Improving Native Soil Athletic Field Drainage

Michigan State University
Department of Crop and Soil Sciences

Alexander Kowalewski,
James R. Crum, and John N. Rogers, III

High School Athletic Field

- Sports and community events
  - Football
  - Lacrosse
  - Soccer
  - Cheerleading
  - Marching band
  - Rugby
  - Track and field

Native Soil Athletic Fields

- High in silt and clay
  - Advantage
    - Stable when dry
  - Disadvantage
    - Low infiltration rates

During Heavy Rainfall

- Saturated field conditions

- Decrease soil stability

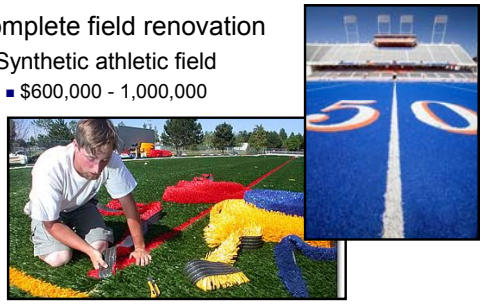
Field Failure

- Reduced
  - Playability
  - Visual aesthetics

Haslett, Mich., November 2006

Solutions

- Complete field renovation
  - Synthetic athletic field
    - $600,000 - 1,000,000

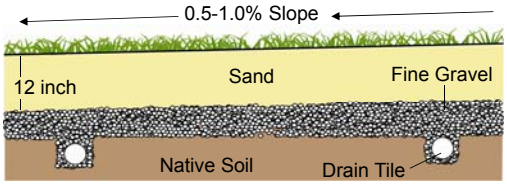


Complete Field Renovation

- Sand-based systems
  - Natural playing surface
  - Rapid infiltration rates
  - Maintain stability during periods of heavy use

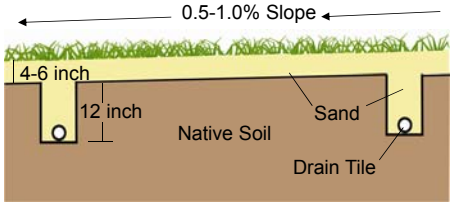
Sand-Based Systems

- Conventional sand-based field
  - $400,000 - 600,000



Sand-Based Systems

- Sand-capped system
  - $200,000 - 300,000



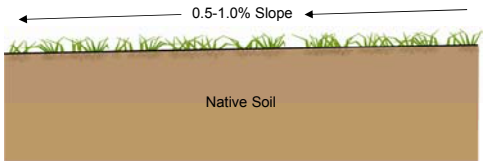
Complete Field Renovations

- Expensive
- Field temporarily useless

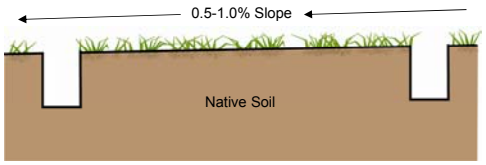
Alternative Renovation Process

- Intercept drain tile installation
- Cumulative topdressing
  - Built-up sand-capped system

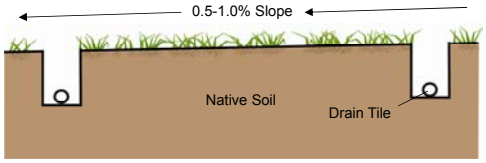
Native Soil Athletic Fields



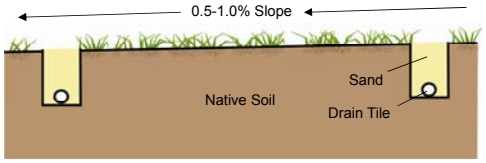
Cut Drain Lines



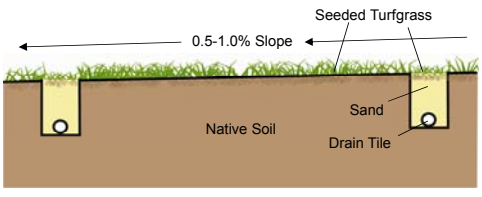
Install Drain Tiles



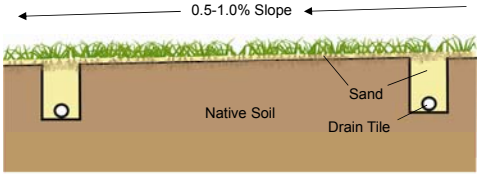
Fill Drain Lines with Sand



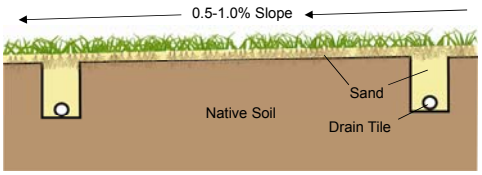
Inter-seed



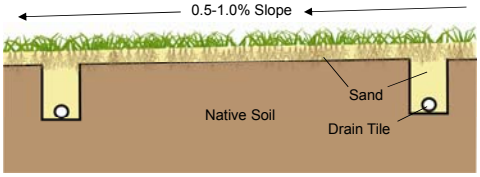
Sand Topdressing #1



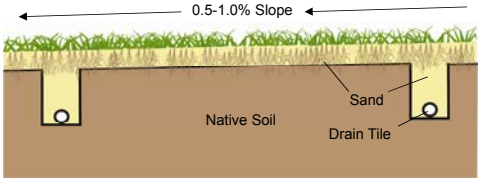
Sand Topdressing #2



Sand Topdressing #3



Sand Topdressing #4



Built-up Sand-capped System

- Benefits
  - Field is never totally out of play
  - $36,000 - 75,000
    - Increase drain tile spacing
    - Decrease sand layer depth



Questions

- How much sand can be applied in a single topdressing application?
- How many annual topdressing applications can be made?
- Can field use continue throughout the topdressing process?
- When sand topdressing is included, what drain tile spacing is necessary to provide a dry and stable playing surface?

Experiment 1

How much sand can be applied in a single topdressing application?


Materials and Methods

- Greenhouse
  - Initiated Mar. 7, 2007
- Sand topdressing rates (depth)
  - 0 (control)
  - 1/16 inch
  - 1/12 inch
  - 1/8 inch
  - 1/6 inch
  - 1/4 inch
  - 1/3 inch

Materials and Methods

- Recently established
  - Kentucky bluegrass
  - Perennial ryegrass
  - Kentucky bluegrass - perennial ryegrass mix

Materials and Methods

- Data collection (Mar. 23 – Apr. 28, 2007)
  - Turfgrass injury (1 – 9, 6 ≥ acceptable)
  - Percent cover (0 – 100%)
  - Weekly growth (inch)

Results 2007

- Sand topdressing, regardless of rate, produced no long term effects on turfgrass health (injury, growth or cover)
- Up to 1/3 inch can safely be applied in one application to recently established turfgrass

Experiment 2

How many annual topdressing applications can be made?

Can field use continue throughout the topdressing process?

Materials and Methods

- Research initiated Apr. 10, 2007
- Hancock Turfgrass Research Center
  - East Lansing, Mich.
- Native soil
  - Sandy loam

Materials and Methods

- Placed into a constructed research plot
- Compacted
  - Heavy machinery traffic
  - Vibratory compactor


Materials and Methods

- May 23, 2007
  - Core cultivated
- Seeded
  - 90% Kentucky bluegrass
  - 10% perennial ryegrass
- Starter fertilizer (16-25-13)
  - 1 lbs / 1000 ft^2 of P


Materials and Methods

- July 11 – Aug. 15, 2007
  - Cumulative topdressing applications
    - Well-graded sand (90% sand - 10% silt/clay)
      - ¼ inch per application
- Henderson, J.J., 2000
  - 98% sand – 2% silt/clay
  - 95% sand – 5% silt/clay
  - 93% sand – 7% silt/clay
  - 92% sand – 8% silt/clay
  - 90% sand – 10% silt/clay
  - 88% sand – 12% silt/clay
  - 85% sand – 15% silt/clay
  - 81% sand – 19% silt/clay

Drainage ↑↓ Stability

Materials and Methods

- July 11 – Aug. 15, 2007
  - Cumulative topdressing applications
    - Well-graded sand (90% sand - 10% silt/clay)
      - ¼ inch per application
- Henderson, J.J., 2000
  - 98% sand – 2% silt/clay
  - 95% sand – 5% silt/clay
  - 93% sand – 7% silt/clay
  - 92% sand – 8% silt/clay
  - 90% sand – 10% silt/clay
  - 88% sand – 12% silt/clay
  - 85% sand – 15% silt/clay
  - 81% sand – 19% silt/clay

Drainage ↑↓ Stability

Materials and Methods

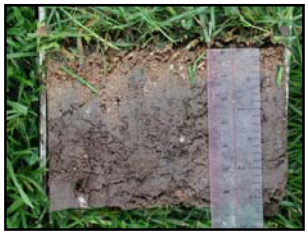
- Cumulative topdressing treatments
  - 0
  - 2 (½ inch)
  - 4 (1 inch)
  - 6 (1 ½ inch)
  - 8 (2 inch)

Materials and Methods

- 0 topdressing applications (0 inch)
  - August 15, 2007

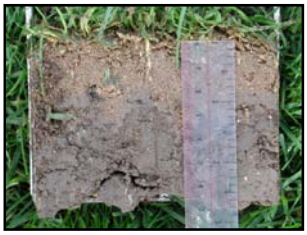
Materials and Methods

- 2 topdressing applications (½ inch)
  - August 15, 2007



Materials and Methods

- 4 topdressing applications (1 inch)
  - August 15, 2007



Materials and Methods

- 6 topdressing applications (1 ½ inch)
  - August 15, 2007

Materials and Methods

- 8 topdressing applications (2 inch)
  - August 15, 2007

Materials and Methods

- During the cumulative topdressing period
  - July 11 – Aug. 15, 2007

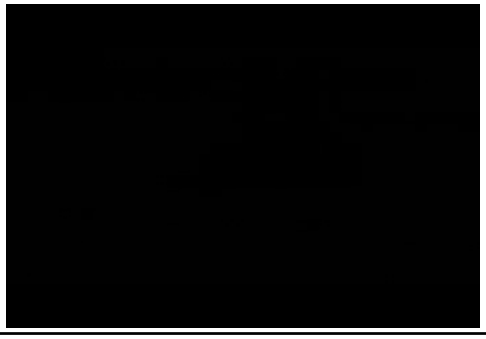
1 application per week
Cady Traffic Simulator

No traffic

Cady Traffic Simulator

- 1 application
  - Backward and forward direction

Cady Traffic Simulator



Summer Use

Materials and Methods

- Fall (In-season) traffic
  - Oct. 10 – Nov. 3, 2007
- High traffic level
  - 2 applications per week

2007 Results

- How many annual topdressing applications can be made?

2007 Results

- Clegg Turf Shear Tester (Nm)
  - Surface strength
- Following fall traffic
  - Oct. 10 – Nov. 3, 2007

Effects of topdressing depth (inch) on Clegg Turf Shear Tester strength (Nm) following 10 fall traffic applications, Nov. 9, 07.

Topdressing Depth (in)†	2007 Mean Turf Shear Tester (Nm)	
0.0	60.7	b
0.5	87.1	a
1.0	63.6	ab
1.5	51.2	b
2.0	47.9	b

† ¼ inch sand topdressing per application; Fisher's $LSD_{(0.05)}$.

Effects of topdressing depth (inch) on Clegg Turf Shear Tester strength (Nm) following 10 fall traffic applications, Nov. 9, 07.

Topdressing Depth (in)†	2007 Mean Turf Shear Tester (Nm)	
0.0	60.7	b
0.5	87.1	a
1.0	63.6	ab
1.5	51.2	b
2.0	47.9	b

† ¼ inch sand topdressing per application; Fisher's $LSD_{(0.05)}$.

Effects of topdressing depth (inch) on Clegg Turf Shear Tester strength (Nm) following 10 fall traffic applications, Nov. 9, 07.

Topdressing Depth (in)†	2007 Mean Turf Shear Tester (Nm)	
0.0	60.7	b
0.5	87.1	a
1.0	63.6	ab
1.5	51.2	b
2.0	47.9	b

† ¼ inch sand topdressing per application; Fisher's $LSD_{(0.05)}$.

2007 Results

- Can the field use continue throughout the topdressing process?

2007 Results

- Turfgrass Cover (0-100%)
  - Throughout fall traffic period
    - Oct. 10 – Nov. 3, 2007

Effects of summer and fall traffic on turfgrass cover (0-100%) after 0, 4, and 8 fall traffic applications, Oct. 10 – Nov. 3, 2007

	Fall Traffic Applications					
	0 apps		4 apps		8 apps	
	Oct-10-07		Oct-19-07		Nov-02-07	
Traffic	2007 Mean Turfgrass Cover (0-100%)					
fall traffic only	100.0	a	78.7	a	49.3	ns
summer & fall traffic††	85.3	b	57.7	b	40.7	ns

†† Summer & fall traffic treatments received traffic applied once a week from July 11 – Aug. 15, 2007, then twice a week from Oct. 10 – Nov. 3, 2007; Fisher's LSD(0.05).

Effects of summer and fall traffic on turfgrass cover (0-100%) after 0, 4, and 8 fall traffic applications, Oct. 10 – Nov. 3, 2007

	Fall Traffic Applications					
	0 apps		4 apps		8 apps	
	Oct-10-07		Oct-19-07		Nov-02-07	
Traffic	2007 Mean Turfgrass Cover (0-100%)					
fall traffic only	100.0	a	78.7	a	49.3	ns
summer & fall traffic††	85.3	b	57.7	b	40.7	ns

†† Summer & fall traffic treatments received traffic applied once a week from July 11 – Aug. 15, 2007, then twice a week from Oct. 10 – Nov. 3, 2007; Fisher's LSD(0.05).

Effects of summer traffic on turfgrass coverage, July 20, 2007.

■Low rate ■Control

2007 Conclusions

- Two cumulative topdressing applications (½ inch) over a one month period provided the greatest strength
- Up to 8 topdressing applications (2 inches) over a one month period was no different than the control
- Summer use on a recently established turfgrass stand, while being topdressed, will be detrimental to turfgrass cover

2008 Results

- Apr. 22, 2008
  - Core cultivated
  - Inter-seeded
- July 14 – Aug. 22, 2008
  - Topdressing repeated

2008 Results

- Cumulative Topdressing Treatments
  - 0
  - 4 (1 inch)
  - 8 (2 inch)
  - 12 (3 inch)
  - 16 (4 inch)

16 topdressing applications applied over two years providing a 4 inch sand layer, Sep. 18, 2008.

2008 Results

- How many annual topdressing applications can be made?

2008 Results

- Turfgrass Cover (0-100%)
  - Throughout fall traffic period
    - Oct. 13 – Nov. 5, 2008

Effects of topdressing depth (inch) on turfgrass coverage (0-100%) after 0, 4 and 8 fall traffic applications, Oct. 13-Nov. 5, 08.

	Fall Traffic Applications					
	0 apps		4 apps		8 apps	
	Oct-13-08		Oct-22-08		Nov-05-08	
Topdressing Depth (in)†	2008 Mean Turfgrass Cover (0-100%)					
0.0	100.0	ns	83.3	b	56.7	c
1.0	100.0	ns	93.3	a	67.5	b
2.0	100.0	ns	92.5	a	73.3	ab
3.0	100.0	ns	93.3	a	74.2	ab
4.0	100.0	ns	91.7	a	78.3	a

† ¼ inch sand topdressing per application; Fisher's $LSD_{(0.05)}$.

Effects of topdressing depth (inch) on turfgrass coverage (0-100%) after 0, 4 and 8 fall traffic applications, Oct. 13-Nov. 5, 08.

	Fall Traffic Applications					
	0 apps		4 apps		8 apps	
	Oct-13-08		Oct-22-08		Nov-05-08	
Topdressing Depth (in)†	2008 Mean Turfgrass Cover (0-100%)					
0.0	100.0	ns	83.3	b	56.7	c
1.0	100.0	ns	93.3	a	67.5	b
2.0	100.0	ns	92.5	a	73.3	ab
3.0	100.0	ns	93.3	a	74.2	ab
4.0	100.0	ns	91.7	a	78.3	a

† ¼ inch sand topdressing per application; Fisher's $LSD_{(0.05)}$.

2008 Results

- Effects of cumulative topdressing applications on turfgrass coverage, Nov. 7, 2008.

- Control (0 inch)
- 4 treatments (1 inch)

2008 Results

- Clegg Turf Shear Tester (Nm)
  - Surface strength
- Following fall traffic
  - Oct. 13 – Nov. 12, 2008

Effects of topdressing depth (inch) on Clegg Turf Shear Tester strength (Nm) following 10 fall traffic applications, Nov. 12, 08.

Topdressing Depth (in)†	2008 Mean Turf Shear Teater (Nm)	
0.0	129.4	a
1.0	133.6	a
2.0	98.5	b
3.0	92.3	b
4.0	83.7	b

† ¼ inch sand topdressing per application; Fisher's $LSD_{(0.05)}$.

Effects of topdressing depth (inch) on Clegg Turf Shear Tester strength (Nm) following 10 fall traffic applications, Nov. 12, 08.

Topdressing Depth (in)†	2008 Mean Turf Shear Teater (Nm)	
0.0	129.4	a
1.0	133.6	a
2.0	98.5	b
3.0	92.3	b
4.0	83.7	b

† ¼ inch sand topdressing per application; Fisher's $LSD_{(0.05)}$.

Effects of topdressing depth (inch) on Clegg Turf Shear Tester strength (Nm) following 10 fall traffic applications, Nov. 12, 08.

Topdressing Depth (in)†	2008 Mean Turf Shear Teater (Nm)	
0.0	129.4	a
1.0	133.6	a
2.0	98.5	b
3.0	92.3	b
4.0	83.7	b

† ¼ inch sand topdressing per application; Fisher's $LSD_{(0.05)}$.

2008 Results

- Can the field use continue throughout the topdressing process?

2008 Results

- Turfgrass cover (0-100%)
  - Throughout fall traffic period
    - Oct. 13 – Nov. 5, 2008

Effects of summer and fall traffic on turfgrass cover (0-100%) after 0, 4, and 8 fall traffic applications, Oct. 13 – Nov. 5, 2007

	Fall Traffic Applications					
	0 apps		4 apps		8 apps	
	Oct-13-08		Oct-22-08		Nov-05-08	
Traffic	2008 Mean Turfgrass Cover (0-100%)					
fall traffic only	100.0	ns	90.3	ns	71.0	ns
summer & fall traffic††	100.0	ns	91.3	ns	69.0	ns

†† Summer & fall traffic treatments received traffic applied once a week from July 14 – Aug. 12, 2008, then twice a week from Oct. 13 – Nov. 5, 2008; Fisher's LSD(0.05).

Effects of summer and fall traffic on turfgrass cover (0-100%) after 0, 4, and 8 fall traffic applications, Oct. 13 – Nov. 5, 2007

	Fall Traffic Applications					
	0 apps		4 apps		8 apps	
	Oct-13-08		Oct-22-08		Nov-05-08	
Traffic	2008 Mean Turfgrass Cover (0-100%)					
fall traffic only	100.0	ns	90.3	ns	71.0	ns
summer & fall traffic††	100.0	ns	91.3	ns	69.0	ns

†† Summer & fall traffic treatments received traffic applied once a week from July 14 – Aug. 12, 2008, then twice a week from Oct. 13 – Nov. 5, 2008; Fisher's LSD(0.05).

Effects of year-round use on turfgrass coverage, Sep. 4, 2008.

- Low rate
- Control

2008 Conclusions

- All cumulative topdressing application rates improved turfgrass coverage
- One inch of topdressing sand applied over a two year provided the greatest strength
- Year round use on an established turfgrass stand, while being topdressed, was be detrimental to turfgrass cover

Experiment 3

When sand topdressing is included, what drain tile spacing is necessary to provide a dry and stable playing surface?

Materials and Methods

- Research initiated Apr. 10, 2007
- Hancock Turfgrass Research Center
  - East Lansing, Mich.
- Native soil
  - Sandy loam

Materials and Methods

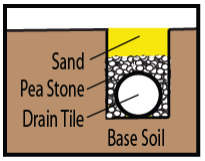
- Plywood research boxes
  - 5.5 ft wide x 8 – 26.5 ft long

Materials and Methods

- Soil placed in boxes
- Compacted
- Leveled 1% surface slope

Materials and Methods

- May 15, 2007
  - Drain tiles (4 inch diameter)
  - Back filled
    - Pea stone
    - Sand (97.6%)



Materials and Methods

- Drain tile spacing
  - 6.5 ft
  - 10 ft
  - 13 ft
  - 20 ft
  - Control (26.5 ft plot without drain tiles)

Materials and Methods

- Core cultivated
- Seeded
  - 90 % Kentucky bluegrass
  - 10% perennial ryegrass
- Starter fertilizer (16-25-13)
  - 1 lbs/1000 ft^2 of P

Materials and Methods

- July 11 – Aug. 15, 2007
  - Cumulative topdressing applications
    - Well-graded sand (90% sand-10% silt/clay)
      - 4 applications at ¼ inch depth per application

Materials and Methods

- In-season traffic
  - Oct. 10 – Nov. 8, 2007
- High traffic level
  - 2 applications per week

2007 Results

- When sand topdressing is included, what drain tile spacing is necessary to provide a dry and stable playing surface?

2007 Results

- Surface moisture (v/v)
  - Dryness
    - TDR probes

2007 Results

- Surface moisture (v/v)
  - Dryness
- ½ inch (17 minute) irrigation events
  - Prior to topdressing (control)
    - July 10, 2007
  - After 2 topdressing applications
    - July 26, 2007
  - After 4 topdressing applications
    - August 10, 2007

Effects of drain tile spacing and cumulative sand topdressing applications on surface (0.5 inch) moisture (v/v) following a 0.5 inch irrigation event, July 10 – Aug. 10, 2007.

	Time (hrs) from Initiation of Irrigation			
	0:00†	1:00	2:00	4:00
Drain Spacing (ft)	2007 Mean Surface Moisture (v/v)			
control‡	29.1 a	37.9 a	36.5 a	31.1 a
20.0	27.5 a	37.3 a	33.9 a	30.5 a
13.0	24.6 b	33.6 b	29.1 b	25.7 b
10.0	25.6 b	34.5 b	29.5 b	26.1 b
6.5	23.3 b	31.9 b	28.2 b	24.3 b
Topdressing Layer (in)‖	2007 Mean Surface Moisture (v/v)			
0.0	39.7 a	46.5 a	43.6 a	40.7 a
0.5	17.5 b	28.8 b	24.6 b	20.7 b
1.0	20.9 b	29.9 b	26.1 b	21.2 b

†Time (hrs) from initiation of irrigation (0.5 inch = 17 min); ‡26.5 ft plot without drain tiles; ‖1/4 inch depth sand per topdressing application; Fisher's $LSD_{(0.05)}$.

Effects of drain tile spacing and cumulative sand topdressing applications on surface (0.5 inch) moisture (v/v) following a 0.5 inch irrigation event, July 10 – Aug. 10, 2007.

	Time (hrs) from Initiation of Irrigation			
	0:00†	1:00	2:00	4:00
Drain Spacing (ft)	2007 Mean Surface Moisture (v/v)			
control‡	29.1 a	37.9 a	36.5 a	31.1 a
20.0	27.5 a	37.3 a	33.9 a	30.5 a
13.0	24.6 b	33.6 b	29.1 b	25.7 b
10.0	25.6 b	34.5 b	29.5 b	26.1 b
6.5	23.3 b	31.9 b	28.2 b	24.3 b
Topdressing Layer (in)‖	2007 Mean Surface Moisture (v/v)			
0.0	39.7 a	46.5 a	43.6 a	40.7 a
0.5	17.5 b	28.8 b	24.6 b	20.7 b
1.0	20.9 b	29.9 b	26.1 b	21.2 b

†Time (hrs) from initiation of irrigation (0.5 inch = 17 min); ‡26.5 ft plot without drain tiles; ‖1/4 inch depth sand per topdressing application; Fisher's $LSD_{(0.05)}$.

Effects of drain tile spacing and cumulative sand topdressing applications on surface (0.5 inch) moisture (v/v) following a 0.5 inch irrigation event, July 10 – Aug. 10, 2007.

	Time (hrs) from Initiation of Irrigation			
	0:00†	1:00	2:00	4:00
Drain Spacing (ft)	2007 Mean Surface Moisture (v/v)			
control‡	29.1 a	37.9 a	36.5 a	31.1 a
20.0	27.5 a	37.3 a	33.9 a	30.5 a
13.0	24.6 b	33.6 b	29.1 b	25.7 b
10.0	25.6 b	34.5 b	29.5 b	26.1 b
6.5	23.3 b	31.9 b	28.2 b	24.3 b
Topdressing Layer (in)‖	2007 Mean Surface Moisture (v/v)			
0.0	39.7 a	46.5 a	43.6 a	40.7 a
0.5	17.5 b	28.8 b	24.6 b	20.7 b
1.0	20.9 b	29.9 b	26.1 b	21.2 b

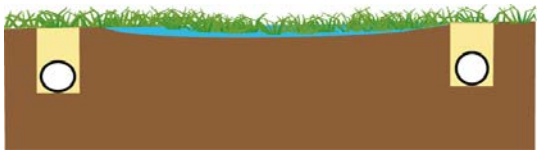
†Time (hrs) from initiation of irrigation (0.5 inch = 17 min); ‡26.5 ft plot without drain tiles; ‖1/4 inch depth sand per topdressing application; Fisher's $LSD_{(0.05)}$.

2007 Results

- Control treatments have high surface moisture (v/v).

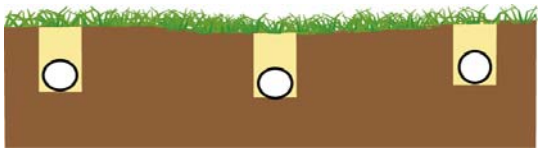
2007 Results

- Treatments with 20 ft drain spacing also have high surface moisture (v/v).



2007 Results

- Decrease drain tile spacing to minimum of 13 ft will prevent increased surface moisture (v/v).



2007 Results

- Clegg Turf Shear Tester (Nm)
  - Stability
- Following fall traffic
  - Oct. 10 – Nov. 8, 2007

Effects of drain tile spacing on Clegg Turf Shear Tester strength (Nm) following one inch of cumulative sand topdressing and 10 fall traffic applications, Nov. 8, 07.

Drain Spacing (ft)	2007 Mean Turf Shear Tester (Nm)	
Control†	60.6	b
20.0	68.8	ab
13.0	82.9	a
10.0	71.7	ab
6.5	81.3	a

† 26.5 ft plot without drain tiles; Fisher's LSD(0.05).

Effects of drain tile spacing on Clegg Turf Shear Tester strength (Nm) following one inch of cumulative sand topdressing and 10 fall traffic applications, Nov. 8, 07.

Drain Spacing (ft)	2007 Mean Turf Shear Tester (Nm)	
Control†	60.6	b
20.0	68.8	ab
13.0	82.9	a
10.0	71.7	ab
6.5	81.3	a

Topdressing layer - 1 inch

† 26.5 ft plot without drain tiles; Fisher's LSD(0.05).

Effects of drain tile spacing on Clegg Turf Shear Tester strength (Nm) following one inch of cumulative sand topdressing and 10 fall traffic applications, Nov. 8, 07.

Drain Spacing (ft)	2007 Mean Turf Shear Tester (Nm)	
Control†	60.6	b
20.0	68.8	ab
13.0	82.9	a
10.0	71.7	ab
6.5	81.3	a

† 26.5 ft plot without drain tiles; Fisher's LSD(0.05).

Effects of drain tile spacing on Clegg Turf Shear Tester strength (Nm) following one inch of cumulative sand topdressing and 10 fall traffic applications, Nov. 8, 07.

Drain Spacing (ft)	2007 Mean Turf Shear Tester (Nm)	
Control†	60.6	b
20.0	68.8	ab
13.0	82.9	a
10.0	71.7	ab
6.5	81.3	a

† 26.5 ft plot without drain tiles; Fisher's LSD(0.05).

2007 Conclusions

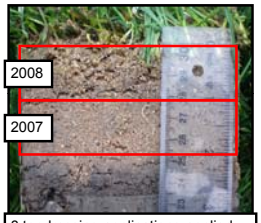
- Drain tiles spaced 13 ft apart provided a dry and stable surface, after 1 inch of topdressing was applied
- Treatments without drain tiles produced a wet surface with the lowest stability
- 1/2 inch of topdressing sand will substantially decreases surface moisture

2008 Results

- Apr. 22, 2008
  - Core cultivated
  - Inter-seeded
- July 14 – Aug. 22, 2008
  - Repeated topdressing

2008 Results

- Topdressing
  - 8 applications
    - 2.0 inch



8 topdressing applications applied over two years providing a 2 inch sand layer, Sep. 4, 2008.

2008 Results

- Surface moisture (v/v)

Effects of drain tile spacing and cumulative sand topdressing applications on surface (0.5 inch) moisture (v/v) following a 0.5 inch irrigation event, July 14 – Aug. 22, 2007.

	Time (hrs) from Initiation of Irrigation							
	0:00†		1:00		2:00		4:00	
Drain Spacing (ft)	2008 Mean Surface Moisture (v/v)							
control‡	26.2	a	30.4	a	29.2	a	27.3	ns
20.0	24.3	b	28.5	ab	28.6	a	26.1	ns
13.0	23.6	b	29.3	ab	28.0	ab	25.9	ns
10.0	22.1	c	27.5	bc	26.1	b	24.5	ns
6.5	20.8	d	25.9	c	24.0	c	21.5	ns
Topdressing Layer (in)ǂ	2008 Mean Surface Moisture (v/v)							
1.0	24.7	ns	30.4	a	28.1	a	25.4	ns
1.5	23.5	ns	25.6	c	27.5	a	25.8	ns
2.0	22.0	ns	28.9	b	26.0	b	24.0	ns

†Time (hrs) from initiation of irrigation (0.5 inch = 17 min); ‡26.5 ft plot without drain tiles; ǂ1/4 inch depth sand per topdressing application; Fisher's $LSD_{(0.05)}$.

Effects of drain tile spacing and cumulative sand topdressing applications on surface (0.5 inch) moisture (v/v) following a 0.5 inch irrigation event, July 14 – Aug. 22, 2007.

	Time (hrs) from Initiation of Irrigation							
	0:00†		1:00		2:00		4:00	
Drain Spacing (ft)	2008 Mean Surface Moisture (v/v)							
control‡	26.2	a	30.4	a	29.2	a	27.3	ns
20.0	24.3	b	28.5	ab	28.6	a	26.1	ns
13.0	23.6	b	29.3	ab	28.0	ab	25.9	ns
10.0	22.1	c	27.5	bc	26.1	b	24.5	ns
6.5	20.8	d	25.9	c	24.0	c	21.5	ns
Topdressing Layer (in)‡	2008 Mean Surface Moisture (v/v)							
1.0	24.7	ns	30.4	a	28.1	a	25.4	ns
1.5	23.5	ns	25.6	c	27.5	a	25.8	ns
2.0	22.0	ns	28.9	b	26.0	b	24.0	ns

†Time (hrs) from initiation of irrigation (0.5 inch = 17 min); ‡26.5 ft plot without drain tiles; ‡1/4 inch depth sand per topdressing application; Fisher's $LSD_{(0.05)}$.

2008 Results

- Clegg Turf Shear Tester (Nm)
  - Stability
- Following fall traffic
  - Oct. 13 – Nov. 12, 2008

Effects of drain tile spacing on Clegg Turf Shear Tester strength (Nm) following two inches of cumulative sand topdressing applied over a two year period and 10 fall traffic applications, Nov. 12, 08.

Drain Spacing (ft)	2008 Mean Turf Shear Tester (Nm)	
Control†	111.6	ns
20.0	125.8	ns
13.0	117.2	ns
10.0	111.3	ns
6.5	105.4	ns

† 26.5 ft plot without drain tiles; Fisher's LSD(0.05).

Effects of drain tile spacing on Clegg Turf Shear Tester strength (Nm) following two inches of cumulative sand topdressing applied over a two year period and 10 fall traffic applications, Nov. 12, 08.

Drain Spacing (ft)	2008 Mean Turf Shear Tester (Nm)	
Control†	111.6	ns
20.0	125.8	ns
13.0	117.2	ns
10.0	111.3	ns
6.5	105.4	ns

† 26.5 ft plot without drain tiles; Fisher's LSD(0.05).

Topdressing layer - 2 inches

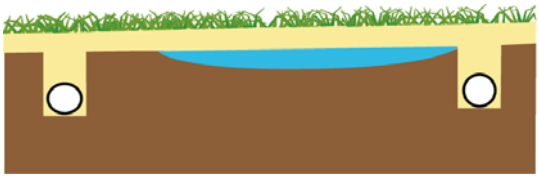
Effects of drain tile spacing on Clegg Turf Shear Tester strength (Nm) following two inches of cumulative sand topdressing applied over a two year period and 10 fall traffic applications, Nov. 12, 08.

Drain Spacing (ft)	2008 Mean Turf Shear Tester (Nm)	
Control†	111.6	ns
20.0	125.8	ns
13.0	117.2	ns
10.0	111.3	ns
6.5	105.4	ns

† 26.5 ft plot without drain tiles; Fisher's LSD(0.05).

2008 Results

- 2 inch topdressing depth regardless of drain tile spacing was adequate to provide a stable surface

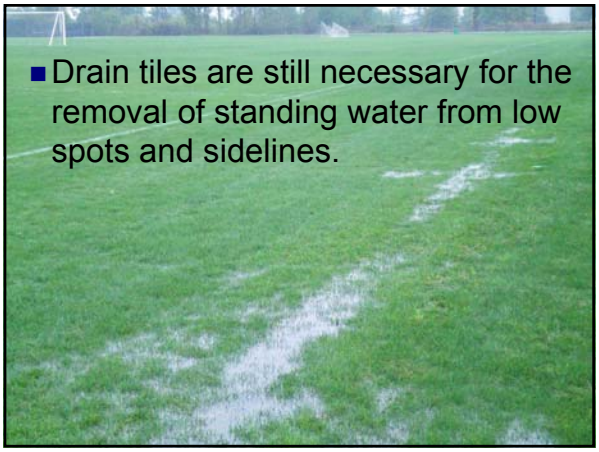


2008 Conclusions

- Drain tiles regardless of spacing decreased surface moisture
- No differences were observed between surface strength when 2 inch of topdressing was accumulated

2008 Conclusions

- Can topdressing alone provide an adequate playing surface without drain tile installation ?



Overall Conclusions

- Topdressing
  - As much as 1/3 inch of topdressing can be applied in a single application.
  - Topdressing will improved turfgrass coverage over time.
  - ½ inch of topdressing accumulated over a one month period will increase stability.
  - Up to 2 inch of topdressing is not detrimental to stability in comparison to the control.

Overall Conclusions

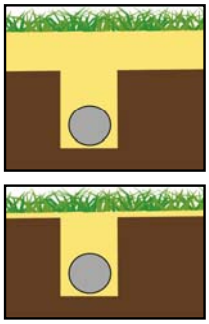
- Drain Tiles
  - A drain tile spacing of 13 ft will provide a dry and stable surface when 1 inch of topdressing has been accumulated.
  - When 2 inches of sand topdressing is accumulated, and a adequate surface slope is available (≥1%), drain tile spacing can be increased to spacing greater than 20 ft.

Cost Analysis

- Drain tiles
  - $5 linear foot
- 6 ft spacing
  - $13,000 / 58,000 ft^2
- 13 ft spacing
  - $6,200 / 58,000 ft^2

Cost Analysis

- Topdressing material
  - 90% sand – 10% silt/clay
    - $8,000 per inch (58,000 ft^2)
- Topdressing depth
  - 6 inches
    - $48,000
  - 2 inches
    - $16,000

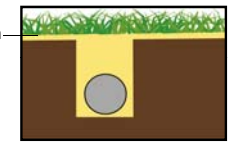


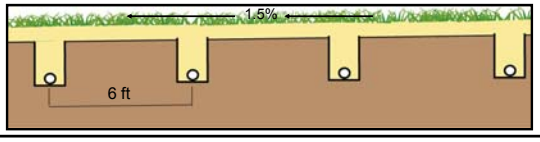
Case Studies



Grand Blanc High School

- May 2007

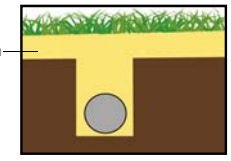



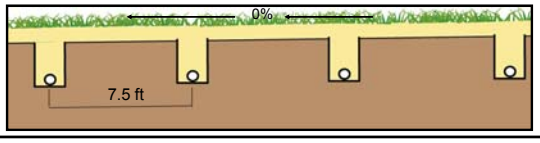


Grand Blanc HS – Dec. 2007

Okemos High School

- Aug. 2007



Okemos Practice Field - Nov. 3, 2008


Okemos High School

- May 2008

Okemos High School

- May 2008

MSU Intramural (IM)

- July 2008

MSU Intramural (IM)

- July 2008

MSU Intramural (IM)

- July 2008

MSU Intramural (IM)

- July 2008

MSU Intramural (IM)

- July 2008

MSU Intramural Field – Oct. 27, 2008

New Research

- Topdressing material
  - 90% sand – 10% silt/clay
    - $8,000 per inch (58,000 ft^2)
- Alterative topdressing material

Objectives

- Evaluate the effects of various topdressing material on the wear tolerance and stability of established turfgrass

Materials and Methods

- Apr. 17, 2008
- Established Kentucky bluegrass
- Native soil
  - Sandy loam
- Topdressing
  - 8 applications @ ¼ inch
    - May 29 - Sep. 12, 08

Materials and Methods

- Topdressing sand

	90-10	2150 TDS	2NS	14 sand
	Particle Size Distribution (%)			
>2mm	0.9	0.0	23.7	0.8
Vcos (1.0-2.0 mm)	10.5	0.1	17.2	11.7
Cos (0.5-1.0 mm)	22.0	2.6	20.4	24.3
MS (0.25-0.5 mm)	35.2	69.2	23.7	37.7
FS (0.1-0.25 mm)	20.5	27.3	11.6	22.1
VFS (0.05-0.1 mm)	3.0	0.2	1.0	1.3
Silt/clay (<0.05 mm)	7.9	0.6	2.4	2.1

Materials and Methods

- Topdressing sand — USGA specifications

	90-10	2150 TDS	2NS	14 sand
	Particle Size Distribution (%)			
>2mm	0.9	0.0	23.7	0.8
Vcos (1.0-2.0 mm)	10.5	0.1	17.2	11.7
Cos (0.5-1.0 mm)	22.0	2.6	20.4	24.3
MS (0.25-0.5 mm)	35.2	69.2	23.7	37.7
FS (0.1-0.25 mm)	20.5	27.3	11.6	22.1
VFS (0.05-0.1 mm)	3.0	0.2	1.0	1.3
Silt/clay (<0.05 mm)	7.9	0.6	2.4	2.1

Materials and Methods

- Topdressing sand — USGA deviations

	90-10	2150 TDS	2NS	14 sand
	Particle Size Distribution (%)			
>2mm	0.9	0.0	23.7	0.8
Vcos (1.0-2.0 mm)	10.5	0.1	17.2	11.7
Cos (0.5-1.0 mm)	22.0	2.6	20.4	24.3
MS (0.25-0.5 mm)	35.2	69.2	23.7	37.7
FS (0.1-0.25 mm)	20.5	27.3	11.6	22.1
VFS (0.05-0.1 mm)	3.0	0.2	1.0	1.3
Silt/clay (<0.05 mm)	7.9	0.6	2.4	2.1

Materials and Methods

- Crumb rubber
  - Particle size
    - 2.0-6.0 mm
- Sand then crumb rubber

Materials and Methods

- Traffic simulators
  - Cady
  - Brinkman

2008 Results

- Turfgrass cover (0-100%)
  - Following fall traffic
    - Oct. 15 – Nov. 14, 2008

Effects of topdressing material and traffic simulators on turfgrass cover (0-100%) following 10 fall traffic applications, Nov. 14, 08.

Topdressing Material	2008 Mean Turfgrass Cover (0-100%)	
14 sand&crumb	86.7	a
crumb rubber	85.8	a
2150_TDS	62.5	b
14 sand	61.7	b
90-10	54.2	b
2NS	44.2	c
control	43.3	c
Traffic Simulator	2008 Mean Turfgrass Cover (0-100%)	
Cady	69.5	a
Brinkman	55.7	b

Fisher's LSD(0.05).

Effects of topdressing material and traffic simulators on turfgrass cover (0-100%) following 10 fall traffic applications, Nov. 14, 08.

Topdressing Material	2008 Mean Turfgrass Cover (0-100%)	
14 sand&crumb	86.7	a
crumb rubber	85.8	a
2150_TDS	62.5	b
14 sand	61.7	b
90-10	54.2	b
2NS	44.2	c
control	43.3	c
Traffic Simulator	2008 Mean Turfgrass Cover (0-100%)	
Cady	69.5	a
Brinkman	55.7	b

Fisher's LSD(0.05).

Effects of topdressing material and traffic simulators on turfgrass cover (0-100%) following 10 fall traffic applications, Nov. 14, 08.

Topdressing Material	2008 Mean Turfgrass Cover (0-100%)	
14 sand&crumb	86.7	a
crumb rubber	85.8	a
2150_TDS	62.5	b
14 sand	61.7	b
90-10	54.2	b
2NS	44.2	c
control	43.3	c
Traffic Simulator	2008 Mean Turfgrass Cover (0-100%)	
Cady	69.5	a
Brinkman	55.7	b

Fisher's LSD(0.05).

2008 Results

- Surface strength
  - Clegg Turf Shear Tester (Nm)
- Following fall traffic
  - Oct. 15 – Nov. 14, 2008

Effects of topdressing material and traffic simulators on Clegg Turf Shear Tester (Nm) following 10 fall traffic applications, Nov. 14, 08.

Topdressing Material	2008 Mean Turf Shear Tester (Nm)	
control	149.4	a
14 sand&crumb	139.9	ab
90-10	137.9	abc
14 sand	134.0	abc
2NS	123.5	bcd
2150_TDS	118.2	cd
crumb rubber	107.0	d
Traffic Simulator	2008 Mean Turf Shear Tester (Nm)	
Cady	130.96	ns
Brinkman	128.99	ns

Fisher's LSD(0.05).

Effects of topdressing material and traffic simulators on Clegg Turf Shear Tester (Nm) following 10 fall traffic applications, Nov. 14, 08.

Topdressing Material	2008 Mean Turf Shear Tester (Nm)	
control	149.4	a
14 sand&crumb	139.9	ab
90-10	137.9	abc
14 sand	134.0	abc
2NS	123.5	bcd
2150_TDS	118.2	cd
crumb rubber	107.0	d
Traffic Simulator	2008 Mean Turf Shear Tester (Nm)	
Cady	130.96	ns
Brinkman	128.99	ns

Fisher's LSD(0.05).

Preliminary Findings

- 14 sand then crumb rubber provided the best results, a combination of cover and stability
- Crumb rubber provided the greatest cover, but the lowest stability
- 2 NS (high proportion of coarse material) provided the worst results, poor cover and stability

Questions