Tile drained soils receiving manure

Dealing with phosphorus losses

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Phosphorus loss from tiles

Take home

Small losses, big impact

Agronomically insignificant losses can be environmentally significant

Agronomic objective: ppm in soil solution

Environmental problem: ppb in surface waters (ppm/1000)

By-pass

Tiles create "hydrologic connetion"

Route surface runoff and liquid manure

Especially in soils with good structure

Managing manure

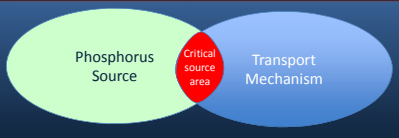
Want to keep P out of tiles?

Adapting the 4 "Rs"

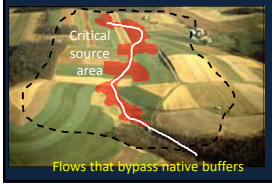
~ rate, timing, placement, form

Phosphorus loss from fields

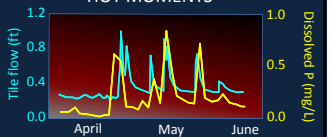
Managing sources and transport pathways



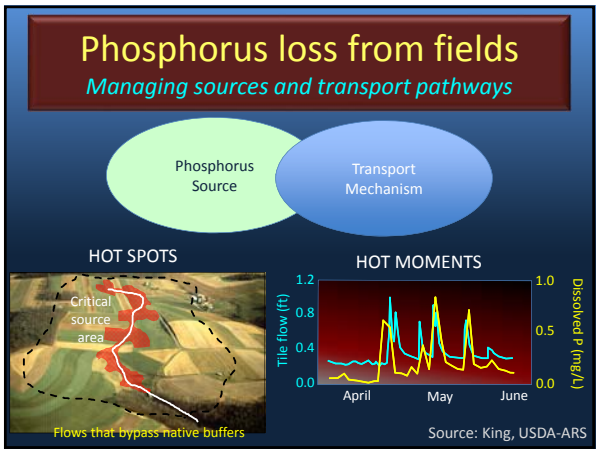
HOT SPOTS

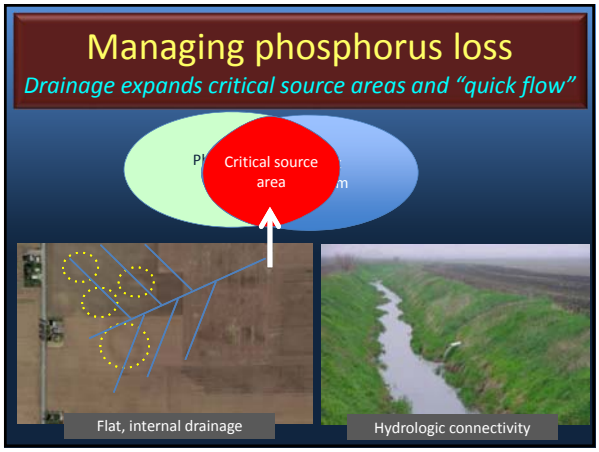


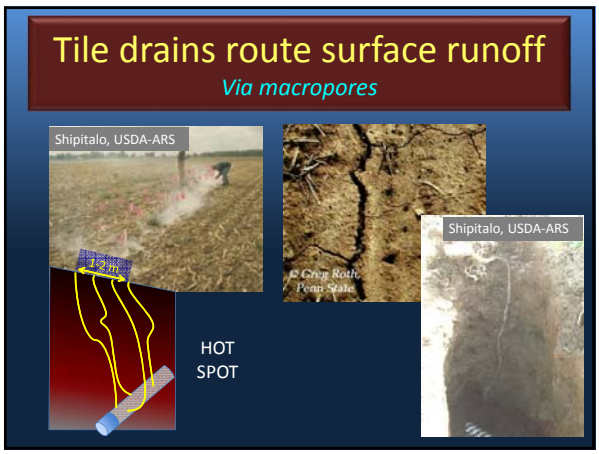
HOT MOMENTS



Source: King, USDA-ARS

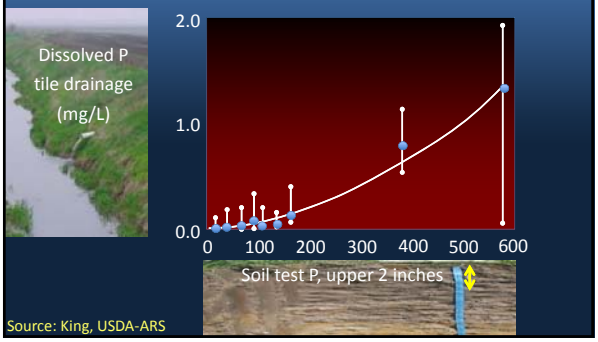

Phosphorus loss from fields
Managing sources and transport pathways
Phosphorus Source
Transport Mechanism
HOT SPOTS
HOT MOMENTS
Critical source area
Flows that bypass native buffers
Tile flow (ft)
1.2
0.8
0.4
0.0
1.0
0.5
0.0
Dissolved P (mg/L)
April
May
June
Source: King, USDA-ARS


Managing phosphorus loss
Drainage expands critical source areas and "quick flow"
Critical source area
Flat, internal drainage
Hydrologic connectivity


Tile drains route surface runoff
Via macropores
Shipitalo, USDA-ARS
HOT SPOT
© Greg Roth, Penn State
Shipitalo, USDA-ARS

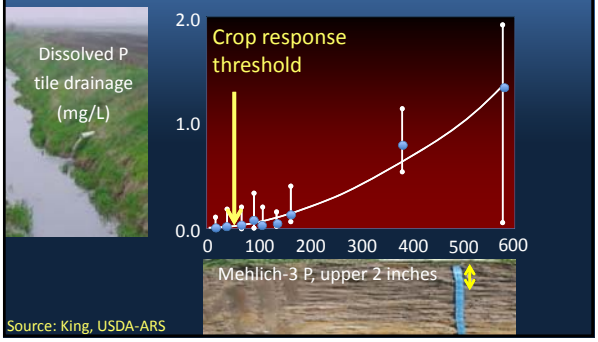
Drainage and subsurface P loss

Many parallels with surface runoff



Drainage and soil P

Follow your land grant university recommendations



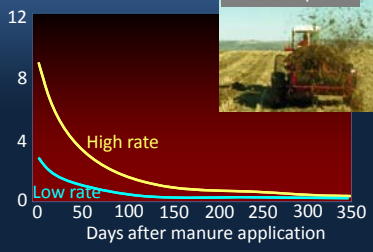
"4 R" Nutrient Stewardship

A bit different when applied to P loss (instead of crops)

Placement	*Promote phosphorus binding by soil, stay away from drained areas*
Timing	*Relative to storms and drainage*
Rate	*Less P means lower losses*
Form	*Liquid manures can flow to tiles*

"4 R" Nutrient Stewardship

Rate and timing - avoid periods of peak drainage (and when soils have limited storage for liquid manures)



Bedded pack

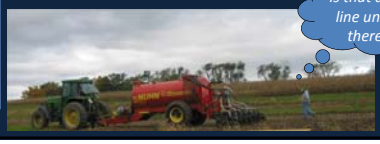
Data: Klausner et al., 1976
Regressions: Brookes et al., 2000

"4 R" Nutrient Stewardship

Right placement – avoid areas near drains

Shipitalo, USDA-ARS

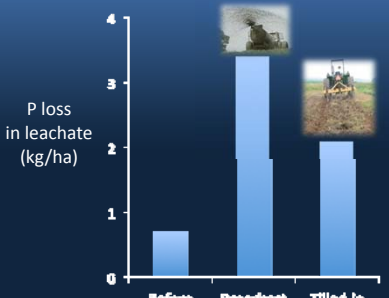
Wilson, OEPA



Is that a tile line under there?

"4 R" Nutrient Stewardship

Right placement – maximize contact with soil

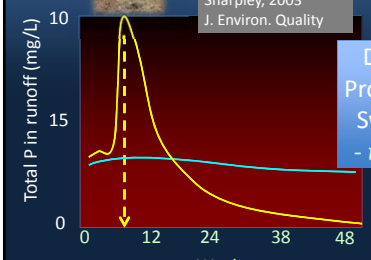


Tillage to incorporate manure and disrupt macropores

Kleinman et al., 2009

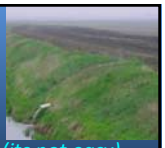
"4 R" Nutrient Stewardship

Right placement – incorporation (tillage trade-offs)



DSI Ag Prototype Sweeps - *testing*

Myths



P doesn't move through tile drains – wrong
P in tile drainage is only dissolved – wrong
P in tile drainage can't be managed – wrong (its not easy)

Manure management

Placement	*Close contact with soil minimizes P in drainage water.*
	Applying 1-2 m away from drains avoids bypass.
	Tillage effects are mixed (especially fine textured soils)
Timing	*Avoid periods before storm events and when soils are wet (can't store liquid manures) or dry (and cracked)*
Rate	*Keep application rates as low as possible*
Form	*Liquid manures, amendments to reduce P solubility*