# **Cover Crops and Water Quality**

The Science of Cover Crops Midwest Cover Crops Council 2016 Annual Meeting Madison, WI February 24, 2016



USDA-ARS National Laboratory for Agriculture and the Environment Ames, Iowa

Tom Kaspar Ben Knutson Keith Kohler Kent Heikens Dan Jaynes Tim Parkin Tom Moorman



#### NO3-N Concentration in the Raccoon River at Des Moines



Data provided by Chris Jones Des Moines Water Works

# Des Moines water quality suit slated for trial in 2016

Des Moines Register, July 15, 2015 Donnelle Eller, deller@dmreg.com *11:56 a.m. CDT July 15, 2015* 

The Des Moines Water Works lawsuit against three northwest lowa counties over water quality is scheduled to be heard by a federal trial judge, beginning Aug. 8, 2016, unless a continuance is sought, a court document indicates.

U.S. District Court Judge Mark Bennett expects the bench trial in Sioux City to last up to two weeks. The Des Moines utility is suing Buena Vista, Calhoun and Sac counties, claiming drainage districts there act as conduits for nitrates to move from farm fields into the Raccoon River, one of two sources of drinking water for 500,000 residents in the Des Moines metro area.

### Statewide Tile Nitrate Results



Statewide Tile Nitrate Results 2014

ISA RESEARCH Advancing Agricultural Performance<sup>®</sup> and Environmental Stewardship







Funded in part by the soybean checkoff

So why is this such a difficult problem?

# We just need to manage N fertilizer better.

**Right?** 



#### **IOWA STATE UNIVERSITY**

#### **Castellano and Helmers**

### Soil Nitrate Production vs. Crop Nitrate Uptake



In the shaded areas, the soil produces nitrate, but there is no crop to use it. As a result, <u>some</u> nitrate is lost to waterways.

#### IOWA STATE UNIVERSITY

#### **Castellano and Helmers**

## Nitrate Loss in Tile Drainage





Land management and land use impact evapotranspiration and infiltration, which in turn impact surface runoff, subsurface drainage, deep percolation

### **IOWA STATE UNIVERSITY**

#### **Castellano and Helmers**

## Nitrate Loss in Tile Drainage Measurements



## Flow Meters & Sample Collectors



#### Kaspar et al. J. Environ. Qual. 36:1503-1511.

### **Cumulative Annual Drainage**



### **Nitrate-N Concentration**



#### **2014 Drainage Water Nitrate Concentration**



### Nitrate-N Loss in Drainage



### Total Nitrate-N Lost 2002-2015 in Tile Drainage

Treatment	Nitrate-N Lost in Drainage		
	14-yr total	14-yr avg.	
	lbs/acre	lbs/acre	
Corn-soybean no-till	488	35	
Corn-soybean no-till w.			
rye cover crop	211	15	
Reduction	277	20	
% Reduction	57		

# Total Cover Crop Nitrate-N Uptake 2002-2015

	Cover Crop Shoot Biomass	Cover Crop Shoot N Concentration	Cover Crop Shoot N Content	Reduction of Drainage N Loss
	lbs/acre	%	lbs N/acre	lbs N/acre
Avg 02-15	1499	2.53	33	20
Sum 02-15	20970		458	277

### Reduction of Nitrate Leaching with Rye – Four Other Iowa Sites

- Nashua, Iowa 22 29%
- Gilmore City, Iowa 15 -20%
- COBS Experiment, Kelly, Iowa 36%
- Tim Smith farm, Eagle Grove, Iowa 48%

Data from Matt Helmers, Eileen Bader, Tim Smith, and A.L. Daigh

### **Examples of Improvement**

- Boone River Watershed
  - Corn/Soybean Rotation
  - Cover Crops



ISA RESEARCH Advancing Agricultural Performance® and Environmental Stewardship







Funded in part by the soybean checkoff

### Cover Crop N Losses Summary

- Winter cover crops reduce N losses in tile drainage by taking up N and reducing nitrate concentrations in soil and drainage water when main crop is not there.
- There is some lag between cover crop N uptake and reduced water concentrations.
- Cover crops have to grow to have a benefit.
- Winter cover crops don't seem to have a large impact on the total annual amount of drainage, but could have seasonal effects.

•Unlike other practices used to reduce N contamination of water, winter cover crops provide other benefits.

Effects of Cover Crops On Phosphorus Losses

### Cover Crop Effects on P Losses in Surface Runoff

Reference	Location	Cover crop	Change in total P losses in runoff	Change in soluble P concentration in runoff	Change in soluble P in runoff
Angle et al. (1984)	Maryland	Barley	-92%	+460%	-13%
Langdale et al. (1985)	Georgia	Rye	-66%	+54%	+8%
Pesant et al. (1987)	Quebec	Alfalfa/timothy	-94%	-60%	-12%
Yoo et al. (1988)	Alabama	Wheat	-54%	0%	-50%

(adapted from Sharpley and Smith, 1991)

### Cover Crop Effects on P Losses in Drainage after Freeze/Thaw

Table 5. Combined total P leached from all four simulations from the sand and clay with plant treatments as well as the plant-only experiment.

	Clay soil + plant		Sand soil + plant		Plant only	
Plant	PO₄-P	Total P	PO₄-P	Total P	PO₄-P	Total P
	kg ha <sup>_1</sup>					
Ryegrass	1.55	2.34	0.72	0.95	7.21	9.97
Honey herb	0.51	1.33	0.45	0.76	6.23	18.39
Chicory	1.41	2.55	0.66	1.05	40.5 I	51.71
Oil seed radish	1.05	2.16	0.70	1.29	27.94	43.15
Control	0.20	0.32	0.67	0.88	0.14	0.61

Riddle and Bergstrom, 2013 Agron. J. 105:803–811

### Cover Crop P Losses Summary

• Cover crops can reduce soluble P losses in tile drainage by taking up soluble P when main crop is not there. Not a lot of field evidence, but logical.

• Cover crops can reduce losses of total P in runoff because they increase infiltration and reduce total runoff and sediment loss. Lots of evidence.

• Cover crops can lose soluble P from their residues after they are dead just like any plant in either runoff or percolating water. This P may have been lost anyway if the cover crop had not been there and if it infiltrates into the soil it may be bound in the soil or taken up by the next crop.





### **Questions?**

Tom.Kaspar@ ars.usda.gov



