Seedbanking, seeding rates, and increased nitrogen fertility

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Why?

- Quicker establishment
- Concentration of resources
- Combating high traffic areas
- Sustainability

Seedbanking

- Reserves of viable seeds in soil and surface
- Transient vs. persistent (Bewley and Black, 1994)
  - Short lived (1 yr or less) vs. long lived
- Seed size
  - Small = better potential for banking (Thompson, 1987)
- Perennial ryegrass – low numbers in soil (Roberts, 1981)
- *Poa spp.* – traditionally high (*annua*)

Seedbanking

- Human intervention
  - How do seeding rates affect seedbanking potential?
- Can we form a transient seedbank?
- Incorporation of seed into soil
  - “Cleating in” – ¾” cleats
- Short term evaluation
- Common recommendation for sports fields
  - Build up a ‘seedbank’ – popular literature
- Need research to examine this trend

Nitrogen rate

- What do we know? (Cockerham et al., 1993)
  - Highest need in turf
  - Often severely deficient
  - Too little, biomass lacks
  - Too much, wear tolerance lacks
  - Will increase aboveground biomass
    - The single most important factor in determining shear strength, resilience, and wear tolerance is above ground biomass (Canaway, 1983)
  - Root biomass decreases
  - High seeding rates?

Initial study

- Fall 2008
- Seeded KBG at 3 lb 1000 ft^2
- No traffic applied
- N rates of 2, 4, 6, 8, 10 lb 1000 ft^2 applied
  - Evenly divided applications over 8 weeks

Seeded 9-4-08, Total N applied in Sept and Oct

Three experiments

1. Fate of seed in soil
   - What happens to seed when we plant it?

2. Seedling emergence
   - What practices lead to “banked” seed?

3. Fertility based establishment
   - Can increased inputs of N = more/quicker cover?

1. Fate of seed in soil

- Initiated 20 September 2009
  - ISU Horticulture research station
- Seed buried in nylon mesh
  - Easy retrieval, permeability, containment
- Buried at 1” depth (3/4” cleated in depth)
- 3 x 400 seeds on each of 3 retrieval dates
  - End of traffic season, following spring, 1 yr later
- Ideal planting depth?

Methodology

Analysis

- Non-germinated isolated
- Germination chambers - greenhouse
- Monitored for germination
  - PR: 14-21 days; KB: 21+ days
- Forceps tested
- TZ stained


PR F1
81

1st year results - KBG

Initial germination, secondary germination, abnormal germination, and non viable (dead) seeds of Kentucky bluegrass from three replications buried at one inch depth in Sept 2009, recovered in Dec 2009.

KBG

Sample	Total Seeds	Initial Germination (In Field)	Secondary germination (Greenhouse)	Abnormal germination	Dead seeds	Viable seed	Initial germination %
1	400	338	0	0	62	0	0.845
2	400	337	1	6	53	3	0.8425
3	400	341	0	1	58	0	0.8525
Mean	**400**	**338.67**	**0.33**	**2.33**	**57.67**	**1.00**	**84.67%**

Initial germination, secondary germination, abnormal germination, and non viable (dead) seeds of Kentucky bluegrass from three replications buried at one inch depth in Sept 2009, recovered in April 2010.

KBG

Sample	Total Seeds	Initial Germination (In Field)	Secondary germination (Greenhouse)	Abnormal germination	Dead seeds	Viable seed	Initial germination %
1	400	364	0	0	36	0	0.91
2	400	363	0	0	37	0	0.9075
3	400	375	0	0	24	1	0.9375
Mean	**400**	**367.33**	**0.00**	**0.00**	**32.33**	**0.33**	**91.83%**

1st year results - PR

Initial germination, secondary germination, abnormal germination, and non viable (dead) seeds of perennial ryegrass from three replications buried at one inch depth in Sept 2009, recovered in Dec 2009.

PR

Sample	Total Seeds	Initial Germination (In Field)	Secondary germination (Greenhouse)	Abnormal germination	Dead seeds	Viable seed	Initial germination %
1	400	358	1	0	41	0	0.895
2	400	353	2	0	45	0	0.8825
3	400	345	1	0	53	1	0.8625
Mean	**400**	**352.00**	**1.33**	**0.00**	**46.33**	**0.33**	**88.00%**

Initial germination, secondary germination, abnormal germination, and non viable (dead) seeds of perennial ryegrass from three replications buried at one inch depth in Sept 2009, recovered in April 2010.

PR

Sample	Total Seeds	Initial Germination (In Field)	Secondary germination (Greenhouse)	Abnormal germination	Dead seeds	Viable seed	Initial germination %
1	400	355	0	0	45	0	0.8875
2	400	358	0	0	42	0	0.895
3	400	389	0	0	11	0	0.9725
Mean	**400**	**367.33**	**0.00**	**0.00**	**32.67**	**0.00**	**91.83%**

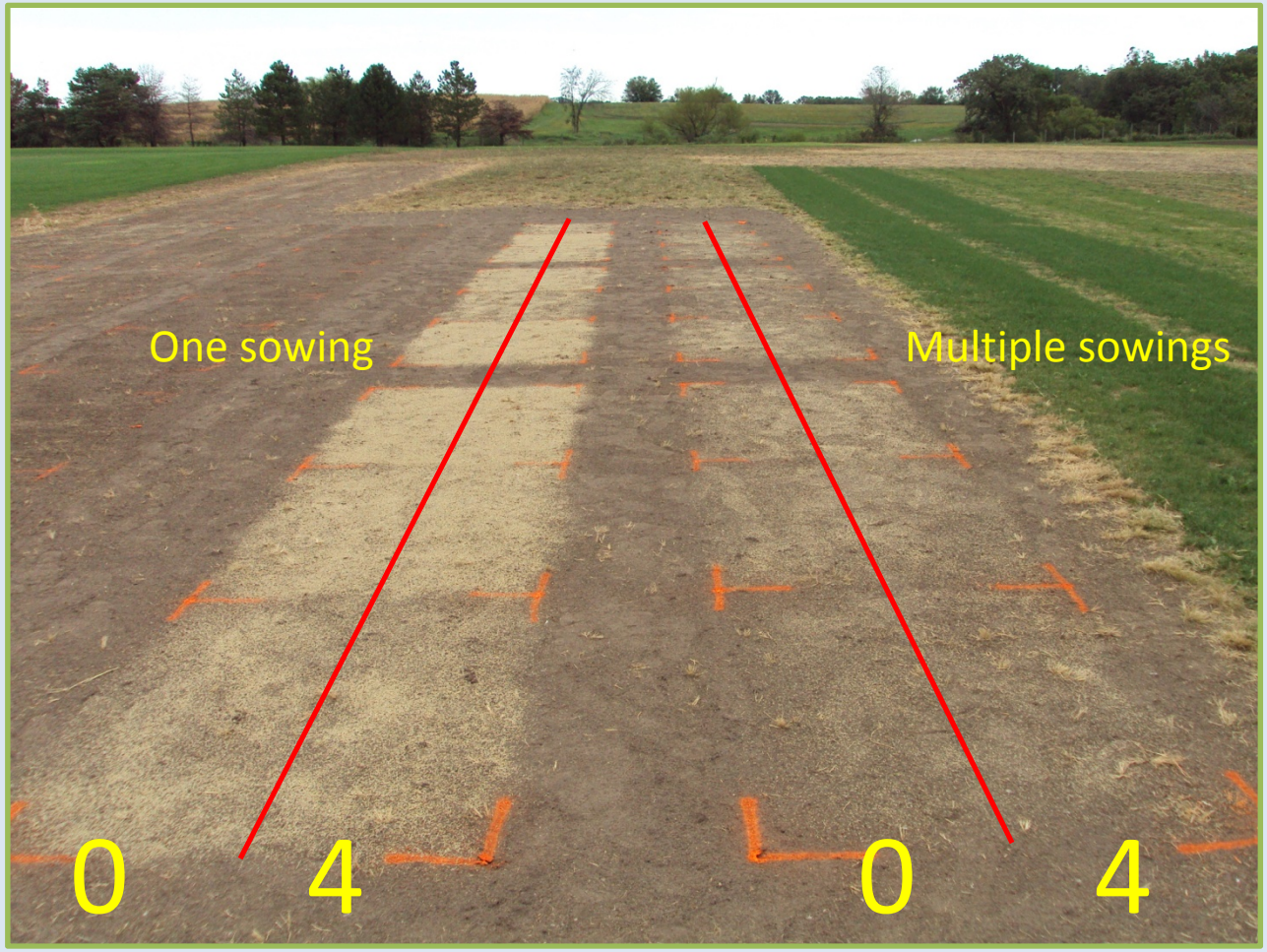
Results

- Most seed germinates at 1”
- Seed leftover is mostly non-viable (dead)
- Year 2 currently being analyzed
- Limited long term viability at 1” depth
- Representing a “one time” seeding

2. Seedling emergence

- Seed at higher than normal rates (increase input)
  - PR: 30, 60, 90 lb 1000 ft^{-2}
  - KB: 6, 12, 24 lb 1000 ft^{-2}
- Two seeding regimes
  - All at once vs. multiple seedings
- Two traffic rates
  - How will traffic affect seedbank potential?
  - No traffic vs. 4 passes/week

Plot layout



Methods

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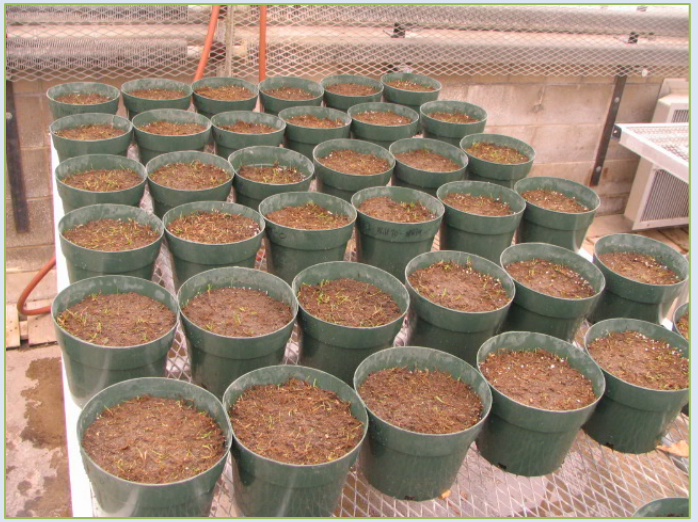


Analysis

- Percentage cover
  - Sept, Oct, Nov
  - Digital image analysis

- Seedling emergence
  - 3 sample dates (Dec, Apr, Sept)
  - Top 1” sliced off core, broken up
  - Spread to ~ ½” in 8” AZ pot
  - Emerged seedlings counted, stirred, counted

Percentage cover

Kentucky bluegrass

Mean values for percentage PR turf cover in Sept, Oct, Nov, and Dec 2010 averaged over three replications.

Source		Month			
2010		Sept	Oct	Nov	Dec
Seeding Rate	df	Percent turf cover			
30	2	36.8	66.7	59.6	58.0
60	2	53.8	78.9	73.8	68.7
90	2	62.8	81.9	79.6	72.6
$LSD_{(0.05)}$		**7.5**	**2.1**	**8.1**	**6.2**

- **One time seeding resulted in 33% greater turf cover**

Perennial ryegrass

Mean values for percentage KBG turf cover in Sept, Oct, Nov, and Dec 2010 averaged over three replications.

Source		Month			
2010		Sept	Oct	Nov	Dec
Seeding Rate	df	Percent turf cover			
6	2	4.1	13.5	19.9	20.1
12	2	9.9	19.3	23.3	21.4
24	2	16.7	22.6	26.5	21.1
$LSD_{(0.05)}$		**4.4**	**5.6**	**4.1**	**NS**

- **One time seeding resulted in 18% greater turf cover**

Emerged seedlings

Kentucky bluegrass

Mean Kentucky bluegrass seedling emergence from top one inch of soil cores over three replications in Dec 2009, Apr 2010, and Sept 2010.

Source		Month		
2009-2010		Dec, 2009	Apr, 2010	Sept, 2010
Seeding regime/traffic level	df	Seedlings emerged		
One - no traffic	6	10.6	0.8	1.8
One - 4 passes/wk	6	4.3	0.1	0.9
Multiple - no traffic	6	40.7	3.2	0.9
Multiple - 4 passes/wk	6	36.3	1.2	0.9
$LSD_{(0.05)}$		**NS**	**2.0**	**NS**
Seedrate	df	Seedlings emerged		
6	4	15.4	0.7	1.5
12	4	27.2	1.4	0.8
24	4	26.3	1.9	1.1
$LSD_{(0.05)}$		**NS**	**NS**	**NS**

Perennial ryegrass

Mean perennial ryegrass seedling emergence from top one inch of soil cores over three replications in Dec 2009, Apr 2010, and Sept 2010.

Source		Month		
2009-2010		Dec, 2009	Apr, 2010	Sept, 2010
Seeding regime/traffic level	df	Seedlings emerged		
One - no traffic	6	3.8	5.8	0.2
One - 4 passes/wk	6	1.7	3.4	1.0
Multiple - no traffic	6	172.4	32.1	0.2
Multiple - 4 passes/wk	6	112.1	19.8	0.0
$LSD_{(0.05)}$		**37.1**	**7.3**	**NS**
Seedrate	df	Seedlings emerged		
30	4	39.3	15.0	0.0
60	4	64.0	15.3	0.4
90	4	114.3	15.5	0.8
$LSD_{(0.05)}$		**28.1**	**NS**	**0.5**

Calculated lb “available” seed

Seedrate (lb 1000 ft^{-2})	Mean emerged seedlings 12.6 in^{-2} (In December 2009)	lb available seed 1000 ft^{-2}
30	40	2
60	64	3
90	114	6

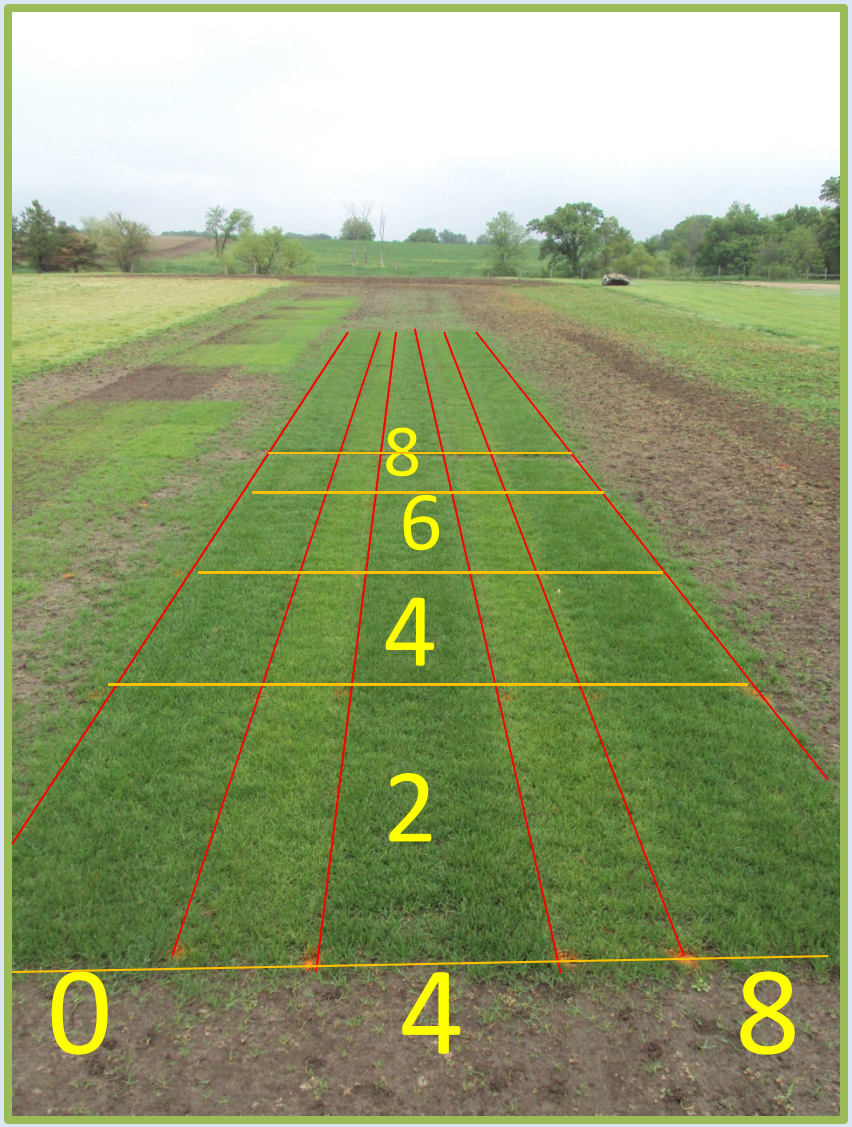
Results

- Percentage cover follows with previous results
- One time vs. multiple
  - Percentage cover
  - Emerged seedlings
- Bare soil situations, seed germinates
  - Limited viability in single seeding regime
  - Multiple inputs increase available seed
- Combination of techniques for best results

3. Fertility (N) based establishment

- One seeding rate per species
  - KB: 5 lb 1000 ft^{-2}
  - PR: 30 lb 1000 ft^{-2}
- Four nitrogen rates (urea)
  - 2, 4, 6, 8 lb 1000 ft^{-2}
  - Eight equal applications (.25, .5, .75, 1.0 x 8)
- Three traffic levels (0, 4, 8)
  - Spring – traffic applied after establishment
  - Fall – traffic applied 1 week after seeding

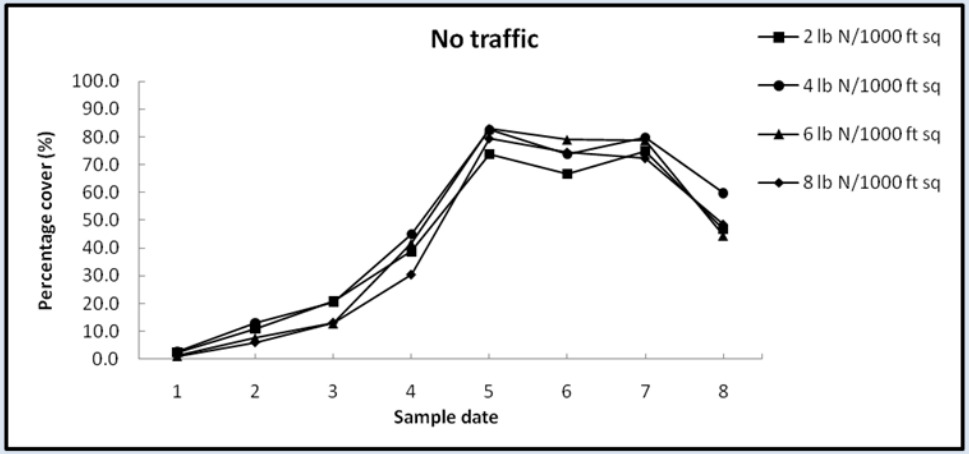
Plot layout

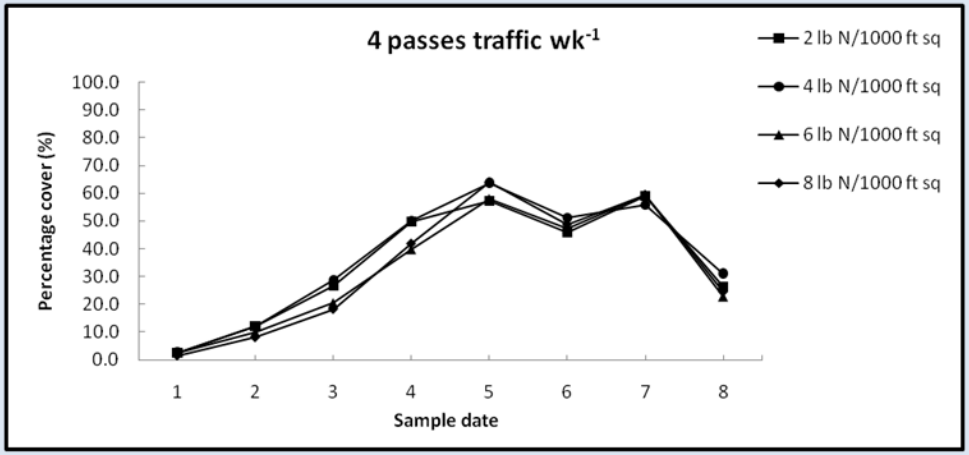


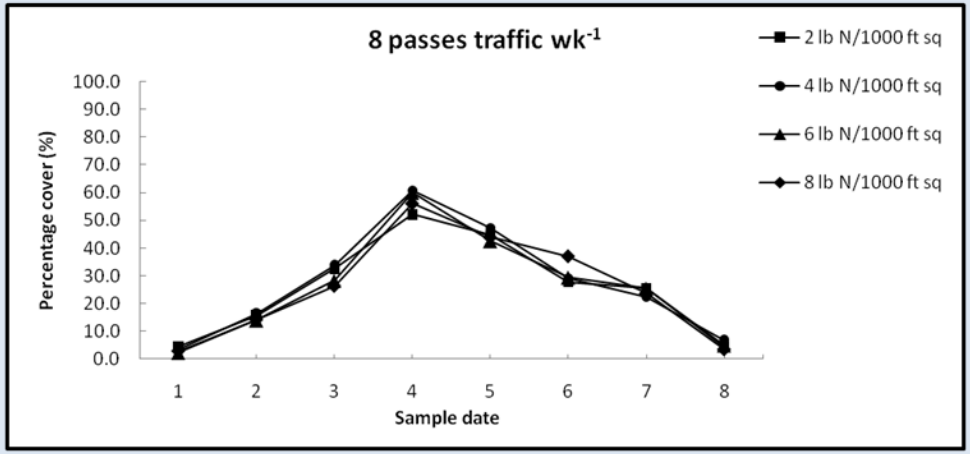
Analysis

- Percentage cover
  - Digital image anaylsis
- Will determine if increased N inputs affect establishment and wear tolerance
- Potential to use weather data
  - More rain = more leached N?

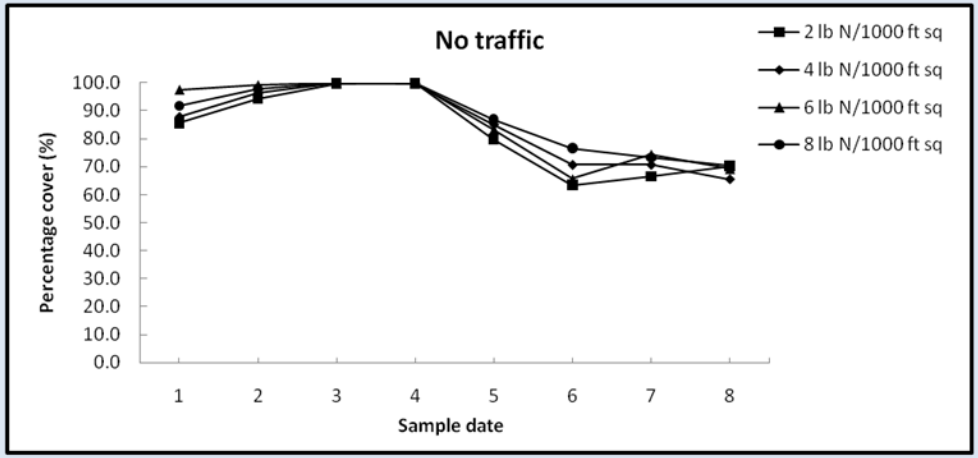
Kentucky bluegrass

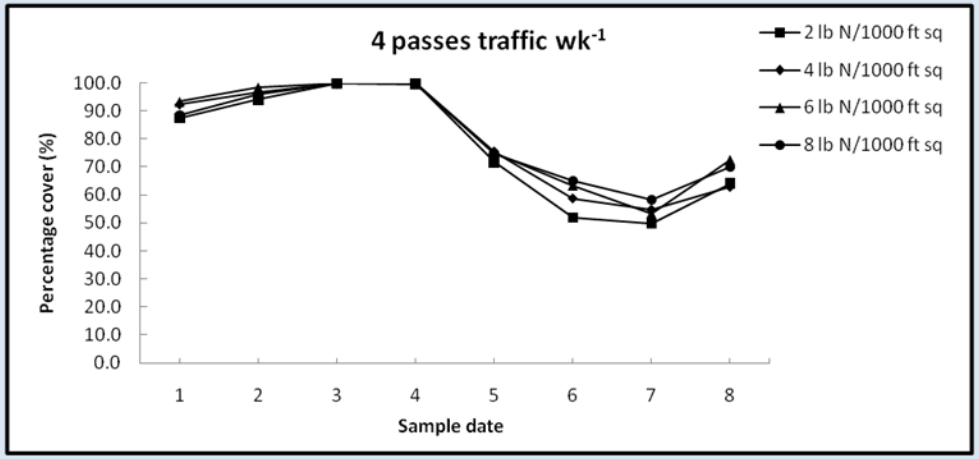


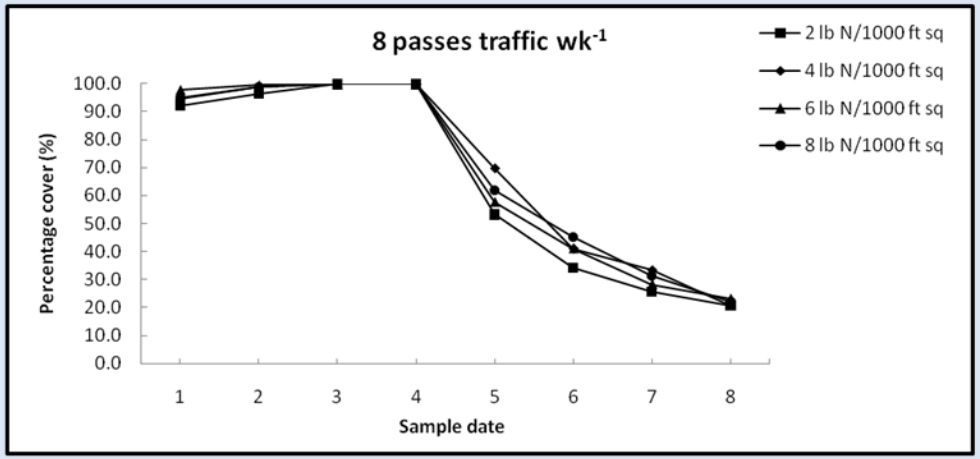




Perennial ryegrass







Results

- No main effect of nitrogen in spring or fall
- Contrasts preliminary study
- Incremental increase in N does not appear to decrease wear tolerance
- Nitrogen effects may be masked by high seeding rates

Questions?

- Contact:

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THANKS!