Low-disturbance Manure Application Methods in a Corn Silage-Rye Cover Crop System

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Situation

- Manure a good source of nutrients for crops
- Large ammonia-N (NH_3-N) losses from surface-applied manure reduce N available to crop and contribute to environmental problems
- Quick tillage or injection minimizes NH_3-N losses, but reduces crop residue cover, which may increase erosion potential.

Objective

- Evaluate methods for applying liquid manure that minimize NH_3-N and nutrient runoff losses, conserve N for crop, while maintaining crop residue cover.

Field Site

- Marshfield Ag Research Station, Marshfield, WI (central WI)
- Withee silt loam (Aquic Glossudalf)
  - Somewhat poorly drained, 0-2% slope

Manure and Fertilizer Application

- Late fall manure application (late Oct-early Nov) into corn silage stubble-rye cover crop
- Target application rate 8000 gal/acre (aim 80% of crop N need)
  - Supplied 190 total N, 90 NH_4-N, 80 P_2O_5, 200 K_2O lb/acre/yr (average; nutrient content and rate variable)
  - Fertilizer N: 0, 60, 120, 180 lb N/acre pre-plant (no manure)
  - Starter (9-11-30-6S) applied to all plots

Broadcast – Surface

Broadcast –Disk Incorporation

Low-disturbance Manure Application Methods

Low-disturbance sweep injection (DSI/Dietrich)

Strip-till/sweep injection (DSI with paired disks – “Clozr”)

Coulter injection (Yetter Avenger)

Aerator-band applicator

All plots except strip-till injection field cultivated in spring

Planting field cultivated plot

Planting strip-till injection plot

Measurements

- Soil sampling
  - Routine, PSNT, deep NO_3
- Plant sampling (N, P, K…)
  - Early growth, earleaf at silk
- Surface residue cover
  - Photos and image analysis
- Ammonia volatilization
  - Dynamic chamber technique
- Runoff (P, N, sediment)
  - Rainfall simulator
- Silage yields and nutrient uptake
  - Silage wagon with weigh cells

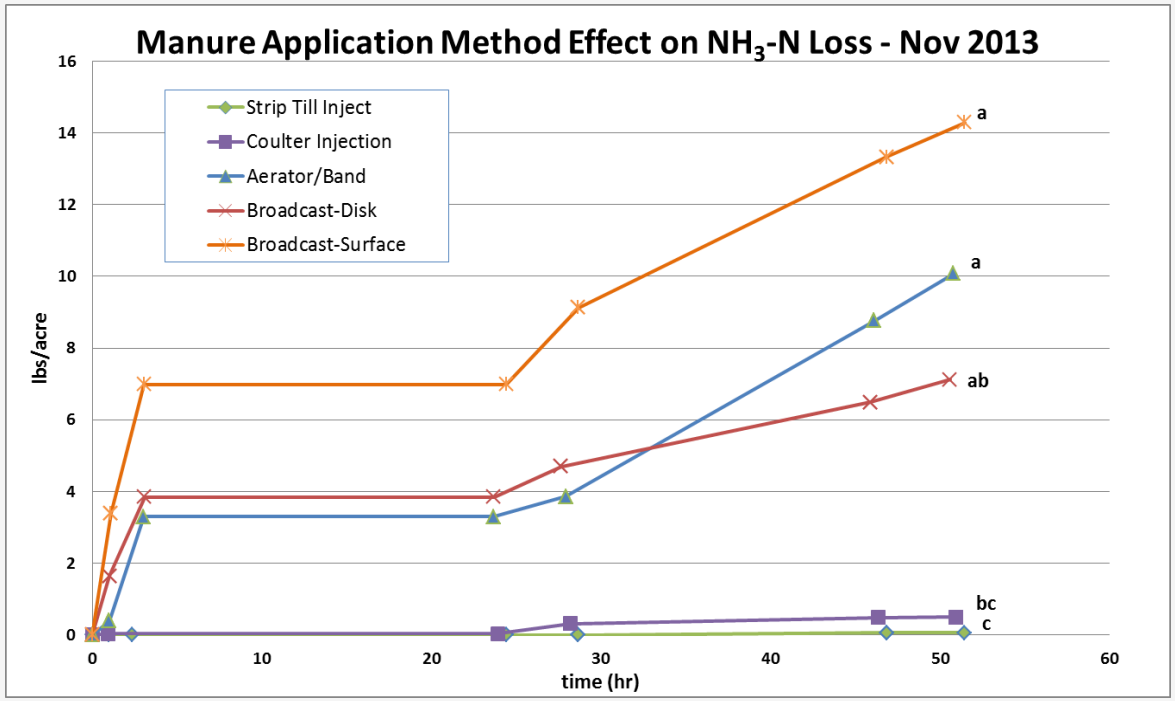
How does manure application method affect…?

- Manure ammonia-N volatilization/loss
- Manure N availability to crop
  - Pre-sidedress Soil Nitrate Test (PSNT)
  - Earleaf N content at silking
  - Silage N content and uptake
- Silage yield
- Surface residue cover
- Sediment and phosphorus loss in runoff

Ammonia Emission

November 2013

- Greatest loss from broadcast-surface
- Least from injection (strip-till, coulter)
- Broadcast-disk and aerator-band intermediate
- Low NH_3 losses due to low temperatures and rain, but probably more in following days



Early November

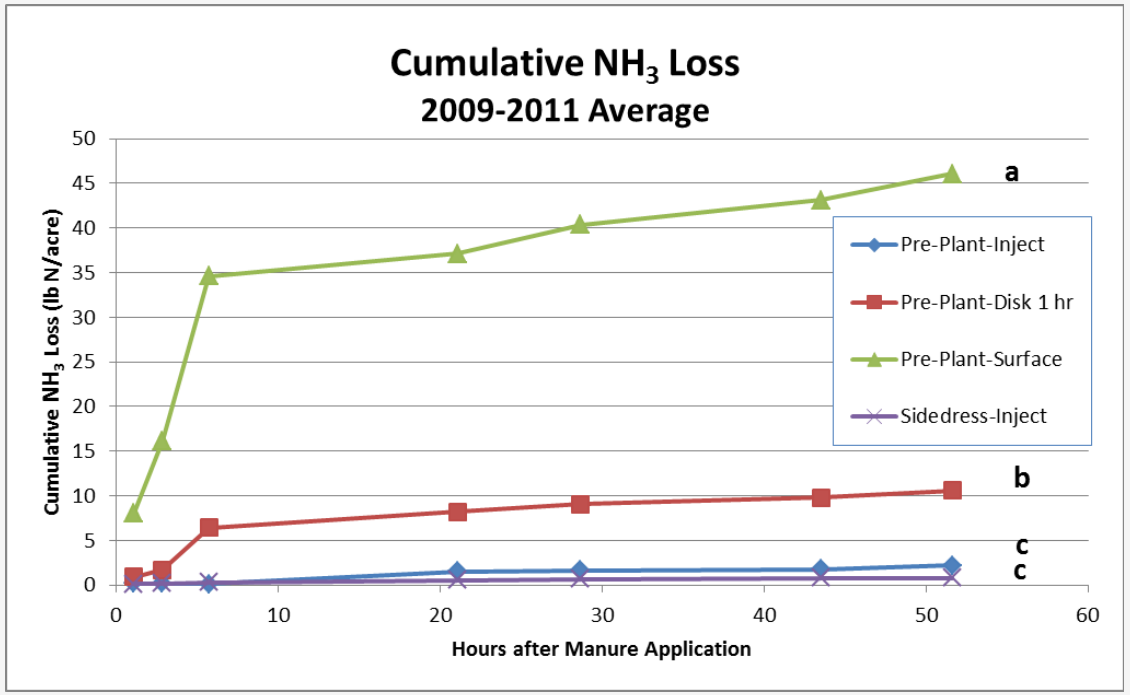
Low temperatures: 25 to 43 F

Rain: 0.6 inch following manure application

Ammonia Emission

Manure N Timing Study, Marshfield, 2009-2011

- Greatest loss from pre-plant-surface
- Large reduction from disk incorporation
- Least loss from injection
- Relative losses similar to current study, but different pattern and greater NH_3 emissions
  - Higher temperatures
  - Little/no rain



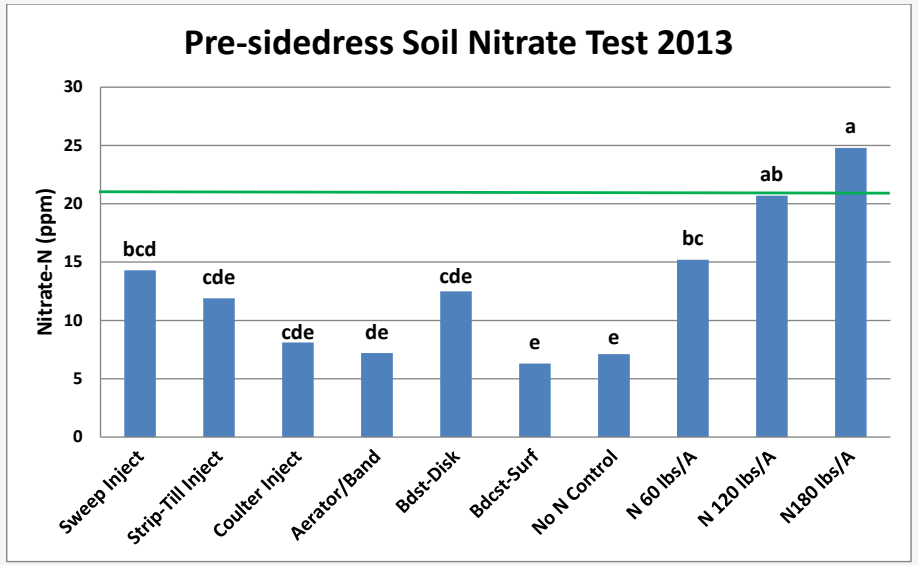
Mid-late May 2009-2011

Indicators of Crop N Availability

2013

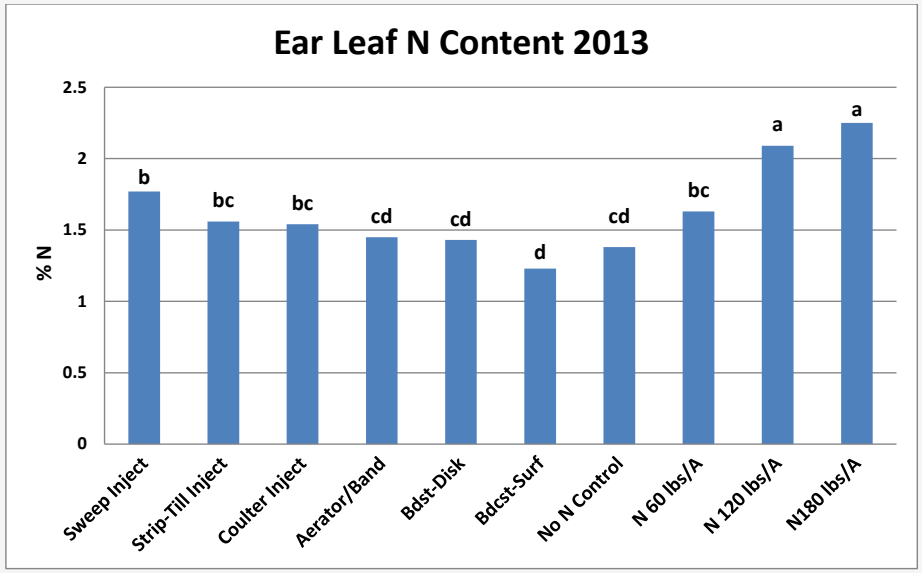
Pre-sidedress Soil Nitrate Test (PSNT)

- Most treatments < threshold for adequate N
- Manure
  - Injection and disk highest
  - Surface lowest = Control
- Fertilizer N (spring) > Manure (fall)



Earleaf N Content at Silking

- Similar trends to PSNT, but less pronounced

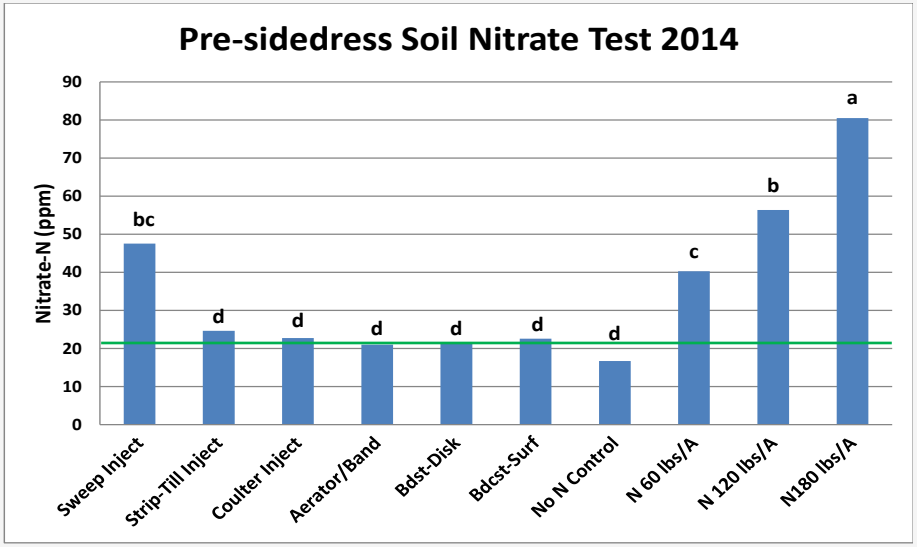


Indicators of Crop N Availability

2014

Pre-sidedress Soil Nitrate Test (PSNT)

- All but No N Control > threshold for adequate N
- Fertilizer N and Sweep Injection highest



Earleaf N Content at Silking

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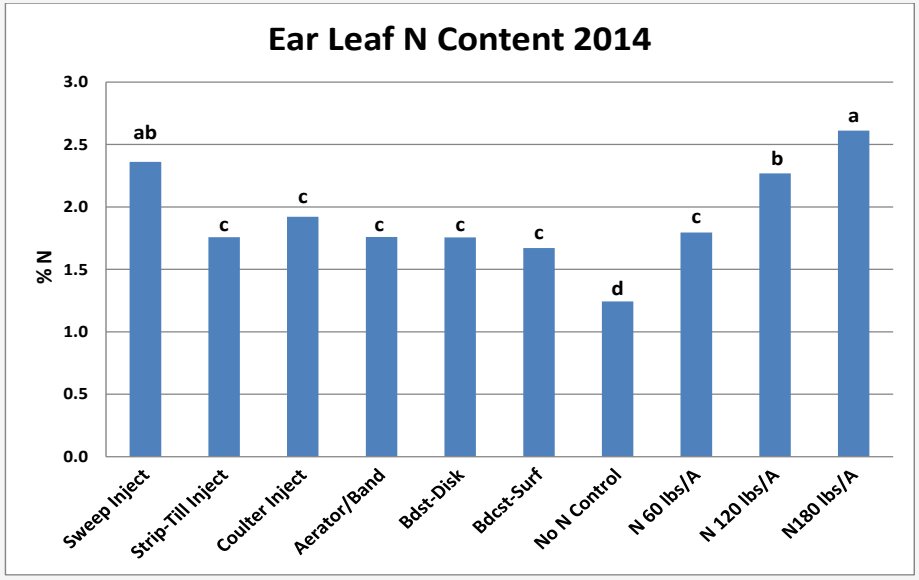
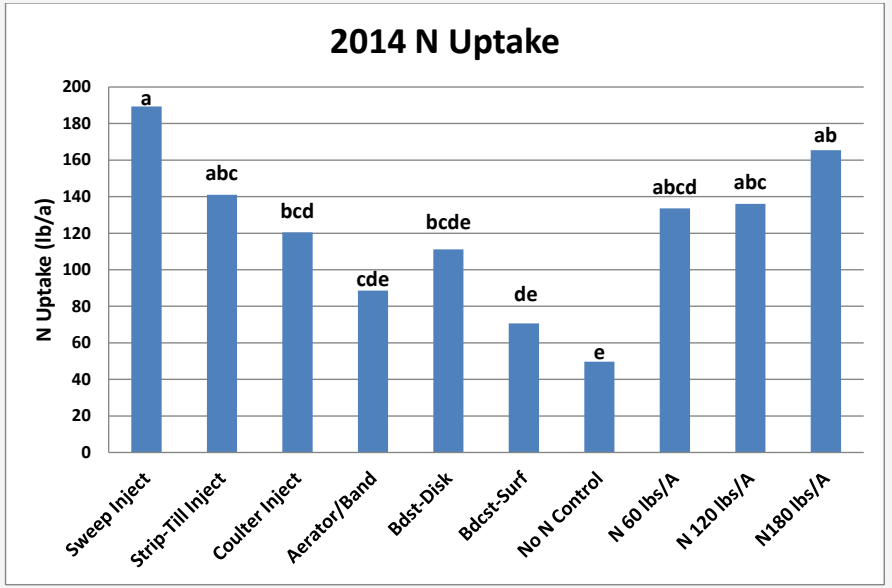
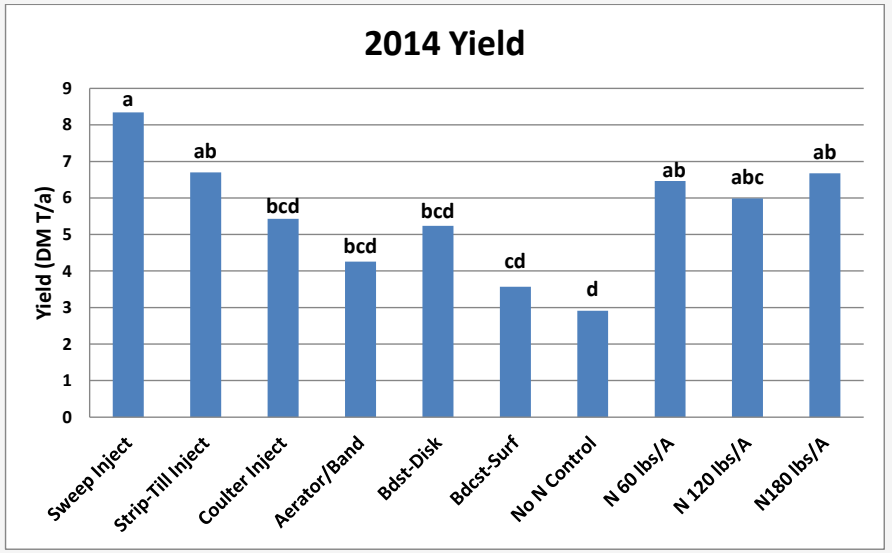


Silage Yield and N Uptake

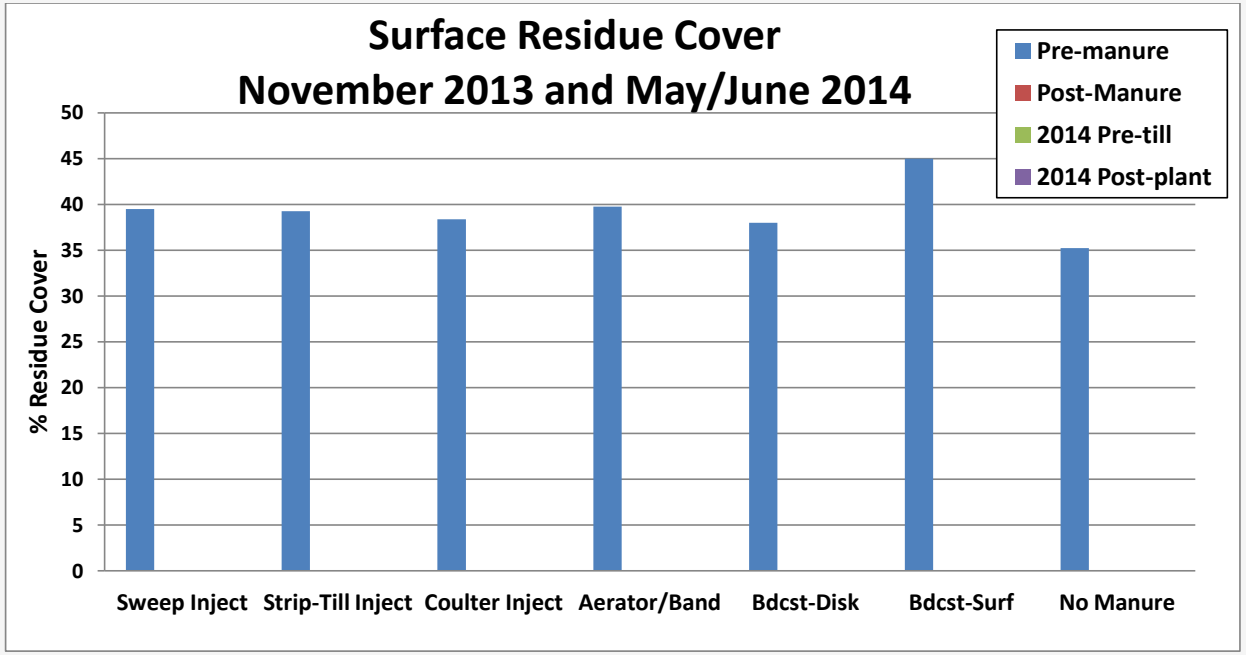
- Injected and disk incorporated manure = Fertilizer N
- Broadcast-surface manure and No N Control lowest (not significantly different)





Surface Residue Cover

Pre-Manure, November 2013

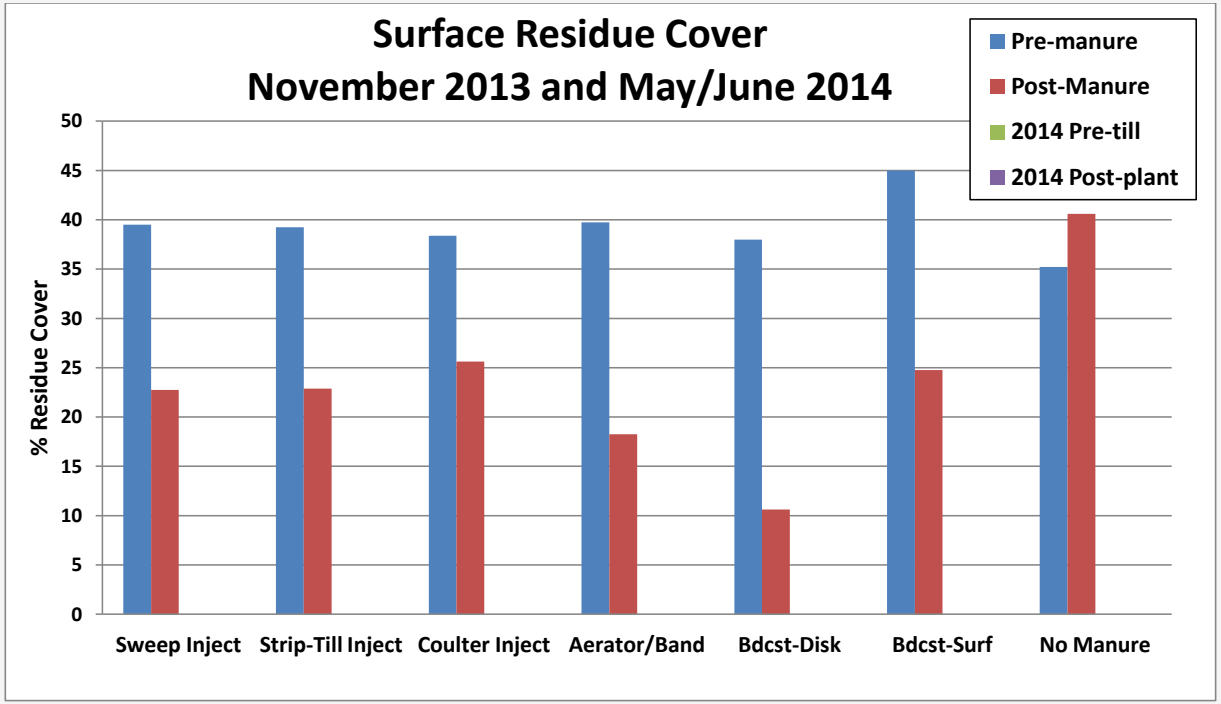


- Residue = corn stubble, rye, weeds (no manure)
- Minimal rye growth in fall

Surface Residue Cover

Post-Manure, November 2013

- Greatest residue decrease from broadcast-disk, least from injection of manure



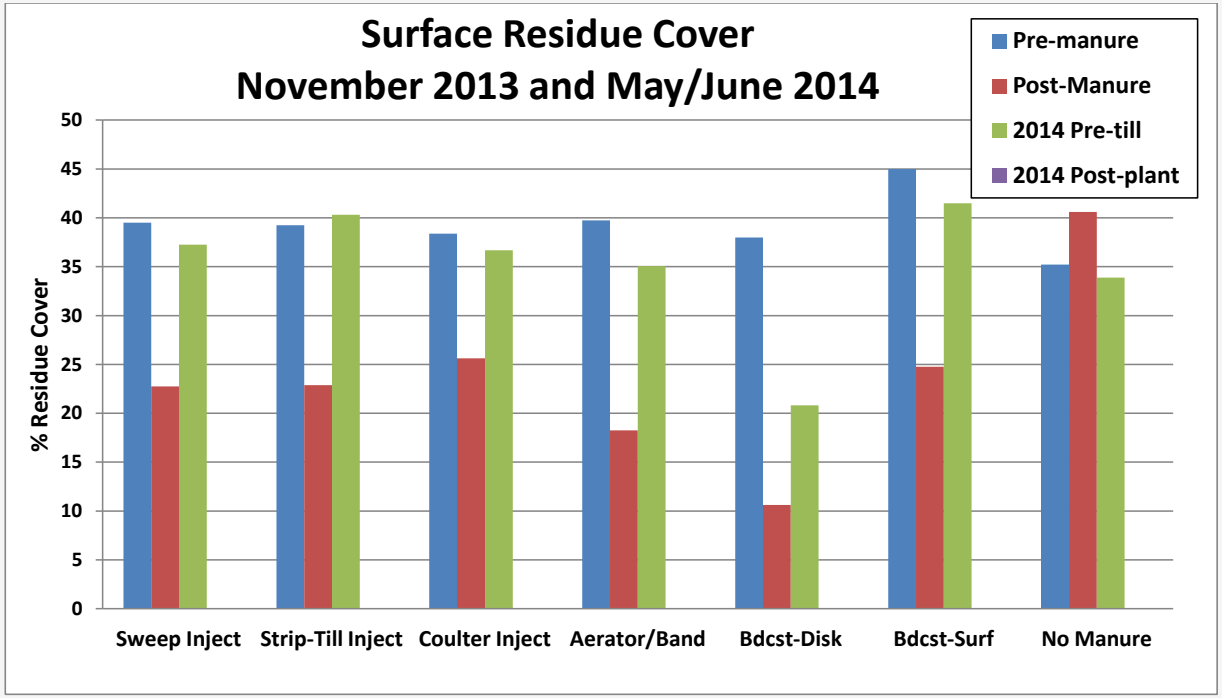
Broadcast-Disk

Strip-till Inject

Surface Residue Cover

Pre-tillage Spring 2014

- Greatest residue decrease from broadcast-disk, least from injection of manure
- Spring residue cover increased to pre-manure levels, except disk



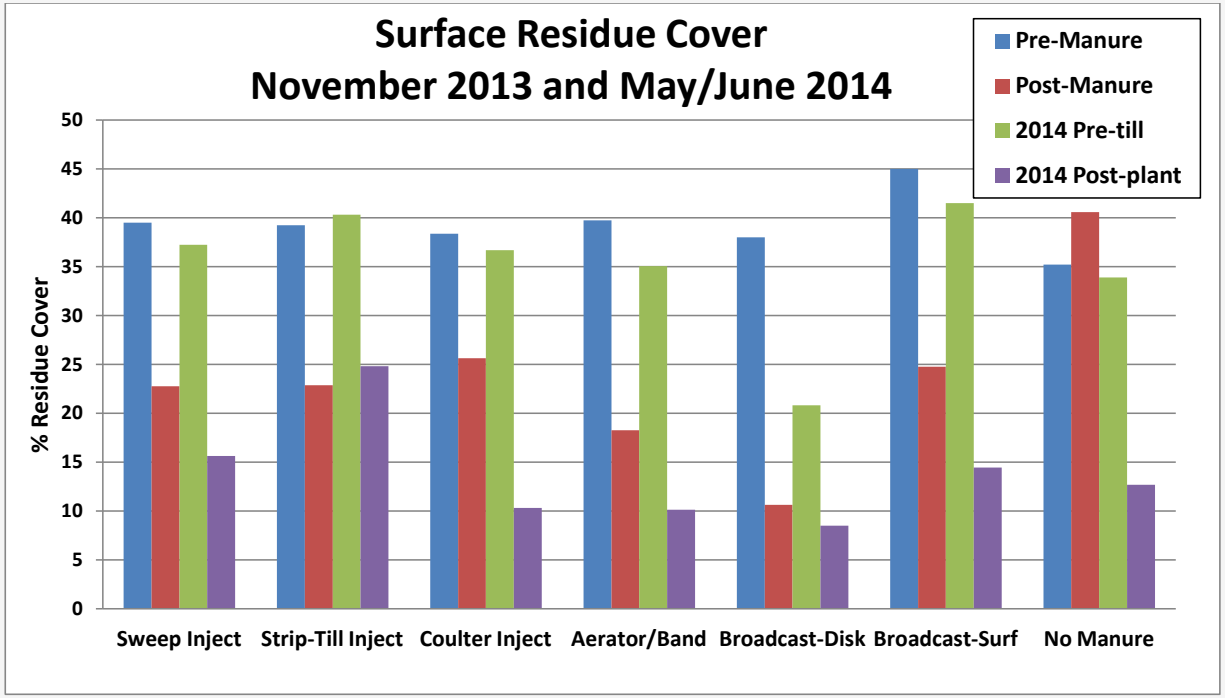
Broadcast-Disk

Sweep Inject

Surface Residue Cover

Post-Planting Spring 2014

- Greatest residue decrease from broadcast-disk, least from injection of manure
- Spring residue cover increased to pre-manure levels except disk
- Large residue decrease from spring tillage, except strip-till injection

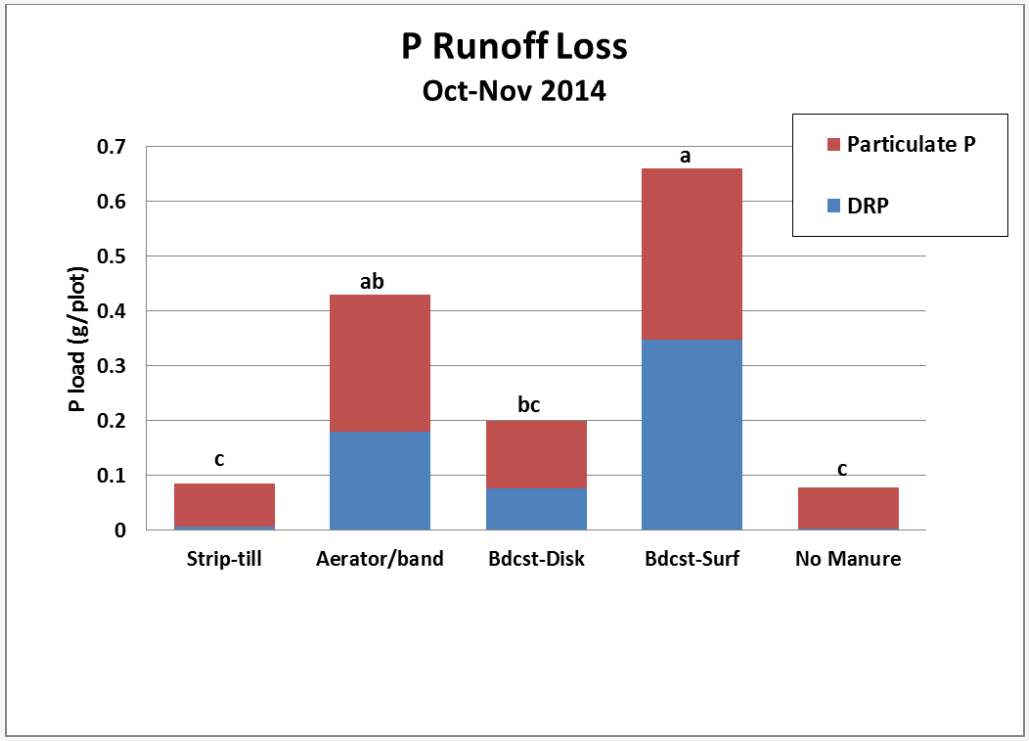


Spring field cultivated

Strip-till Inject

Nutrient Runoff Losses

- No significant effect on runoff quantity
- No significant effect on sediment loss
- Big effect on P losses
  - Total P
  - Dissolved P (DRP)
- Decreased P losses vs. Bdcst-Surface
  - Aerator-Band 35%
  - Bdcst-Disk 70%
  - Strip-till Inject 90% = No Manure



Preliminary Conclusions

- Low-disturbance manure application methods:
  - Reduced ammonia loss (especially injection, >90%) compared to broadcast surface application
  - Increased manure N availability to the crop compared to surface application
    - PSNT, ear leaf N content, silage N content
  - Maintained residue cover better than disk incorporation of manure
  - Reduced runoff P losses (35-90%) compared to surface application
- In summary, low-disturbance methods provide a viable option to reduce environmental impact of manure application and improve manure N availability to the crop.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