water Flux

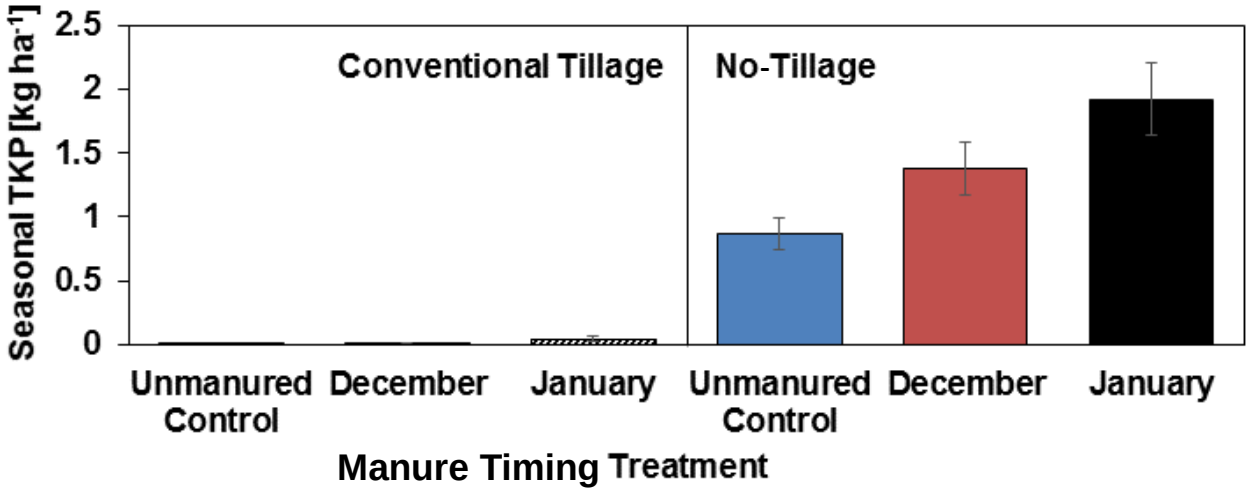
Year 1: Tillage decreased runoff



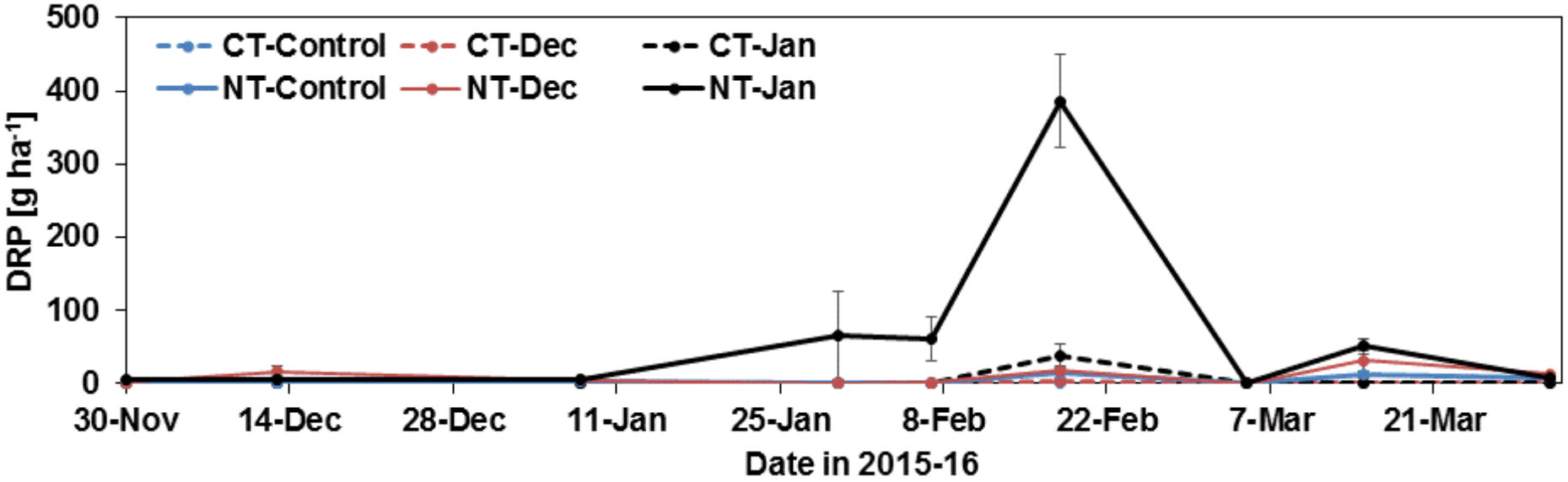


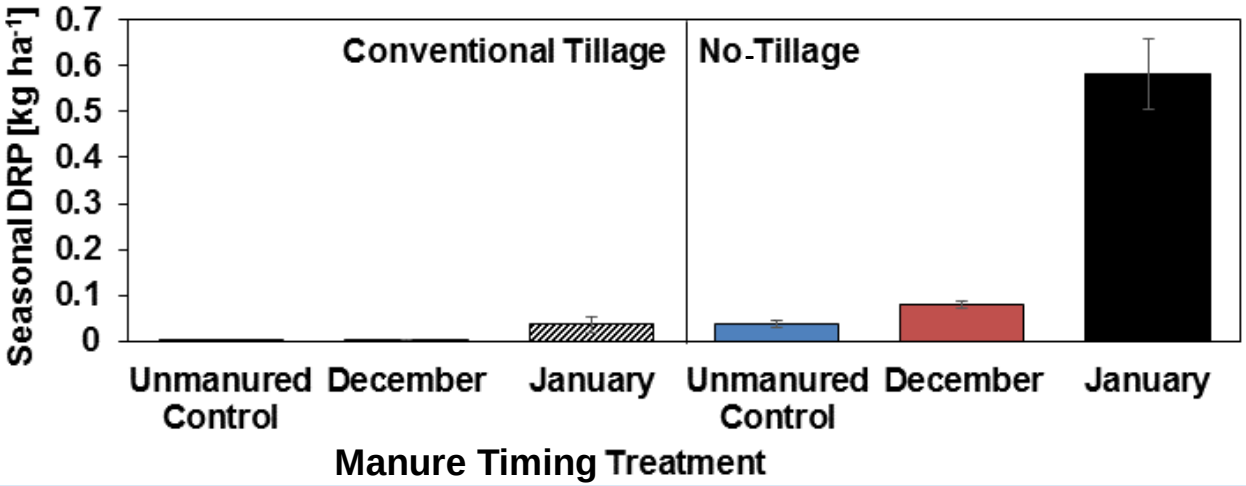
Tillage, early application reduced TKP





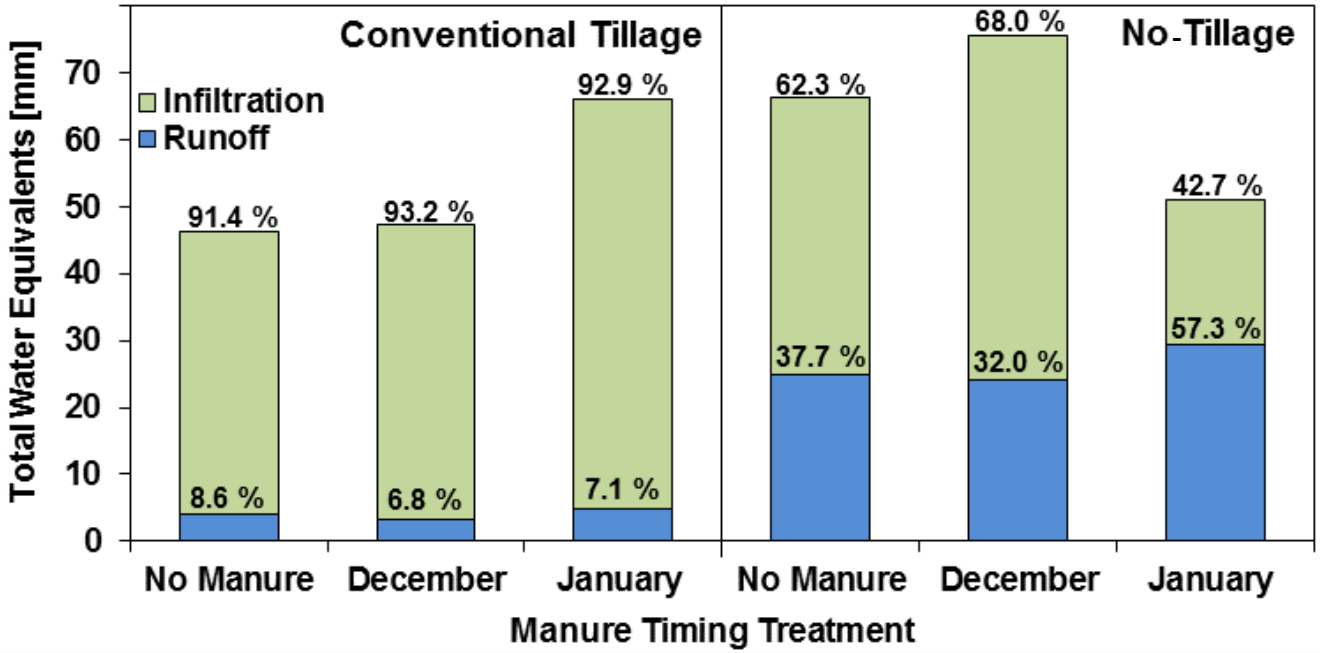
Tillage, early application reduced DRP

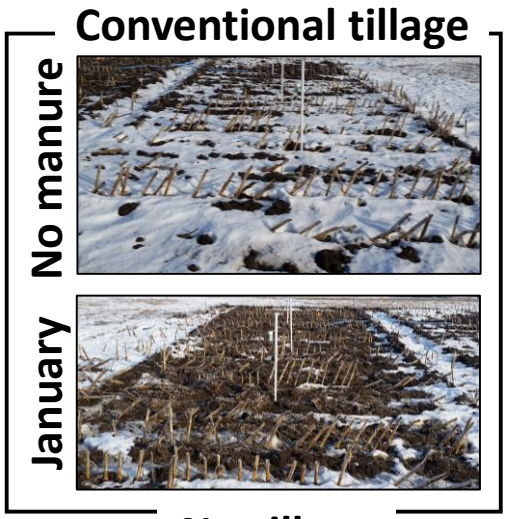


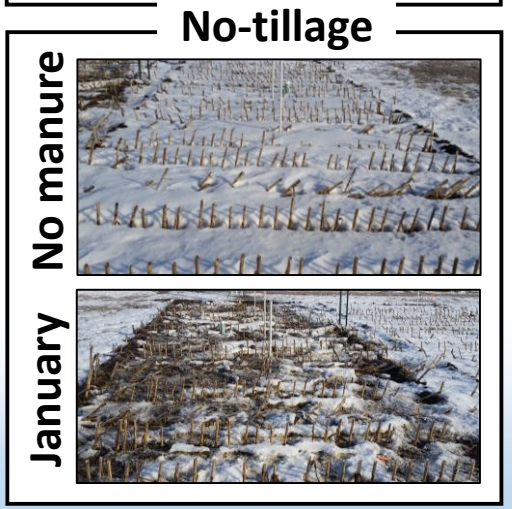


Frozen soil infiltration at a glance

- Tillage promoted infiltration on frozen soils
- January applications accelerated snowmelt, runoff on frozen soils







Hypothesized Mechanisms

Conventional tillage increases frozen soil infiltration

1. Surface depressional storage increases available time for infiltration

January applications accelerate snowmelt, runoff

2. Surface albedo decreases
3. Lowered freezing point of snowpack

Summary of Preliminary Findings

- **Manure application rate reduced**

  65.5 kL ha^{-1} (7000 gal ac^{-1}) to 37.4 kL ha^{-1} (4000 gal ac^{-1})

- **Conventional tillage reduced runoff and P losses, January manure application accelerated P losses**

  TKP losses 45x, DRP 16x higher in no-till January vs conventional till January treatments

- **More data from additional freezing seasons**

Thank you

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DECAGON DEVICES

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