FESCUE-GREEN (2011-2015)

Best management of red fescue (*Festuca rubra*) golf greens for high sustainability and playability

Project core group:

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Sterr

‘FESCUE GREEN’ - OBJECTIVES

Main objective

To elucidate strategies for management of red fescue greens for optimal playability and sustainability

Sub goals

1. To determine the influence of **irrigation strategies and seasonal fertilizer distribution** on turf quality, playability and competition from *Poa annua.*
2. To clarify the impact of increased **mowing height, mowing frequency**, and to what extent mowing can be replaced by light weight **rolling** on a mature golf green with a predominant cover of red fescue.
3. To **initiate** a study on the **long-term effect** of a well-defined and widely used **compost (‘Green Mix’) in the rootzone or in the topdressing sand** on turf quality, colonization of mycorrhiza, disease incidence and competition against *Poa annua.*
4. To actively disseminate results to the golf industry through one article per year in the Nordic greenkeeper magazines, two scientific papers in peer-reviewed journals, and **two workshops /seminars** on fescue management.

Red fescue workshop Oct. 2012, Copenhagen

OUTCOME OF FESCUE WORKSHOP

‘FESCUE GREEN’

Reference group

- 1 March 2012: Copenhagen University
- 28 June 2013: NIBIO Landvik
- 4 July 2014: Smørum GC, Copenhagen

FINANCE BUDGET

Funding	kSEK					
	2011	2012	2013	2014	2015	Sum
STERF	300	600	600	**650**	300	**2450**
Bioforsk: Depreciation and machinery	15	130	100	100		345
Copenhagen University (free hours)	20	10	15	50	15	110
Smørum GC (P. Rasmussen's work)	14	14	14	28	28	98
Høst AS, Norway (Rootzone materials and topdressing)	33	33				66
Solum Group, Denmark (Rootzone materials and topdressing)	33	33				66
Lindholm Maskiner AB (Free rent of light weight rollers)	15	30	30			75
Svenningsen Maskiner (Free rent of triplex mower)	23	45	45			113
TOTAL	**453**	**895**	**804**	**828**	**343**	**3323**

Subproejct 3: Effects of two different rootzone mixtures and topdressing materials on red fescue performance

STERF Low input Seminar, Copenhagen 5-6 Oct. 2015

Trygve S. Aamlid

NIBIO
NORWEGIAN INSTITUTE OF BIOECONOMY RESEARCH

DRAINAGE OF BOGS FOR PEAT HARVEST IS NOT SUSTAINABLE

- Globally, the pool of carbon in peatlands is about the same as in the atmosphere
- Drainage + peat harvest and/or cultivation stands for about 10 % of CO_2 emisssions in Norway

Composted garden waste:

- *A valuable resource*
- *Replacement of peat*

NIBIO

SCANDINAVIAN TURFGRASS AND ENVIRONMENT RESEARCH FOUNDATION

OBJECTIVES

To determine effects of Green Mix garden compost in the rootzone and/or topdress sand during grown-in and maintenance of red fescue putting greens

1. To clarify effects on Green Mix compost on **soil texture and physica**l conditions, notably infiltration rates
2. To quantify the potential of Green Mix in rootzone and topdress to reduce the **fertilizer requirement during grow-in and maintenance.**
3. To clarify the effects of Green Mix on **visual quality, playing quality and competition from *Poa annua*** on fescue greens
4. To study natural root colonization by **mycorrhiza** on compost-amended and peat-amended rootzones.

The exeriment was conducted in the field lysimeter facility at Landvik, South East Norway

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EXPERIMENTAL TREATMENTS

Factor 1: Rootzone at establishement in Aug. 2011

A. **Peat**: USGA-sand + 17% (v/v) peat, humification class 6 (von Post)
B. **Green Mix:** USGA-sand + 17.5% garden compost

Factor 2: Top dressing sand (starting in spring 2012)

1. **Straight sand** (0.2-0.8 mm)
2. **Green Mix Topdress: 0.2-0.8 mm** + 10 vol % garden compost

Randomized complete block design, four blocks (replicates)


August 2011: Existing turf and rootzone removed down to gravel layer, new rootzone material added

CHEMICAL SOIL ANALYSES OF ROOTZONE AND TOPDRESSING MATERIALS

	Rootzone		Topdress	
	Peat	Green Mix (Høst AS)	Straight sand	Green Mix (Solum)
Ignition loss, %	2.85	2.63	0.10	0.95
CEC, meq/100 g dry soil	3.0	5.4	0.3	5.3
Total C, % of DM	1.5	1.9	< 0.5	0.58
Total N, % of DM	<0.1	0.14	<0.11	<0.11
Mineral-N, mg/100 g dry soil	0.06	3.00	0.17	3.2
pH (H_2O)	5.6	7.8	6.5	8.0
P-AL, mg/100 g dry soil	1.7	6.4	<1.0	5.9
K-AL, mg/100 g dry soil	2.3	25	<2.0	24
Mg-AL, mg/100 g dry soil	2.4	6.8	<1.0	4.9
Ca-AL, mg/100 g dry soil	14	95	<10	111
Na-AL, mg/100 g dry soil	2.2	3.1	< 5.0	< 5.0
Cu, mg/kg dry soil	0.26	1.3	<0.20	0.84
B, mg/kg dry soil	<0.10	0.56	0.36	<0.10
Fe, mg/kg dry soil	6.7	2.5	10	3.8
Mn, mg/kg dry soil	4.5	0.60	< 0.50	< 0.5
Zn, mg/kg dry soil	<1.0	6.7	< 1.0	4.4
Mo, mg/kg dry soil	<0.2	<0.2	<0.20	<0.20

ROOTZONE TEXTURE:
(GRAIN SIZE DISTRIBUTION)

	Gravel >2 mm	Coarse sand 0.6-2 mm	Medium sand 0.2-0.6 mm	Fine sand 0.06-0.2 mm	Silt 0.002-0.06 mm	Clay < 0.002 mm
Peat	2.1	22.1	52.2	21.5	1.7	0.9
Green Mix	1.3	11.9	61.2	21.5	3.2	0.9

Note: The composted garden waste in Green Mix contains not only organic matter, but also fine mineral particles !

Implications ?

SEEDING ON 17 AUG. 2011

Seed mixture	%
Slender creeping red fescue Cezanne	38.8
Chewings fescue Musica	19.4
Chewings fescue Bargreen	19.4
Chewings fescue Calliope	19.4
Poa annua unspecified	3.0
Total	100

Seeding rate: 3 kg per 100 m^2

Fertilizer rates to peat-amended rootzones during grow-in 17 Aug - 15 Nov. 2011:

	kg per 100 m2		
	Preseeding organic fertilizer	Weekly inputs, liquid or granuar	Total
N	0.85	0.80	1.65
P	0.10	0.11	0.21
K	0.75	0.67	1.42

BASED ON THE SOIL ANALYSES AND PRELIMINARY DATA, FERTILIZER INPUTS DURING GROW-IN WERE REDUCED BY 50 % ON GREEN MIX ROOTZONES

Grow-in, 2011

Photo shows
Field emergence after two weeks,
1 Sep. 2011

(Before starting with different fertilizer levels)

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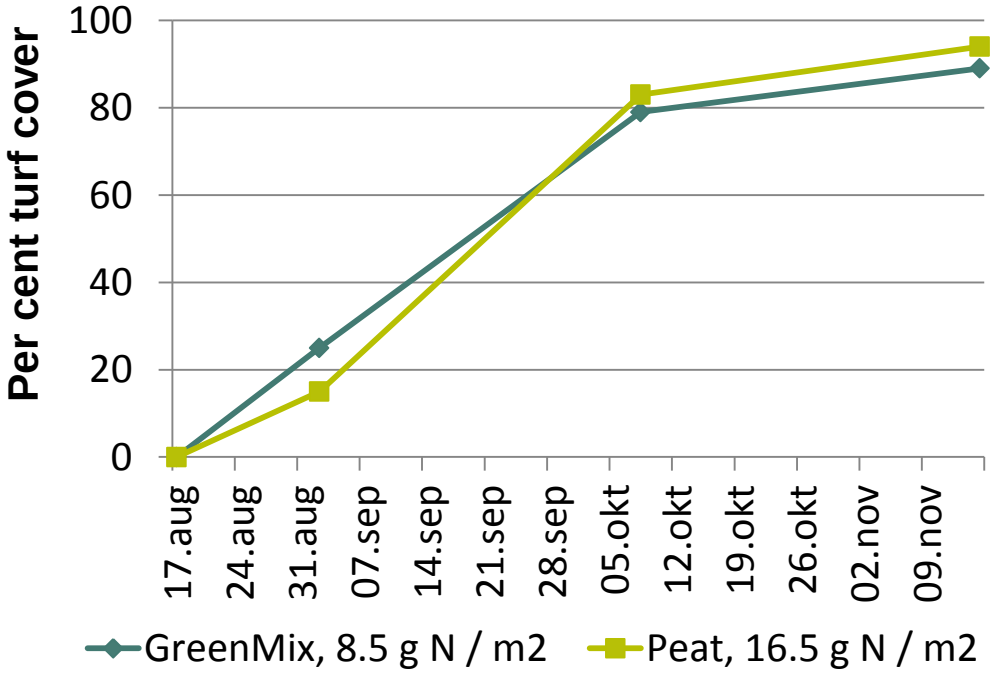
Grow-in phase: Development of turf cover




Establishment by end of grow-in year, Dec. 2011:
Double rate of fertilizer more than compensated for lower nutrient content in rootzones with peat
Peat
Green Mix

MAINTENANCE OF YOUNG GREEN, 2012

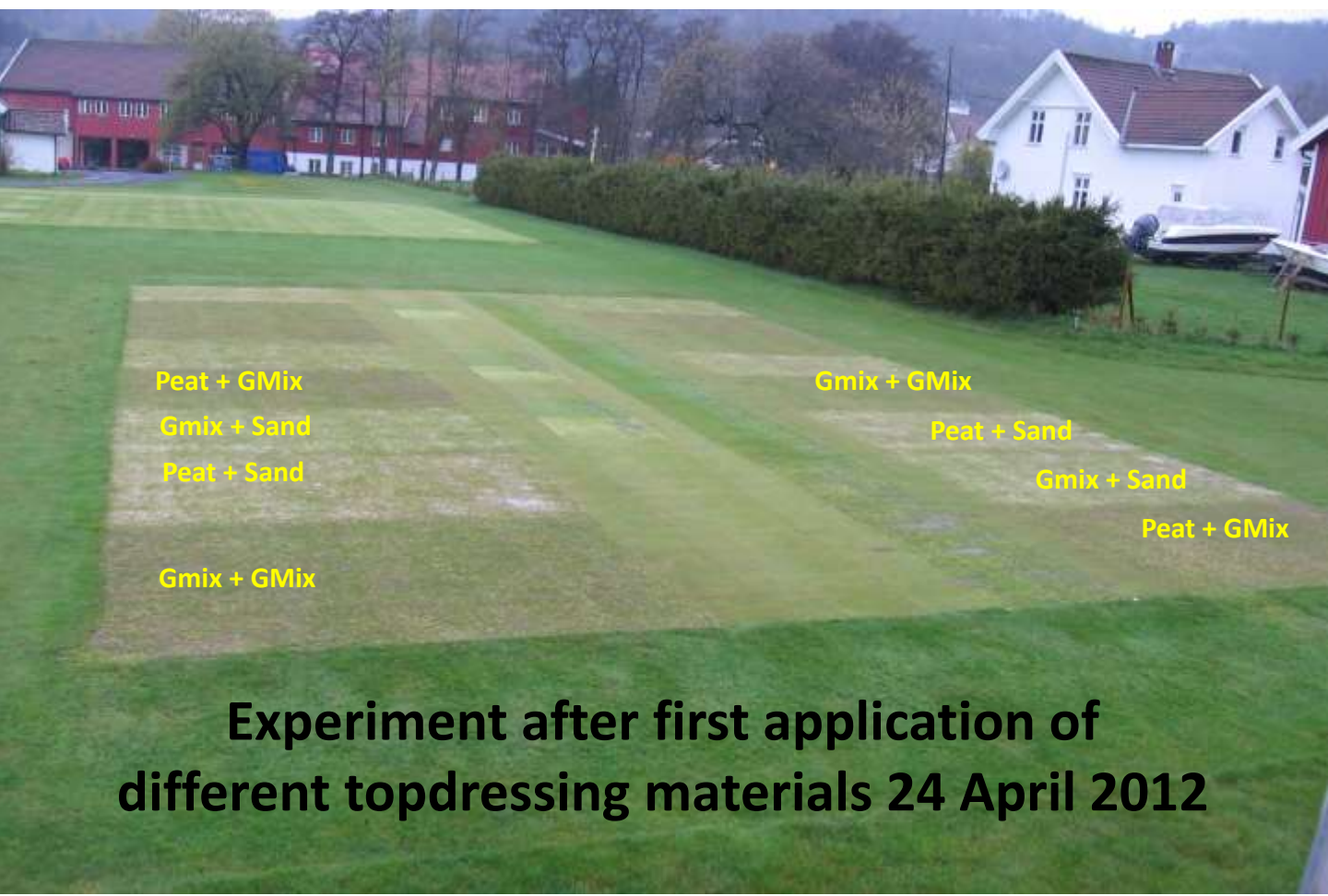
- Same type and amount of fertilizer to all plots (kg / 100 m2):
  The fertilizer plan said : N: 1.30 P: 0.6 K: 1.08
  Liquid fertilizers: Arena Crystal + Greenmaster 10-0-10.

- Topdressing according to experimental plan) every second week from 24 April to 10 Oct. (13 times)
  - 0.63 mm (L/m2) sand per dressing → 8.2 mm over the season

- Aeration with 6 mm solid tines three times (23 April, 5 June, 14 Aug.)

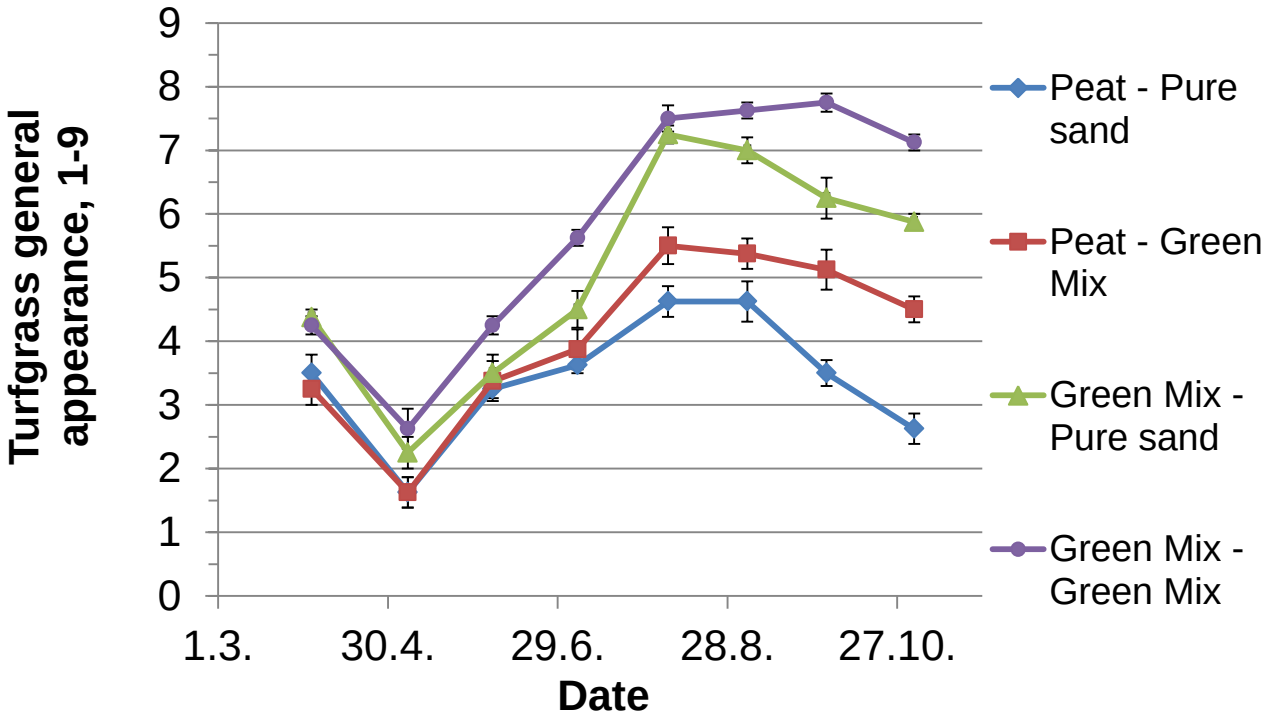
- Mowing: To 5 mm three times per week.

- Wear / rolling: 2 runs per week from early July to early Oct:
  Equivalent to 20000 rounds of golf

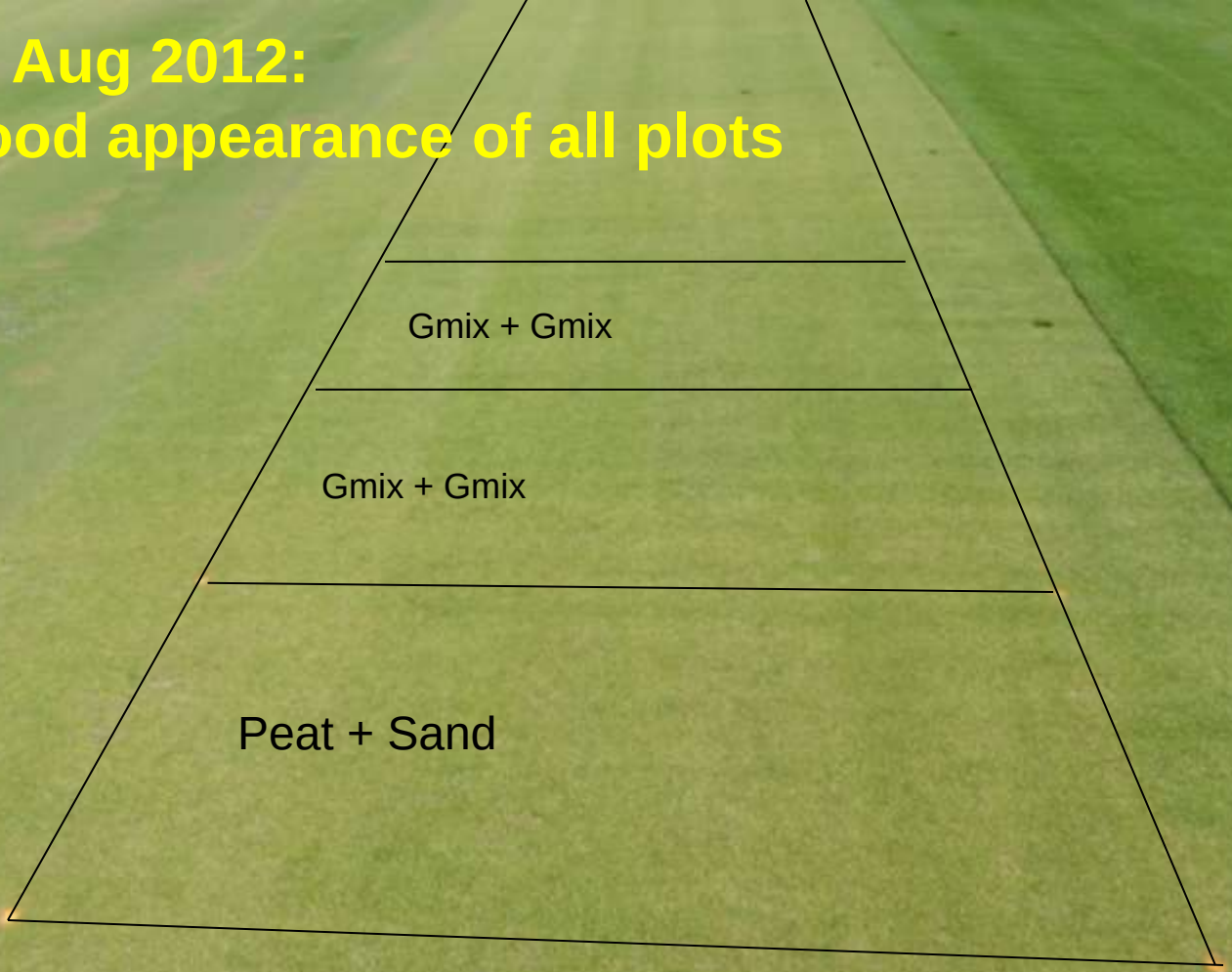


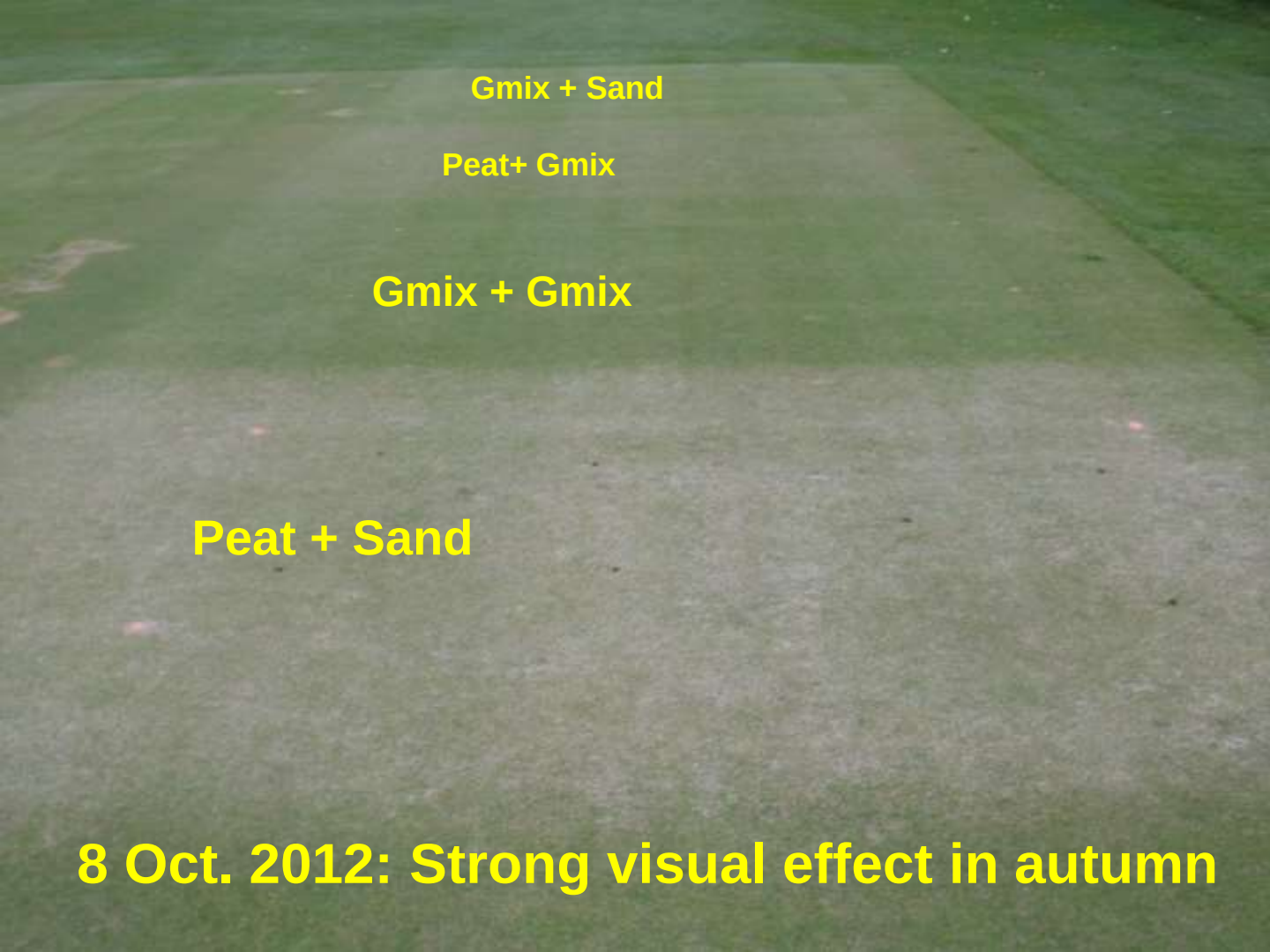
Experiment after first application of different topdressing materials 24 April 2012

RESULTS 2012:
VISUAL TURFGRASS QUALITY (1-9)



25 Aug 2012:
Good appearance of all plots

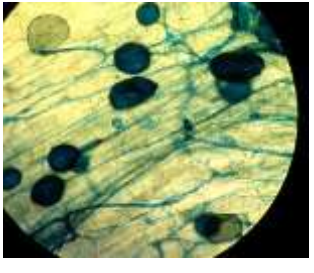




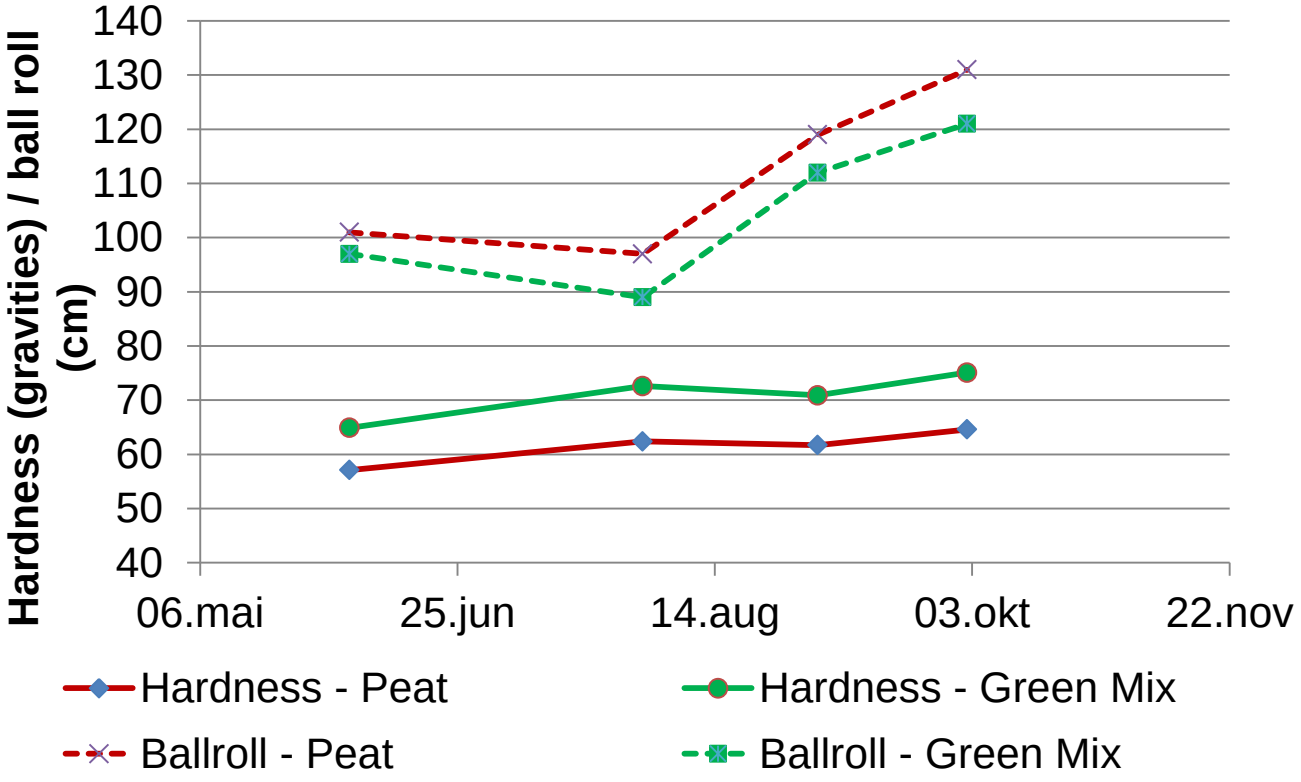
8 Oct. 2012: Strong visual effect in autumn

ROOT DEVELOPMENT AND NATURAL COLONIZATION BY MYCORRHIZA

	% of roots colonized by mycorrhiza		
	18 Oct. 2011	5 June 2012	18 Oct. 2012
Peat	2.1	0.9	21.6
Green Mix	1.9	1.2	58.7
Sign.	ns	ns	***



Green speed and surface hardness, 2012



Firmer but slower greens on Green Mix than on peat-amended rootzones

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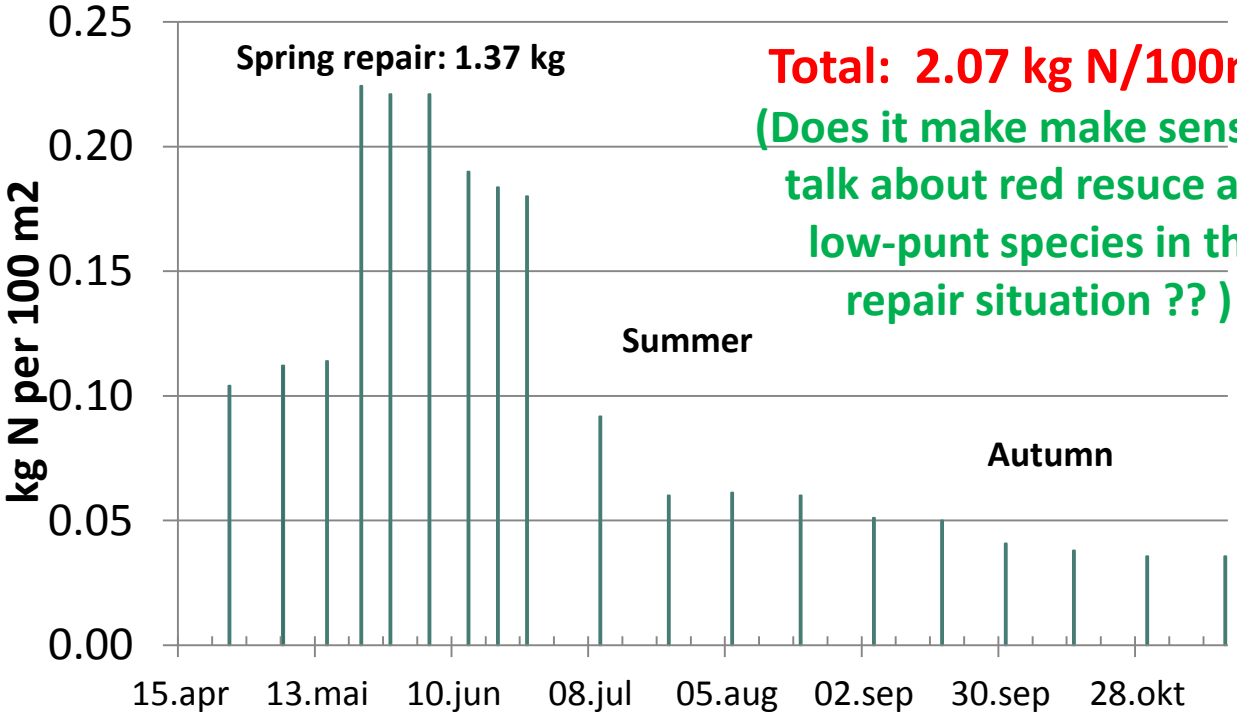
Winter 2012-2013:
100 days of ice encasement


8 April 2013

N inputs to all plots in 2013



Total: 2.07 kg N/100m2:

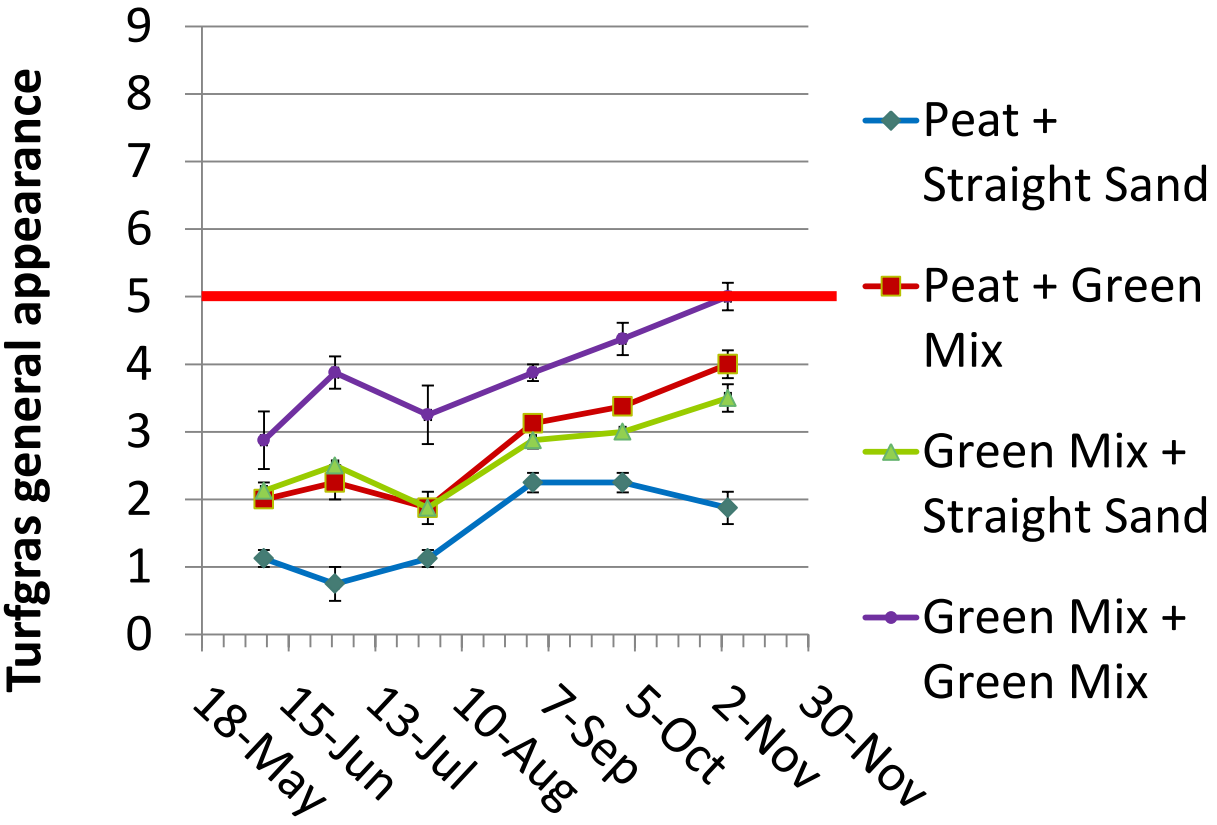
(Does it make make sense to talk about red resuce as a low-punt species in the repair situation ??)


1 June 2013

28 July 2013


Rootzone: Green Mix
Dressing: Green Mix
Rootzone: Peat
Dressing: Straight sand
Rootzone: Peat
Dressing: Green Mix
Rootzone: Green Mix
Dressing: Straight sand
5 Sep. 2013

Visual turf quality 2013




Rootzone: Peat
Dressing: Green Mix
Rootzone: Green Mix
Dressing: Straight sand
Rootzone: Green Mix
Dressing: Green Mix
Rootzone: Peat
Dressing: Straight sand
1 Oct. 2013

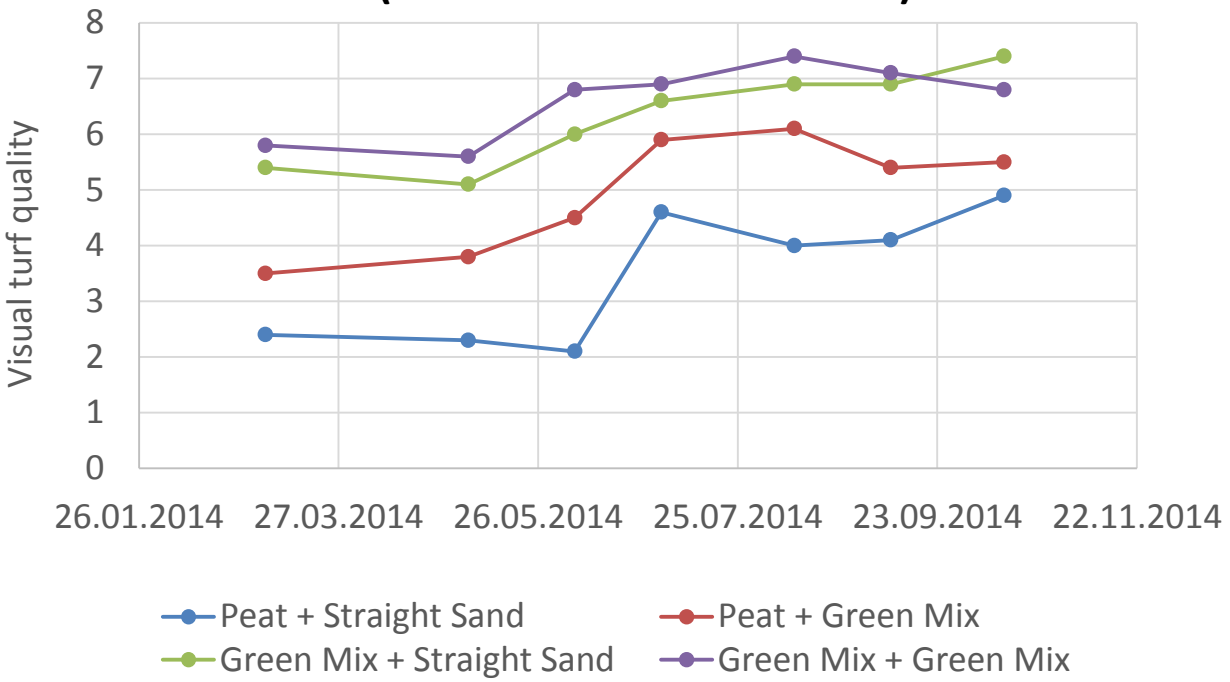
Observations of playing quality in 2013

	Hardness, Gravities, 2.25 kg hammar (6 obs.)	Ball roll, cm (3 obs.)
Main effect of rootzone		
Peat	65.4	112
Gmix	72.1	108
P-value	0.0007	0.14
Main effect of topdressing		
Sand	69.0	107
Gmix	68.5	113
P-value	>0.15	0.062

- **Firmer but slower greens on Green Mix than on peat-amended rootzones**
- **Improved green speed after using Green Mix topdress**

2014
VISUAL TURF QUALITY

(AFTER A MILD WINTER)



Visual quality / density, July 2014

Green Mix rootzone + Green Mix topdress

Green Mix rootzone + Straight Sand topdress

Peat rootzone + Green Mix topdress

Peat rootzone + Green Mix topdress

Hypothesis based on observations at Smørum GC, Copenhagen:

Dressing with Green Mix on the top of a low-fertility rootzone may lead to more competition from *Poa annua* ?

Soil layering effects of using Green Mix topdress on Peat-amended rootzones ?

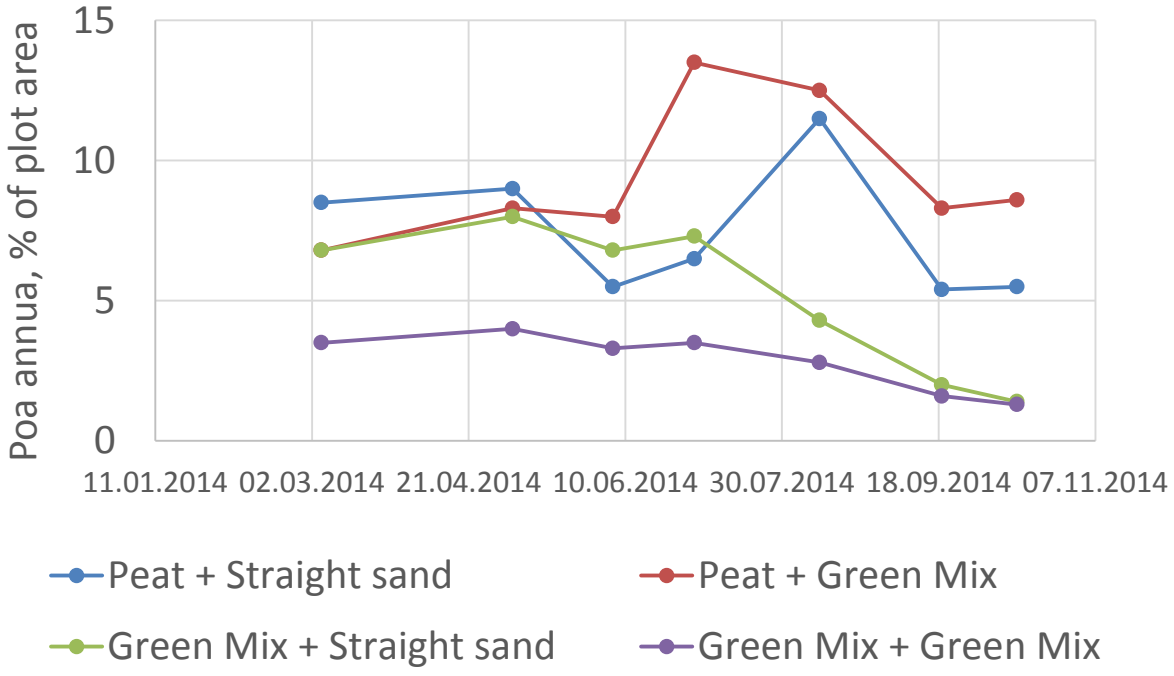
	pH	P-AL	K-AL	Mg-AL	Ca-AL
	Start values August 2011				
Peat rootzone	5.6	1.7	2.3	2.4	14
Green Mix Topdress	8.0	5.9	24.0	4.9	111
Depth	Soil analyses after two years (17 mm topdress added)				
0-2 cm	6.3	1.3	4.5	2.3	32
2-5 cm	6.2	1.4	4.1	2.3	34
5-25 cm	6.2	1.7	4.4	2.4	29

Soil analyses taken in October 2013 did not confirm the hypothesis. Assessments in 2012 and 2013 also did not show more *Poa annua* after use of Gmix topdress

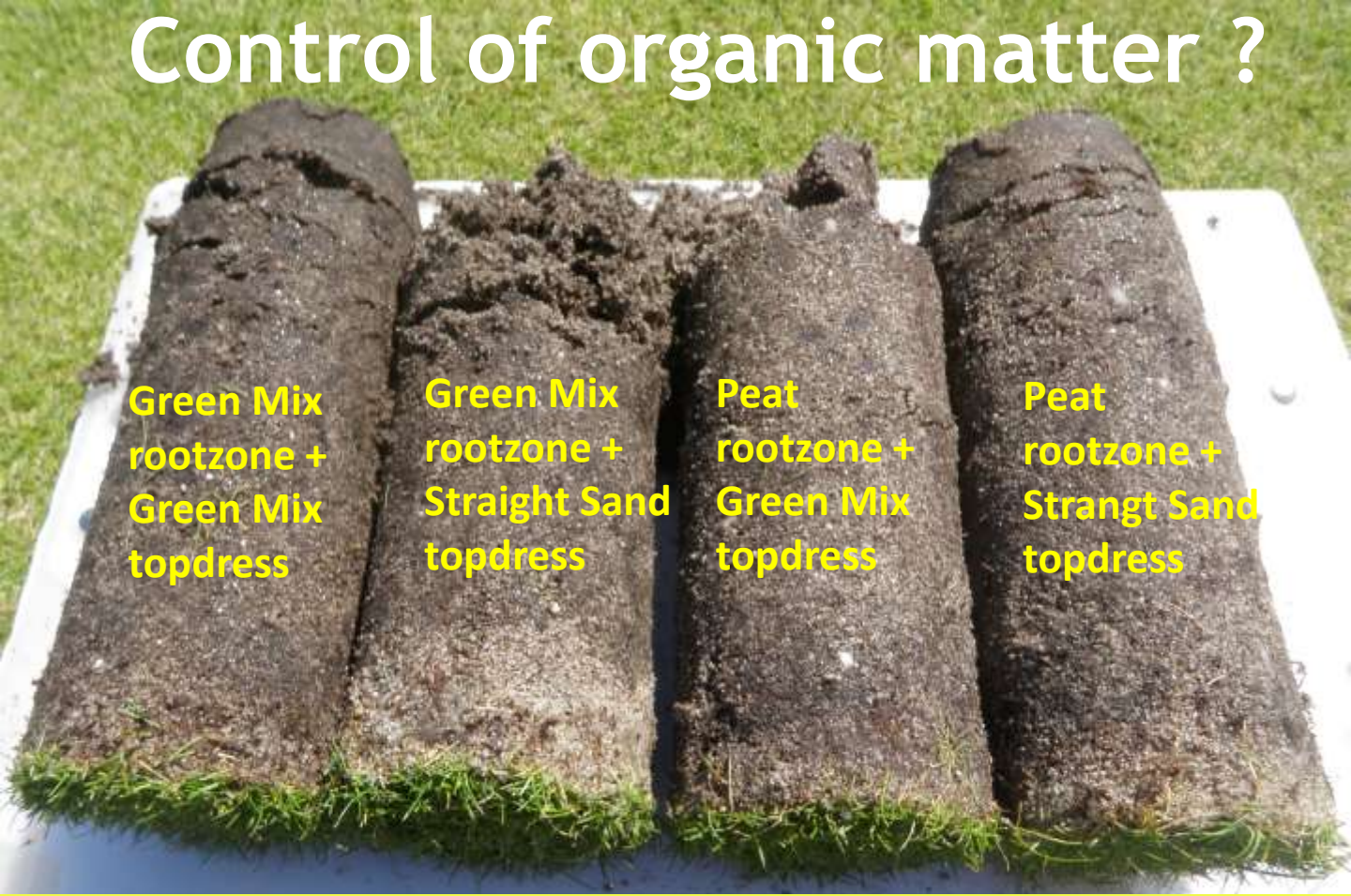
But in summer 2014, after two years' use of Green Mix topdress on top of peat-amended rootzones, we started to see more *Poa annua*

1 July 2014

MORE *POA ANNUA* WITH GREEN MIX TOPDRESS ON TOP OF PEAT ROOTZONE

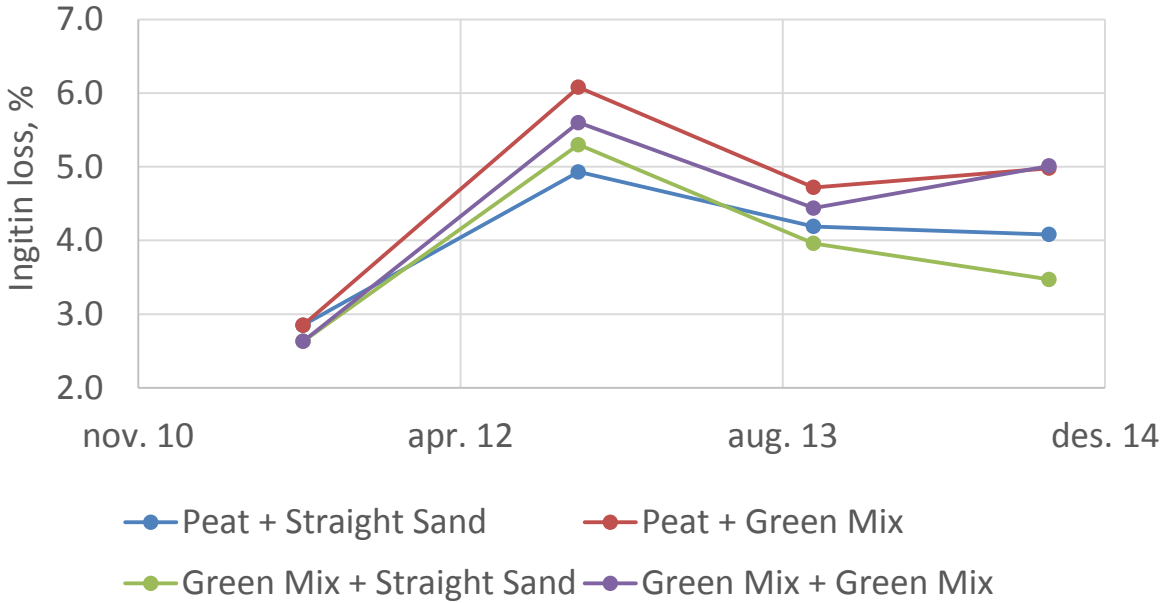


Control of organic matter ?



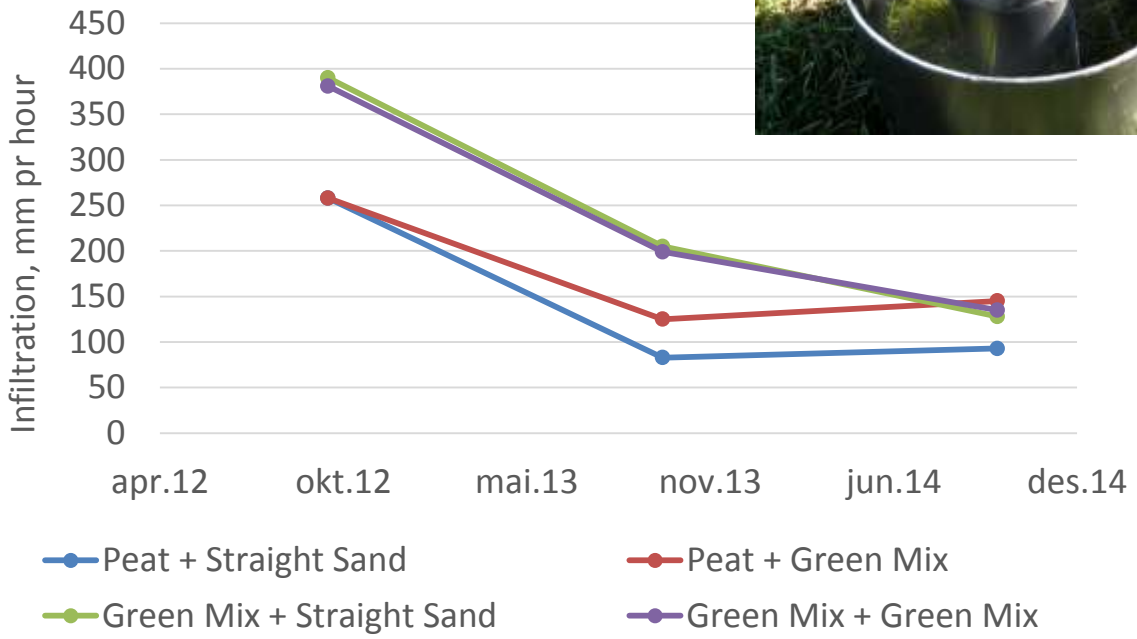
Thatch/mat layer, July 2014

Effect of rootzone and topdressing on ignition loss of the 0-2 cm top layer during three years



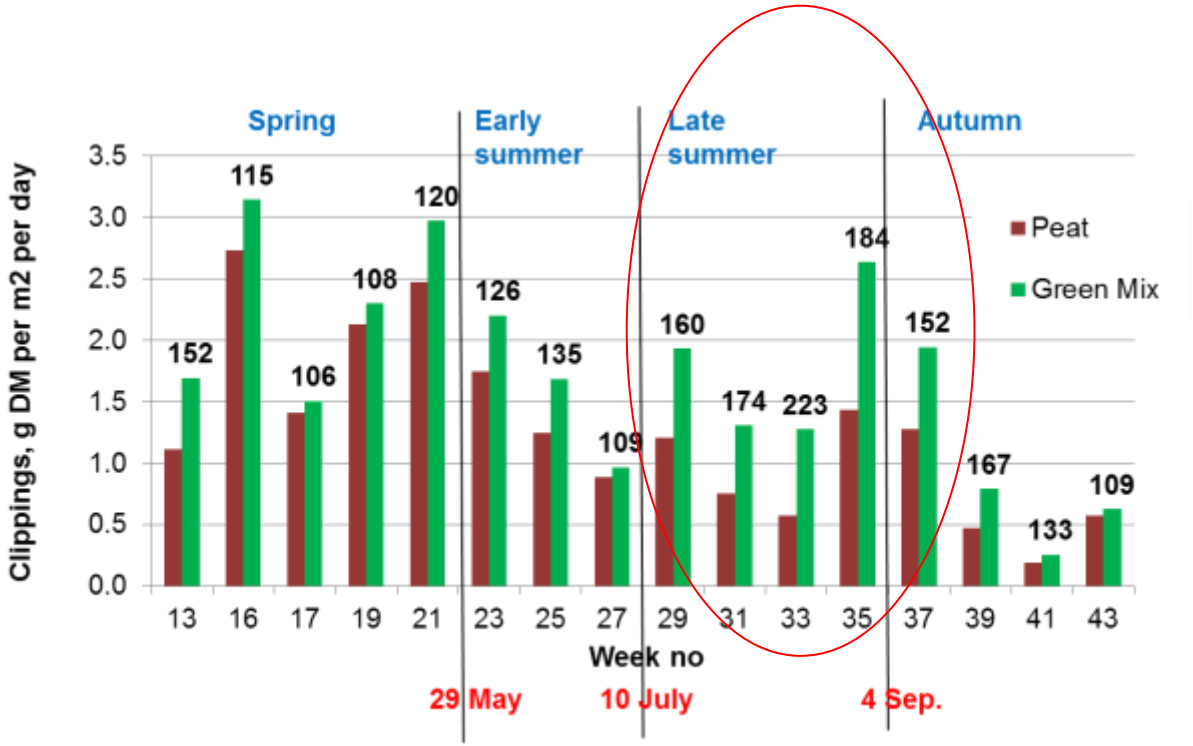
Significant effect of topdressing at all measurements

Effect of rootzone and topdressing on infiltration rates over three years



Significantly better infiltration on Green Mix rootzones in 2012 and 2013

EFFECT OF ROOTZONE ON DAILY WEIGHT OF CLIPPINGS, 2012



Most mineralization from GreenMix in late summer

EFFECT OF ROOTZONE COMPOSTION ON NUTRIENT CONCENTRATION IN CLIPPINGS, 2012

(% OF DRY WEIGHT)

	Nitrogen (N)			Phosphorus (P)			Potassium (K)		
	Peat	Green Mix	AN-OVA	Peat	Green Mix	AN-OVA	Peat	Green Mix	AN-OVA
Spring	2.72	3.07 (113)	**	0.35	0.38 (109)	NS	1.64	1.70 (104)	NS
Early summer	2.94	3.26 (111)	**	0.35	0.45 (129)	***	1.80	1.91 (106)	(*)
Late summer	3.02	3.56 (118)	**	0.40	0.59 (148)	***	2.09	2.46 (117)	(*)
Autumn	2.95	3.55 (134)	***	0.42	0.60 (143)	***	1.89	2.25 (119)	***
Whole year mean	2.91	3.36 (115)		0.38	0.51 (132)		1.86	2.08 (112)	
Relative to nitrogen	100	100		13	15		64	62	

In almost perfect agreement with Tom Ericsson et al. (2012a,b)

POLLUTION OF GROUND AND SURFACE WATER ?

IN RELATION TO EU'S NITRATE DIRECTIVE

EU's-Nitrate directive for drinking water
Max 50 mg nitrate = 11 mg/NO3-N pr liter

Grow-in (3-4 weeks after seeding), 2011:

- Average concentration of NO3-N in leaching water from Green Mix plots 16.5 mg/l (max value: 24)

Established turf, 2012:

- Average concentration of NO3-N in leaching water from Green Mix plots: 1.4 mg/l (max value: 8.7)

Winter-damaged turf, spring 2013:

- Average concentration of NO_3-N in leaching water from Green Mix plots, spring 2013: 11.7 mg/l (max value: 18)

Nutrient loss in clippings and drainage water from rootzones with peat and Green Mix in 2012 and 2013

(kg pr 100 m^2)

	N			P			K	
	Peat	**GMix**		**Torv**	**GMix**		**Torv**	**GMix**
2012: Whole season	Fertilizer input 1.30			Fertilizer input 0.06			Fertilizer input 1.05	

Nutrient loss in clippings and drainage water from rootzones with peat and Green Mix in 2012 and 2013

(kg pr 100 m^2)

	N			P			K	
	Peat	GMix		Torv	GMix		Torv	GMix
2012: Whole season	Fertilizer input 1.30			Fertilizer input 0.06			Fertilizer input 1.05	
Removed in clippings	0.84	1.29		0.11	0.19		0.52	0.79
Leaching	0.08	0.22		0.09	0.19		0.67	2.14

Nutrient loss in clippings and drainage water from rootzones with peat and Green Mix in 2012 and 2013

(kg pr 100 m^2)

	N			P			K	
	Peat	GMix		Torv	GMix		Torv	GMix
2012: Whole season	Fertilizer input 1.30			Fertilizer input 0.06			Fertilizer input 1.05	
Removed in clippings	0.84	1.29		0.11	0.19		0.52	0.79
Leaching	0.08	0.22		0.09	0.19		0.67	2.14
2013: 25 June – 1 Nov.	Fertilizer input 0.70			Fertilizer input 0.07			Fertilizer input 0.59	
Removed in clippings	0.53	0.79		0.08	0.12		0.45	0.63
Leaching	0.07	0.11		0.01	0.12		0.53	0.70

CONCLUSIONS

1. Garden compost contains not only organic matter, but also fine mineral particles. Turfgrass managers should therefore have the rootzone texture analysed after mixing with compost.
2. Despite the higher content of fines, the Green Mix rootzone maintained better infiltration than the peat-amended rootzone during the first two years after establishment. The Green Mix rootzone nevertheless have a harder surface than the peat-amended rootzone
3. Green Mix in the rootzone reduced the N requirement for grow-in by a little less than 50 %, probably more like 30-40 %.
4. The Green Mix rootzone gave better visual turf quality throughout the trial, and a positive effect of Green Mix topdress started to appear already 1-2 months after applications started.
5. On both rootzones, it took ½ - 1 year from sowing for fescue roots to be significantly colonized by mycorrhiza. Once coloninzation started, more roots were colonized on the Green Mix rootzone than on peat-amended rootzone, despite its higher content of P.

CONCLUSIONS (CONTD.)

6. The producer of Green Mix topdress suggests that regular dressing will release 0.3-0.4 kg N/100m2/yr, or 30-40 % of the N requirement to red fescue. Our research suggests that the contribution of N from mineralization may be even higher and that the use Green Mix topdress will completely eliminate the need for P fertilizers. With Green Mix rootzones, K inputs can be omitted in the first year, and over time the K requirement will probably ble 40-50 % less if Gree Mix topdress is used regularly.
7. Savings in fertilizer due to Green Mix topdress will be greater in late summer and autumn than in spring and early summer.
8. There are indications that the use of Green Mix topdress on top of a less fertile rootzone may result in more *Poa annua* over time, but this requires further research.
9. Leaching of nitrate from golf greens is neglegible as long as there is a complete and growing turf cover. NO_3- leaching mainly occurs during grow-in and after damages, e.g. due to tough winters.

TAKE HOME MESSAGE:

GREEN MIX CAN BE RECOMMENDED BOTH IN THE ROOTZONE AND IN THE TOPDRESS ON FESCUE GREENS.

NEED FOR STUDIES OVER LONGER PERIOD !