IOWA STATE UNIVERSITY

Department of Agricultural and Biosystems Engineering

Impacts of Swine Manure & Aqua-ammonia Nitrogen Application Timing on Subsurface Drainage Water Quality

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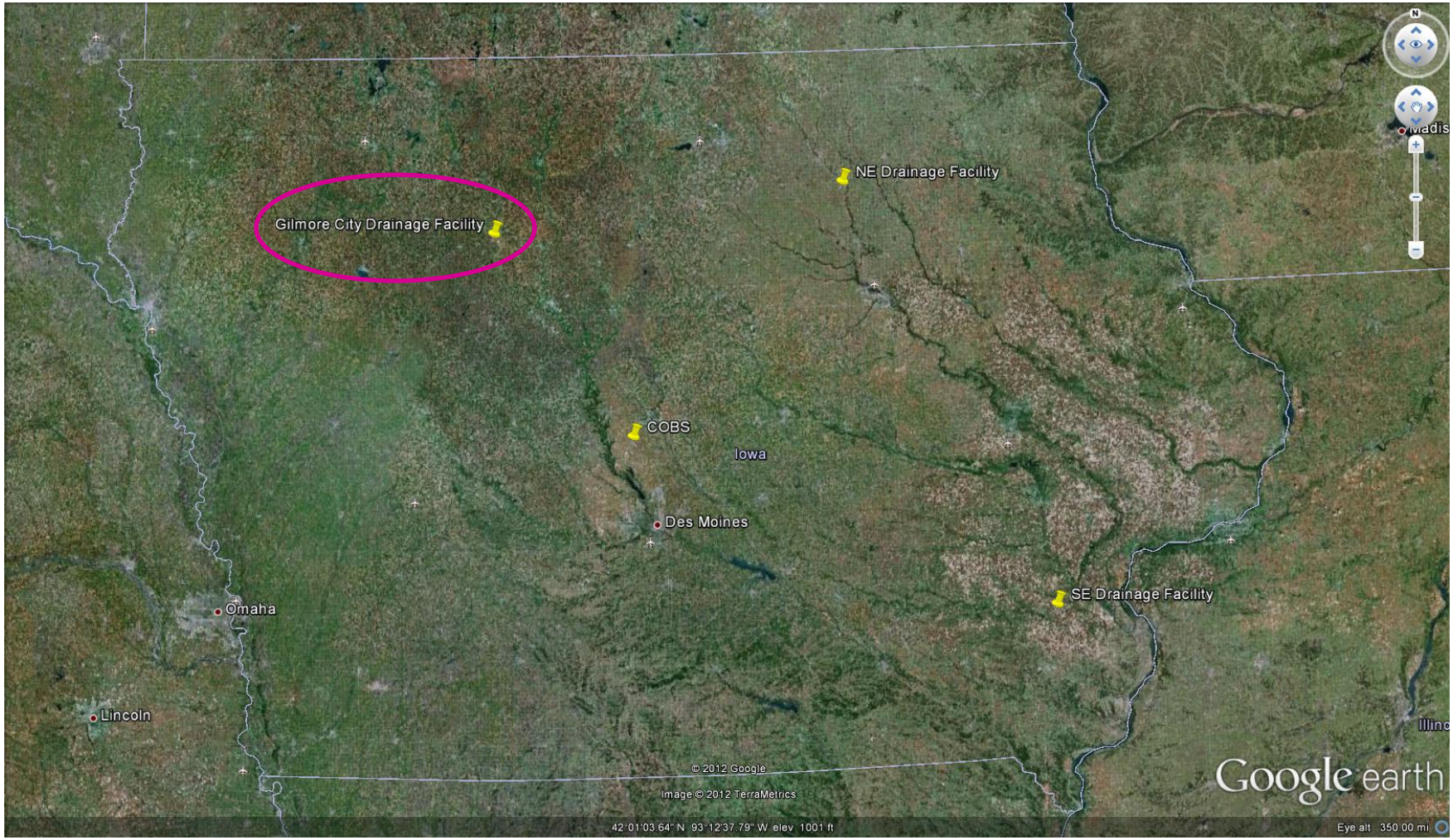
Goals

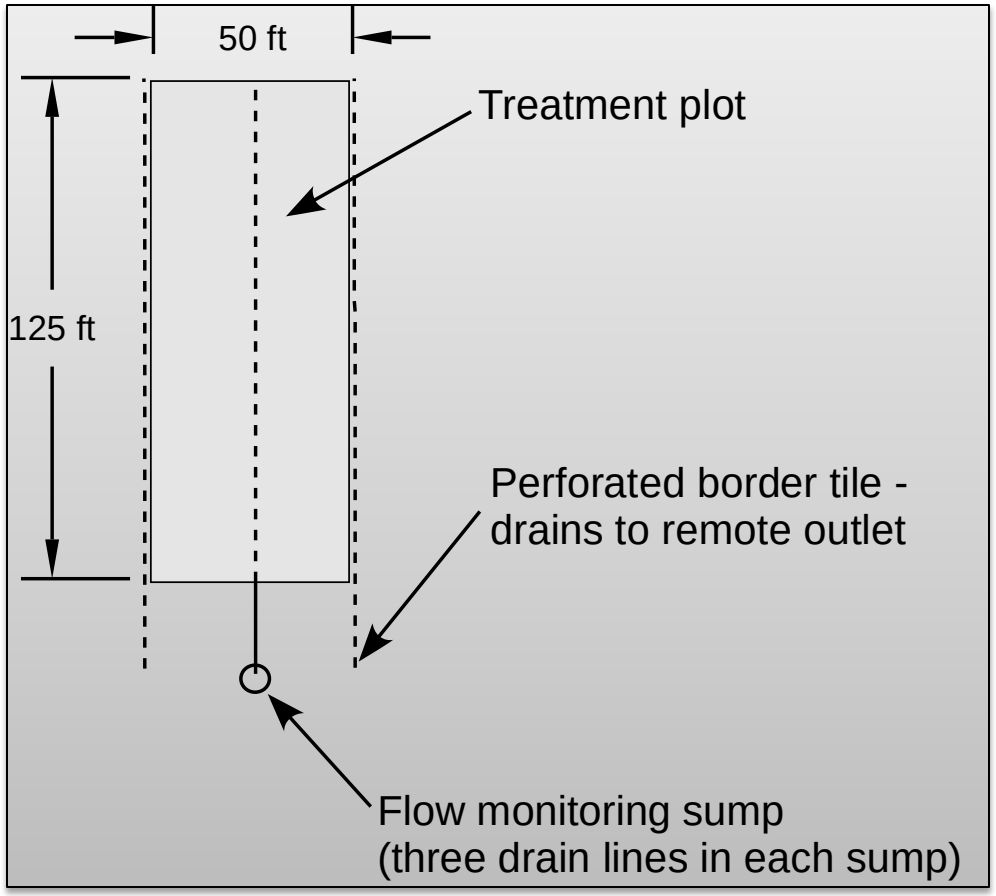
- Investigate the impacts of aqua-ammonia and liquid swine manure application timing on nitrate-nitrogen concentrations in subsurface drainage and the impacts on crop production

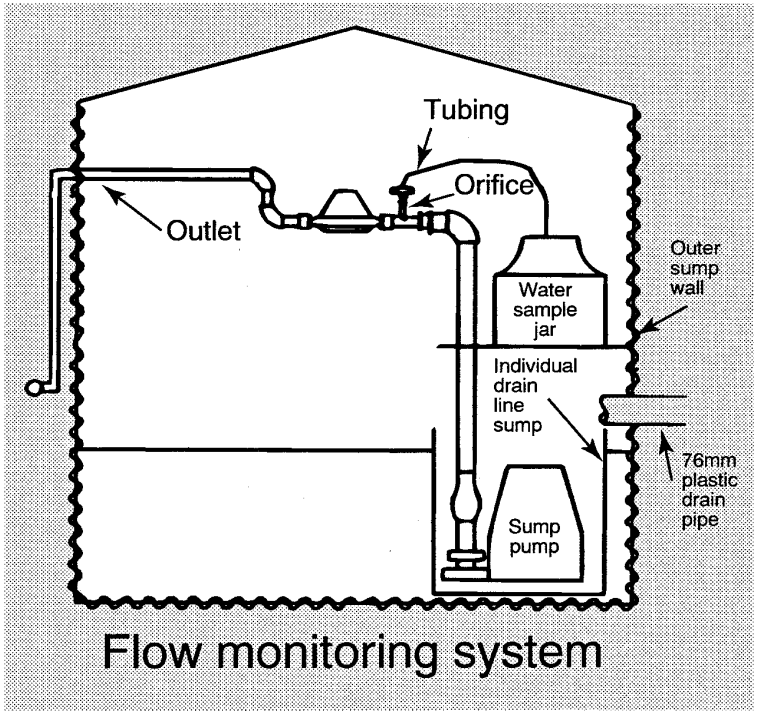
Location



Ag Water Management
Research Group

Plot Sampling Layout





Flow monitoring system

Flow and sampling set-up at Gilmore City site

Gilmore City Treatments 2001-2004

Treatment name	Nitrogen Application Rate (kg-N/ha)	Notes
Fall Ammonia 168	168	Fall Application – Late Oct.-Mid-Nov
Spring Ammonia 168	168	Spring Application – Late May – Early June
Fall Manure	218*	
Spring Manure	218*	
Fall Manure C&S	168*	Manure at 168 kg-N/ha rate was applied to both corn and soybeans
Fall Ammonia 252	252	
Spring Ammonia 252	252	

Note: * Application rates assume 100% nitrogen availability for manure.

Precipitation

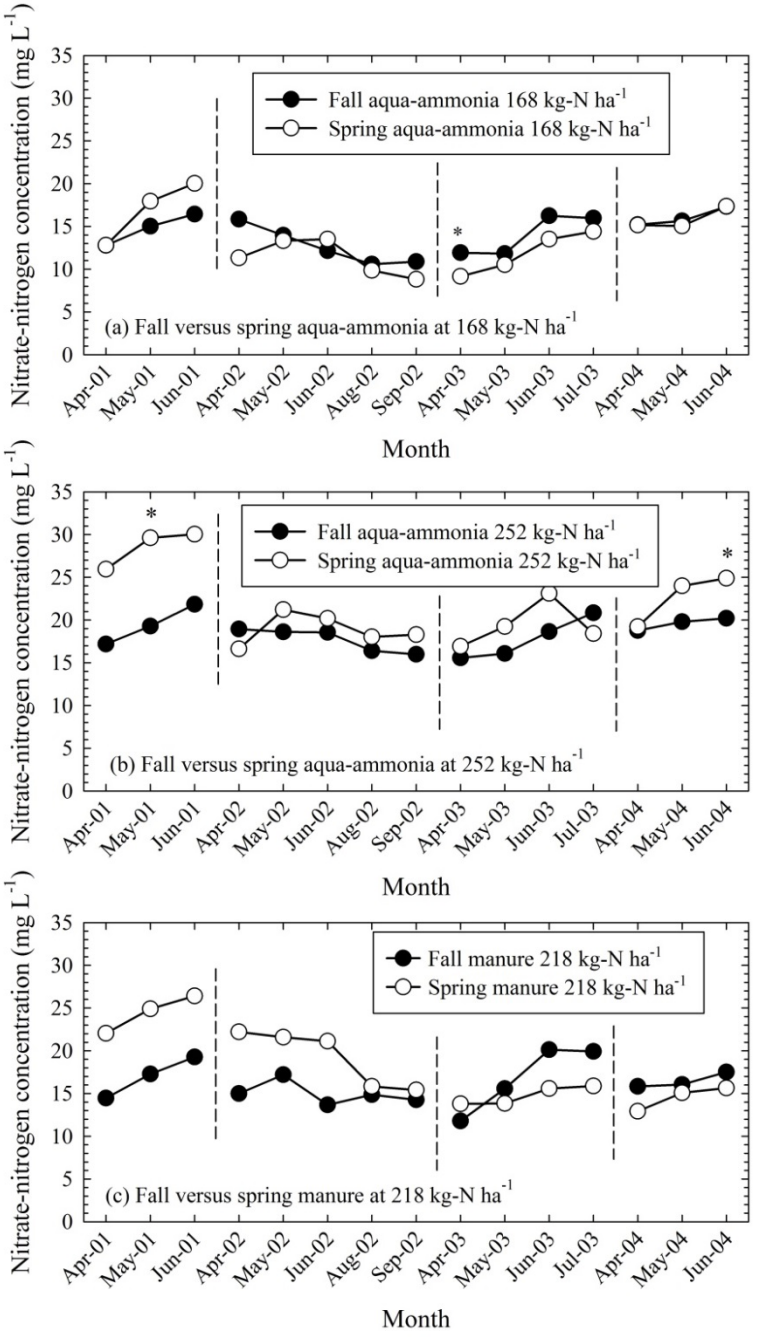
Month	2001	2002	2003	2004	2001-04 average	long term average[a]
	precipitation (mm)					
Mar.	16	7	28	97	37	55
Apr.	89	65	79	80	78	81
May	143	77	109	168	124	99
Jun.	68	51	218	98	109	116
Jul.	90	77	147	80	99	110
Aug.	72	262	42	13	97	111
Sep.	40	30	0	88	40	78
Oct.	42	87	0	14	36	57
Nov.	54	1	0	68	31	46
Drainage season (Mar-Nov) precipitation	614	657	623	706	650	753
Annual precipitation	702	680	689	767	710	821

Timing of Drainage

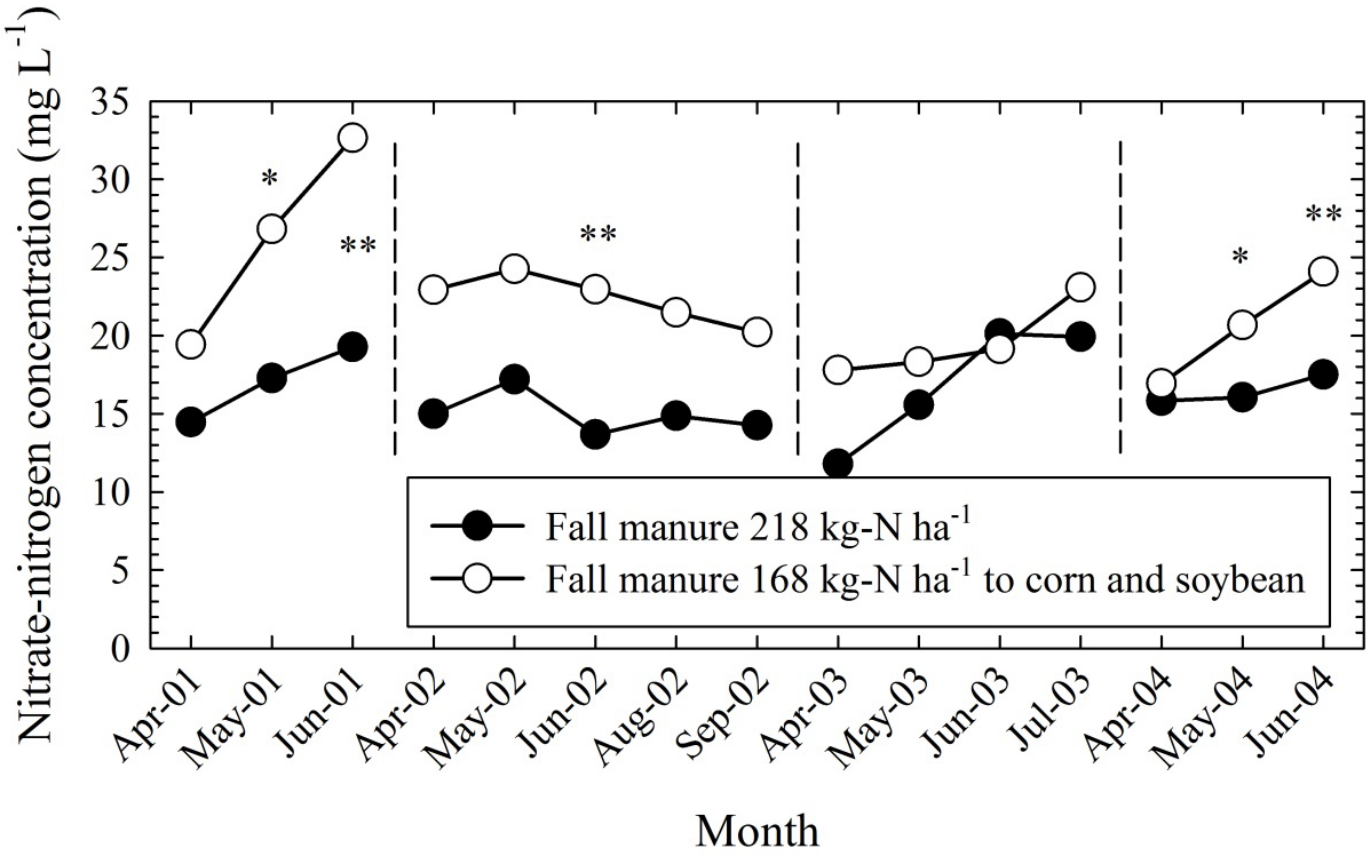
Month	2001	2002	2003	2004	2001-04 average
	drainage (mm)				
Apr.	44	10	34	36	31
May	168	59	91	121	110
Jun.	44	28	142	103	79
Jul.	0	0	91	4	24
Aug.	1	92	0	5	24
Sep.	0	13	0	0	3
Oct.	0	13	0	0	3
Nov.	0	0	0	0	0

~69% of the annual drainage in May and June

Monthly Nitrate Concentration



Monthly Nitrate Concentration



Flow-weighted Annual Nitrate-N Concentrations

Treatment	2001	2002	2003	2004	Average (2001-04)
	NO_3-N concentration (mg L^{-1}) [a]				
Fall 168 - Ammonia	14.8d	11.7c	14.7b	15.7c	14.2c
Spring 168 - Ammonia	18.0bcd	10.9c	15.0b	15.8c	14.9c
Fall 252 - Ammonia	19.5bcd	17.4ab	19.7ab	19.9ab	19.0b
Spring 252 - Ammonia	28.7a	19.3ab	23.0a	21.9a	23.2a
Fall Manure 218	17.0cd	15.6bc	18.6ab	16.0bc	16.8bc
Spring Manure 218	24.6abc	18.7ab	15.0b	15.1c	18.4b
Fall Manure 168 every year	26.3ab	22.5a	20.2ab	23.0a	23.0a
$LSD_{0.05}$	8.4	5.3	6.3	4.1	3.0

[a]means within years and on average with the same letter are not significantly different at p = 0.05

Nitrate-N Loss

Treatment	2001	2002	2003	2004	Average (2001-04)
	NO_3-N loss (kg-N ha^{-1}) [a]				
Fall 168 - Ammonia	32c	27a	44a	41a	36b
Spring 168 - Ammonia	37bc	25a	49a	58a	42b
Fall 252 - Ammonia	53bc	33a	64a	49a	49ab
Spring 252 - Ammonia	86a	47a	74a	49a	64a
Fall Manure 218	38bc	33a	49a	48a	41b
Spring Manure 218	70ab	37a	46a	45a	50ab
Fall Manure 168 every year	58abc	36a	50a	56a	50ab
$LSD_{0.05}$	33	24	43	50	17

[a]means within years and on average with the same letter are not significantly different at p = 0.05

Corn Yield

Treatment	2001	2002	2003	2004	Average (2001-04)
	yield (kg ha^{-1}) [a]				
Fall 168 - Ammonia	8199c	8707b	8293ab	10182c	8845cd
Spring 168 - Ammonia	8871bc	8364b	7477b	10273bc	8740d
Fall 252 - Ammonia	8277c	7973b	7945b	10283bc	8619d
Spring 252 - Ammonia	8967bc	8474b	8450ab	11147ab	9302c
Fall Manure 218	10338a	10906a	9232a	11949a	10607a
Spring Manure 218	10060a	10609a	9227a	11813a	10427a
Fall Manure 168 every year	9562ab	10359a	7864b	11570a	9854b
$LSD_{0.05}$	958	1006	981	901	488
Pocahontas County average	8485	10046	10542	12260	10333

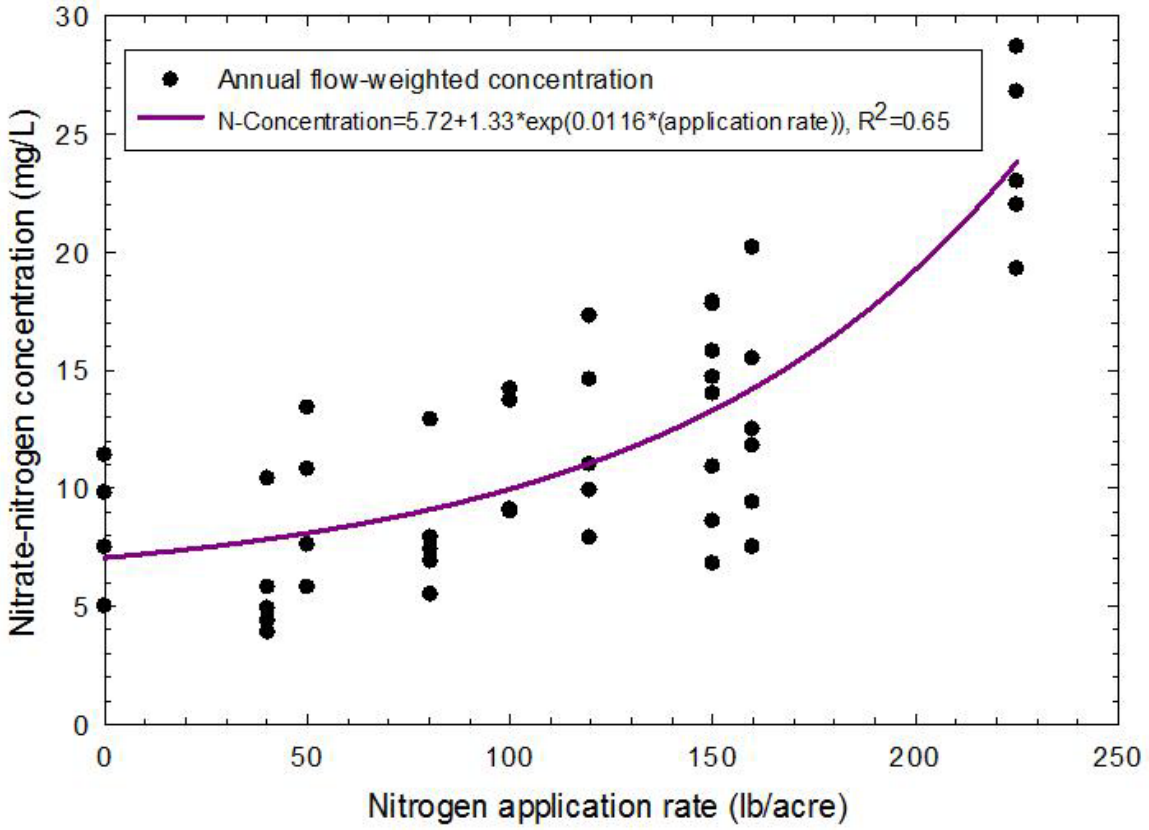
[a]means within years and on average with the same letter are not significantly different at p = 0.05

Soybean Yield

Treatment	2001	2002	2003	2004	Average (2001-04)
	yield (kg ha^{-1}) [a]				
Fall 168 - Ammonia	2895c	2829bc	2020ab	2913c	2683d
Spring 168 - Ammonia	3530ab	3459ab	2222ab	3082abc	3073b
Fall 252 - Ammonia	3006c	2580c	1874b	2890c	2625d
Spring 252 - Ammonia	3670ab	3362ab	2287ab	3254abc	3143ab
Fall Manure 218	3175bc	2916bc	1881b	3025bc	2765cd
Spring Manure 218	3804a	3620a	2506a	3688a	3393a
Fall Manure 168 every year	3193bc	3216abc	2012ab	3563ab	2996bc
$LSD_{0.05}$	499	653	582	612	274
Pocahontas County average	2856	3286	2251	3084	2869

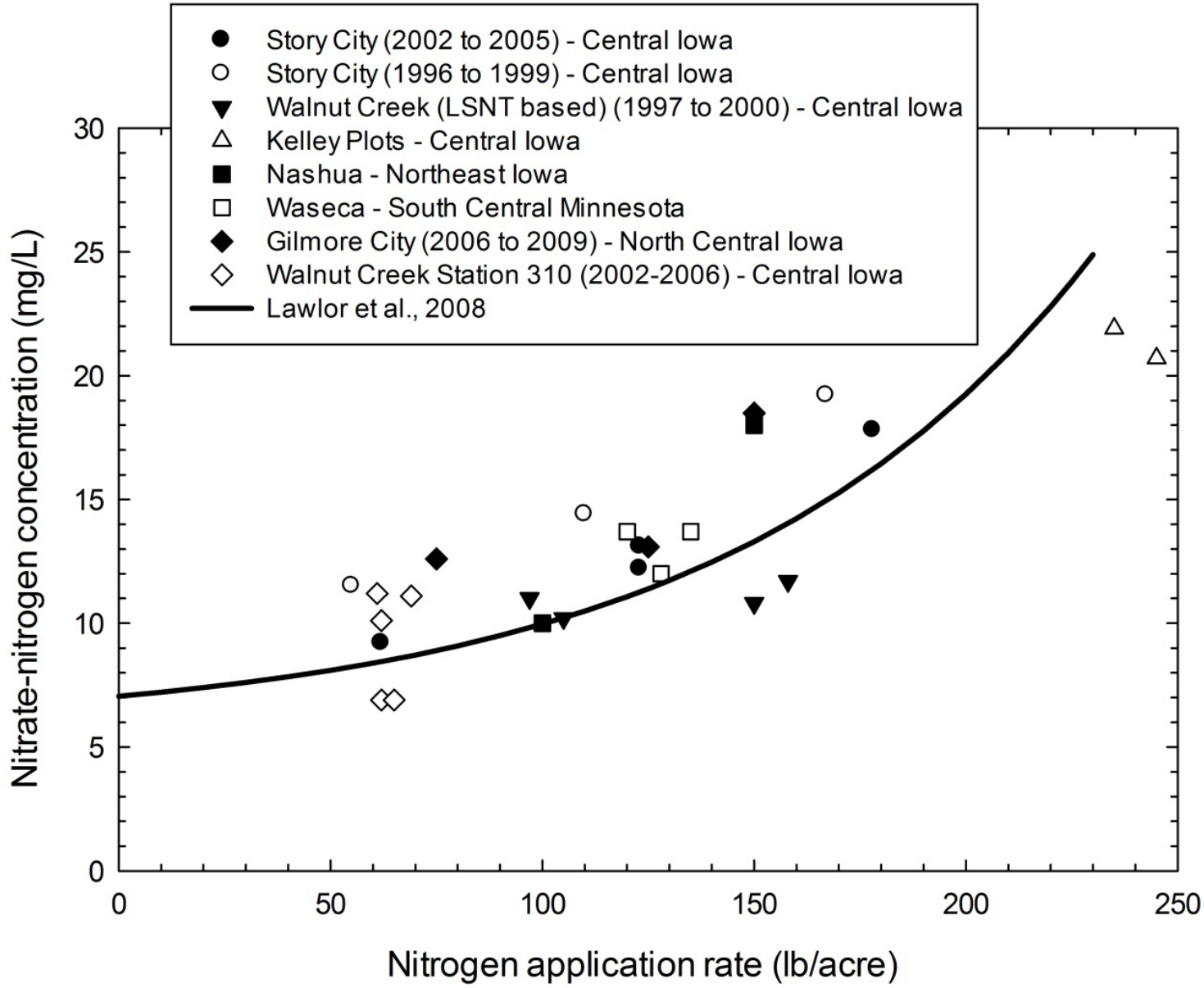
[a]means within years and on average with the same letter are not significantly different at p = 0.05

Impact of Nitrogen Application Rate



Overall Nitrogen Application Rate Effect on Nitrate-Nitrogen Concentration for Corn-Soybean Rotation 1990-2004 (not all rates present in each year)

Impact of Nitrogen Application Rate



Summary

- Fall or spring application of ammonia or manure resulted in similar nitrate-N concentrations in subsurface drainage
- Manure application every year in a corn-soybean rotation increased nitrate-N concentrations in subsurface drainage
- Similar nitrate-N concentrations in subsurface drainage between liquid swine manure and ammonia
- Use of liquid swine manure increase corn yield
- Nitrogen application rate is a critical factor relative to drainage water quality

Source

- Lawlor, P.A., M.J. Helmers, J.L. Baker, S.W. Melvin, and D.W. Lemke. 2011. Comparison of liquid swine manure and ammonia nitrogen application timing on subsurface drainage water quality in Iowa. *Trans. ASABE* 54(3): 973-981.

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Questions and Comments

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