Heathland restoration on former agricultural land: Field trial at the Noordenveld (Dwingelderveld)

Maaike Weijters , Roland Bobbink, Arrie van der Bij, Evi Bohnen-Verbaarschot, Rudy van Diggelen, Jan Frouz, Jim Harris

Presentation outline

- Introduction of the experiment
- Results
  - Soil chemistry
  - Vegetation development
  - Soil community
- Discussion and Conclusions

Project Noordenveld (166 ha)


Noordenveld was an agricultural area…

Constraints in the conversion of agricultural fields to dry and wet heathland:

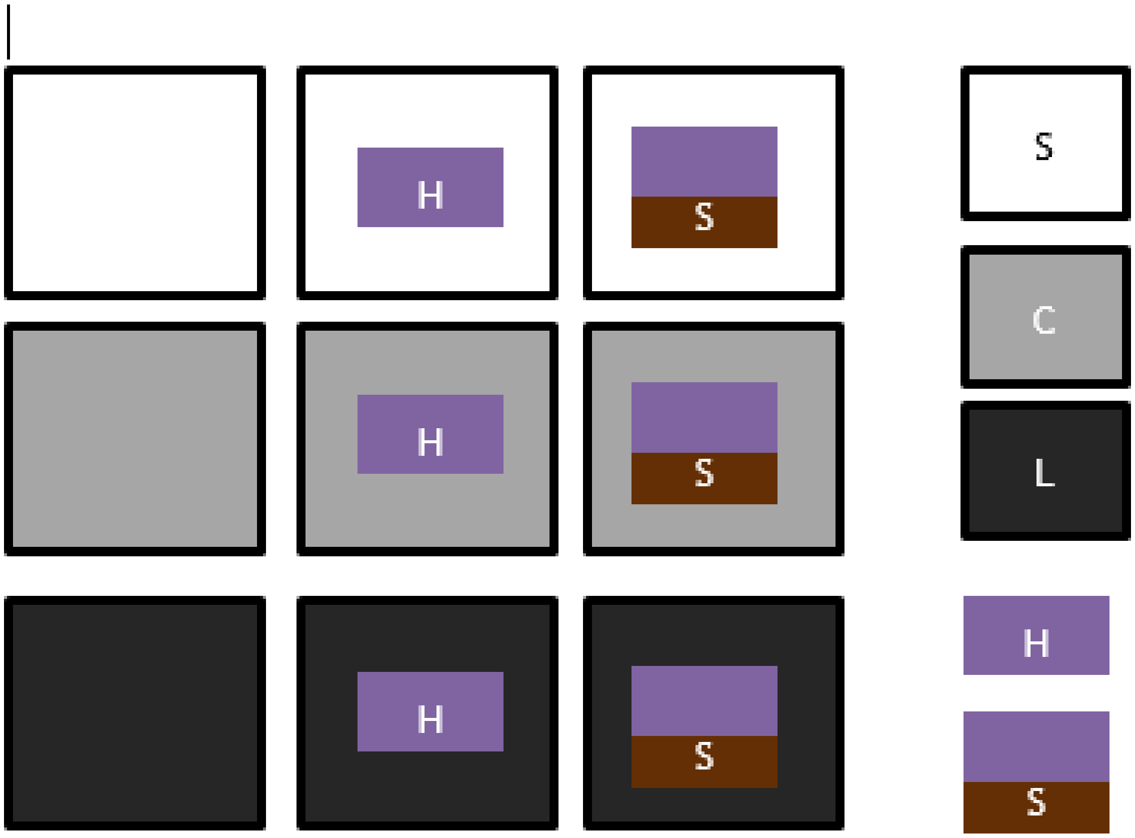
- Extremely high nutrient availability
- Hydrology (drainage ditches)
- Higher soil pH and buffer capacity, much higher than heathland
- Absence of typical heathland soil community (bacteria, fungi, micro- and mesofauna)
- Absence of many animal and plant species (absence of seedbank & dispersal problems)

→ **Field experiment**

Experimental setup

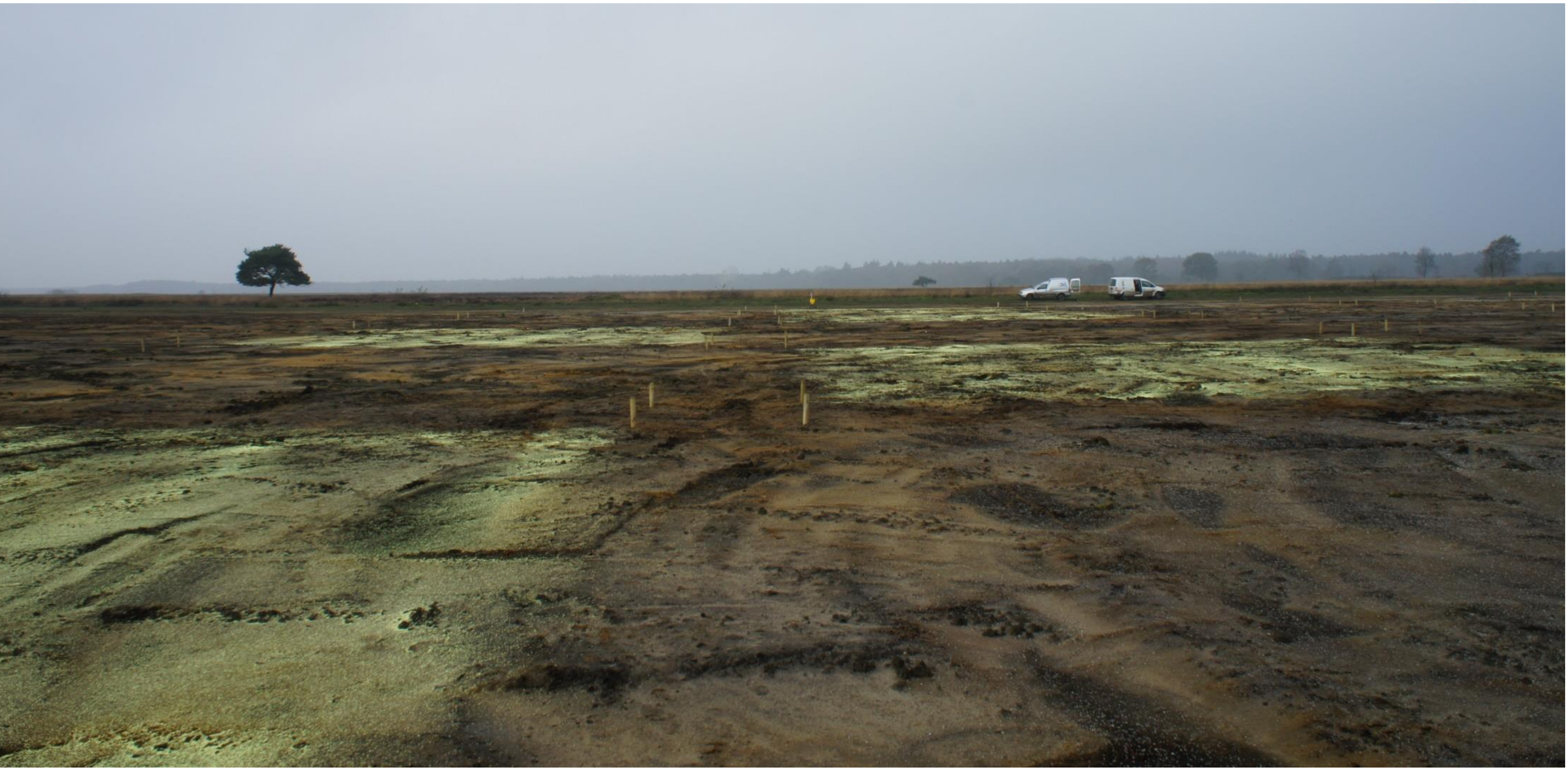
- Nutrient-rich agricultural topsoil (30-40 cm) was removed over 160 ha and drainage ditches closed
- Nutrient conditions became appropriate for heathland development, but soil buffering not (to high)
- Two experiments, aiming on wet heath or dry heath restoration, were installed
- “realistic” scale, plot size 22mx22m at the wet site and 15m x 15m at the dry site

Experimental setup



	Wet site	Dry site
Sulphur (S)	1000 kg/ha	1500 kg/ha
Control (C)	-	-
Limed (L)	3000 kg/ha	2000 kg/ha
Fresh Hay (H)	1:2	1:2
Sods (S)	1:15	1:15

Addition of Lime (**November 2011**), 2000 Kg/ha dry heath, 3000 kg/ha wet heath experiment

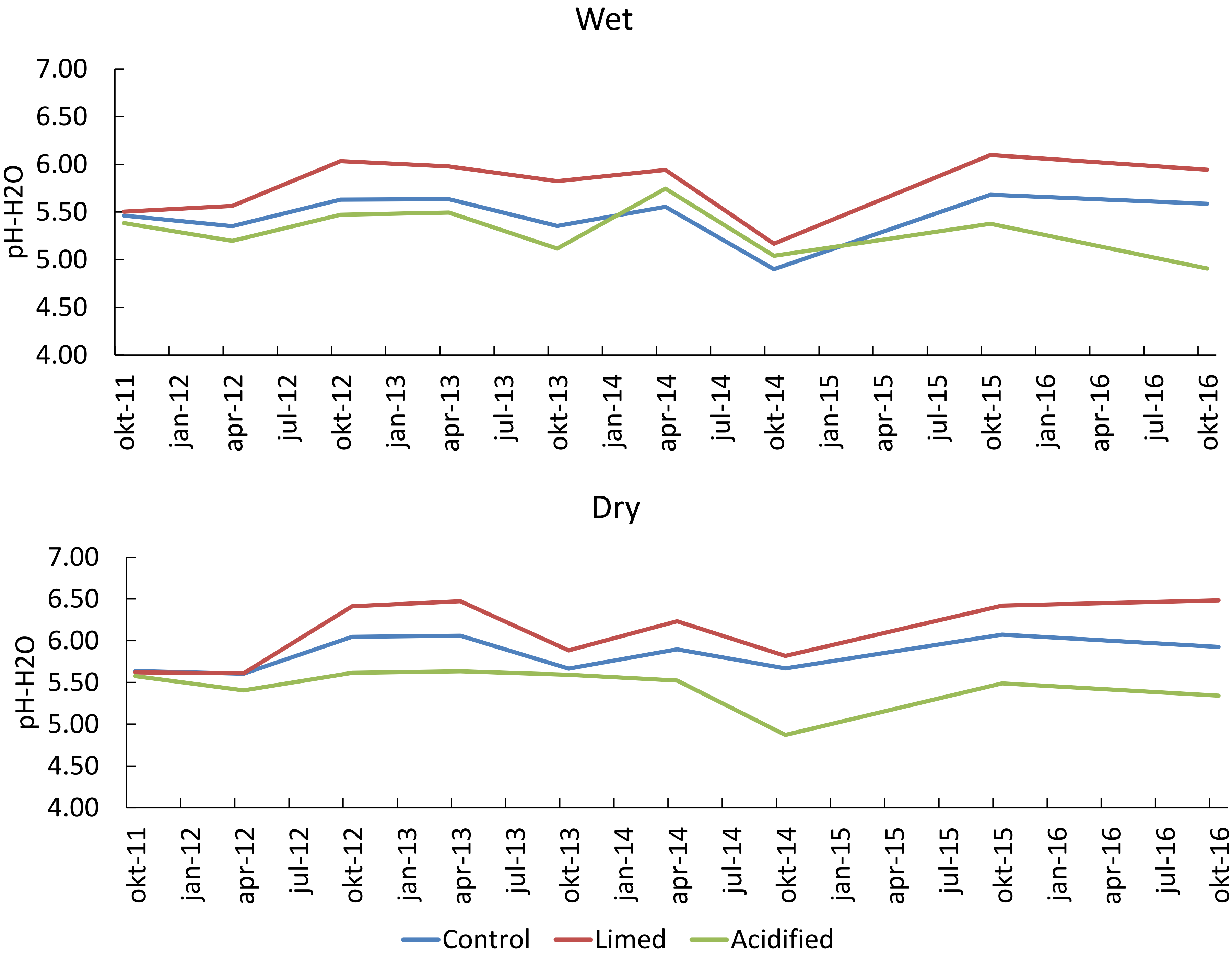


Addition of Sulphur (November 2011), 1500 Kg/ha dry heath, 1000 kg/ha wet heath experiment

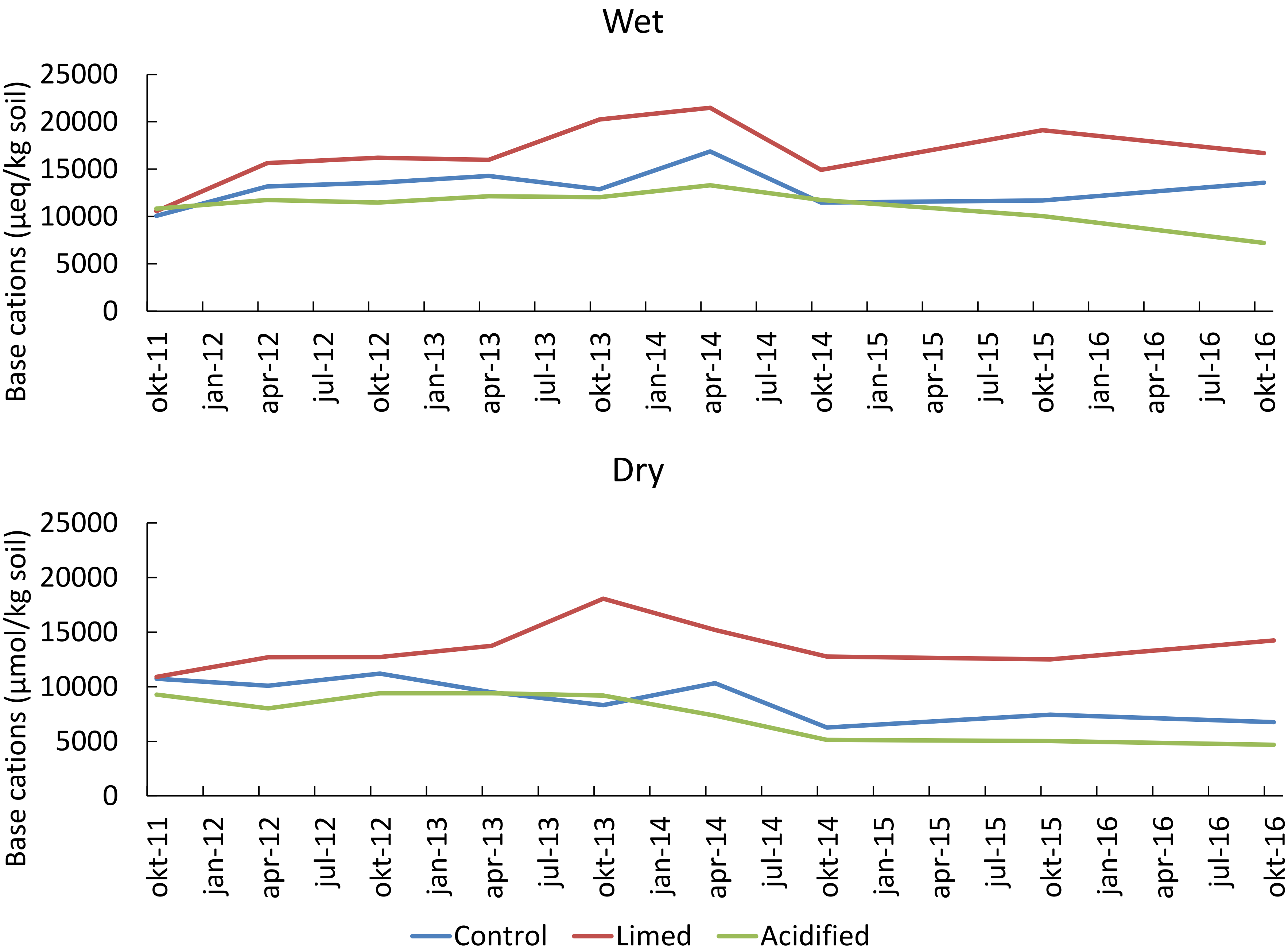
Addition of Soil material (December 2011), 1 m^2 of donor material spread on 15m^2 of experimental plot

Addition of fresh plant material (**September 2012**), 1m^2 donor material on to 2m^2 of experimental plot

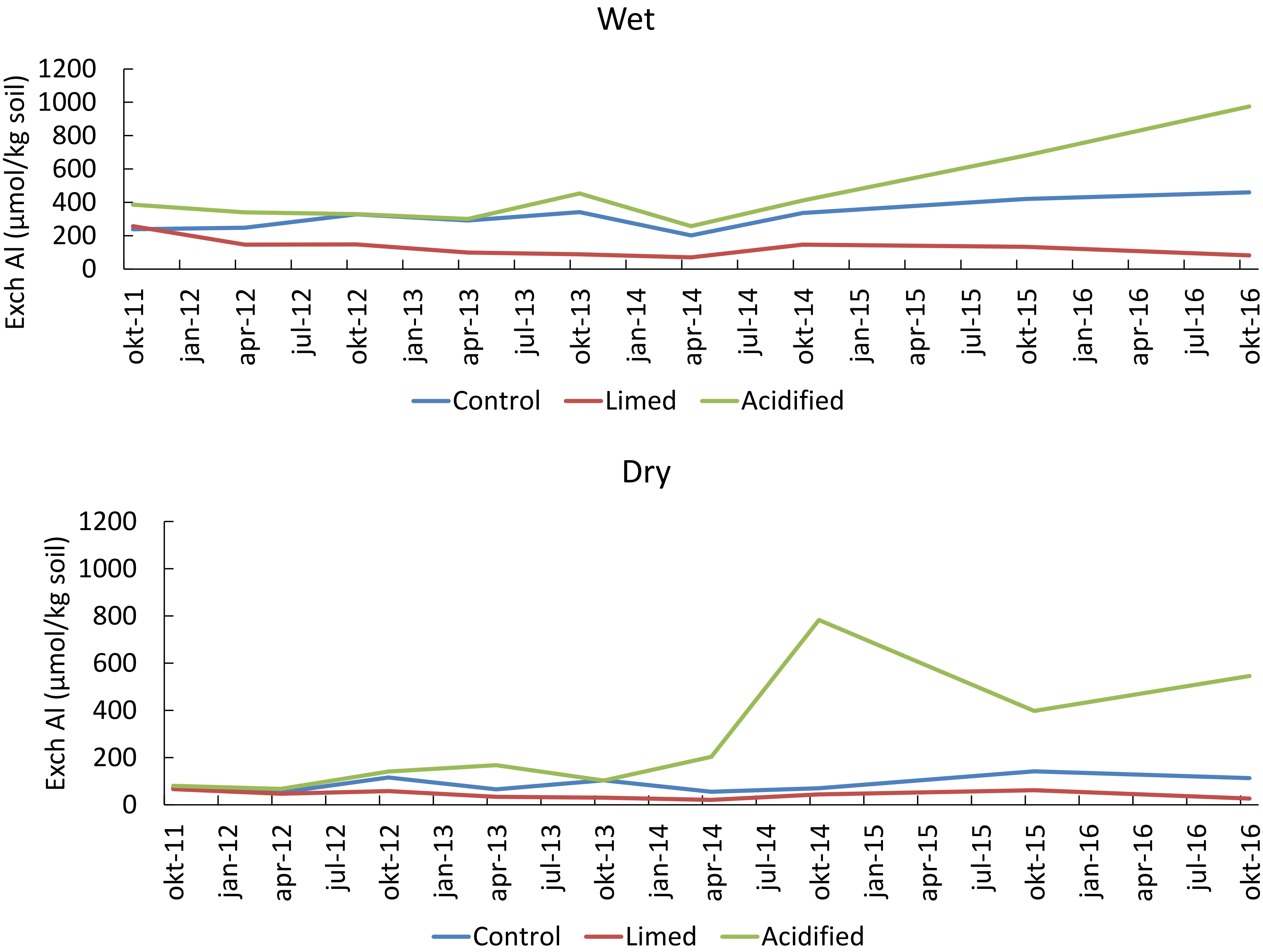

October 2011



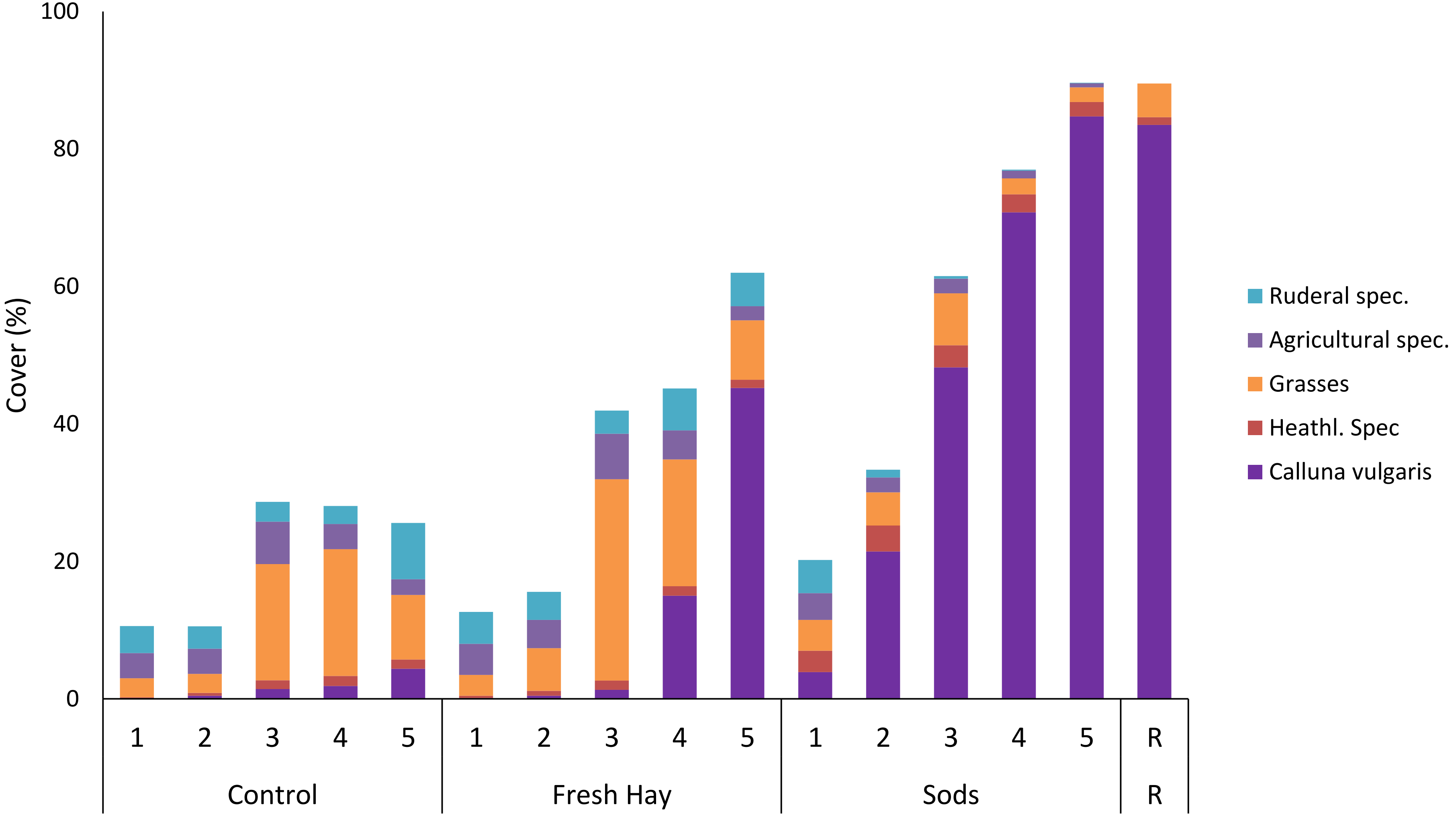
Wet
pH-H2O
7.00
6.50
6.00
5.50
5.00
4.50
4.00
okt-11
jan-12
apr-12
jul-12
okt-12
jan-13
apr-13
jul-13
okt-13
jan-14
apr-14
jul-14
okt-14
jan-15
apr-15
jul-15
okt-15
jan-16
apr-16
jul-16
okt-16
Dry
pH-H2O
7.00
6.50
6.00
5.50
5.00
4.50
4.00
okt-11
jan-12
apr-12
jul-12
okt-12
jan-13
apr-13
jul-13
okt-13
jan-14
apr-14
jul-14
okt-14
jan-15
apr-15
jul-15
okt-15
jan-16
apr-16
jul-16
okt-16
Control
Limed
Acidified



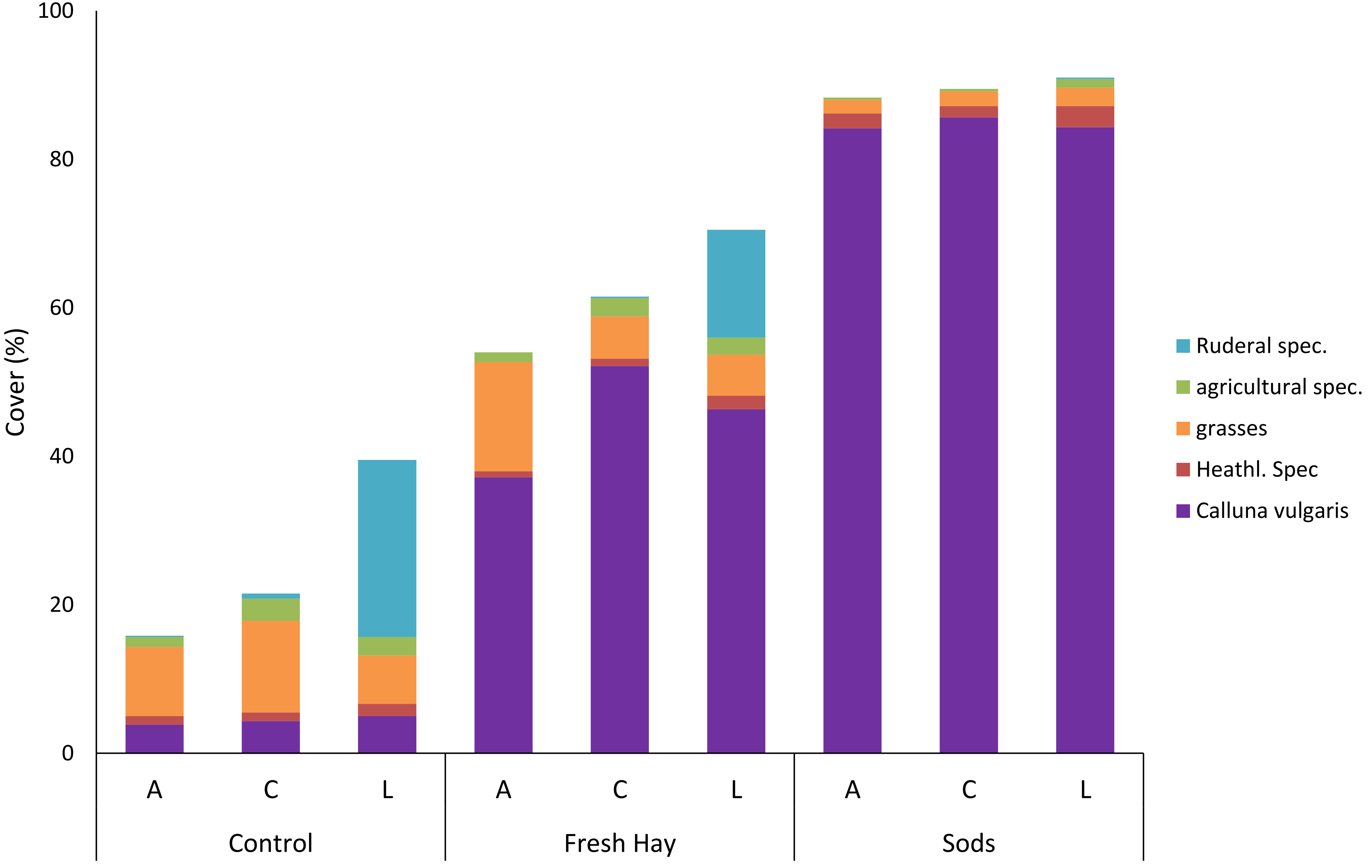
Wet
Base cations (µeq/kg soil)
25000
20000
15000
10000
5000
0
okt-11
jan-12
apr-12
jul-12
okt-12
jan-13
apr-13
jul-13
okt-13
jan-14
apr-14
jul-14
okt-14
jan-15
apr-15
jul-15
okt-15
jan-16
apr-16
jul-16
okt-16
Dry
Base cations (µmol/kg soil)
25000
20000
15000
10000
5000
0
okt-11
jan-12
apr-12
jul-12
okt-12
jan-13
apr-13
jul-13
okt-13
jan-14
apr-14
jul-14
okt-14
jan-15
apr-15
jul-15
okt-15
jan-16
apr-16
jul-16
okt-16
Control
Limed
Acidified


Wet
Exch Al (µmol/kg soil)
1200
1000
800
600
400
200
0
okt-11
jan-12
apr-12
jul-12
okt-12
jan-13
apr-13
jul-13
okt-13
jan-14
apr-14
jul-14
okt-14
jan-15
apr-15
jul-15
okt-15
jan-16
apr-16
jul-16
okt-16
Control
Limed
Acidified
Dry
Exch Al (µmol/kg soil)
1200
1000
800
600
400
200
0
okt-11
jan-12
apr-12
jul-12
okt-12
jan-13
apr-13
jul-13
okt-13
jan-14
apr-14
jul-14
okt-14
jan-15
apr-15
jul-15
okt-15
jan-16
apr-16
jul-16
okt-16
Control
Limed
Acidified

Cover different groups (dry)



Cover vs. pH treatment (dry, 2016)



Conclusions after 5 years

- The addition of lime and elementary S has led to a gradient in soil buffering (pH, BC and Al). In acidified plots buffering is (almost) within range of reference heathland sites
- Soil nutrients (N,P) in range of well-developed heathlands and remain stable
- Addition of sods and fresh hay has led to a much higher cover of heathland species compared to the control
- Addition of sods has strongly improved the development of the soil microbial community after 2 year into the direction of heathland.
- Total cover is much lower in the control plots, somewhat lower in in the acidified situation, and limed plots have more ruderal species.

Conclusions after 5 years

- This year (2017) vegetation, soil chemistry, soil community and coleoptera are sampled again
- Interesting to see how the hay-addition-plots will develop (mismatch between soil community and vegetation), will pH-treatments make the difference?
- Both vegetation and soil chemistry are still in development, but not in the same phase (varying from very closed to very open)
- We will visit the experimental site this afternoon (so no pictures of the current situation)

Thank you!

Questions?

reference	Soil pH-H2O	Exchangeable BC	Plant available phosphorus	N-Total (NO3+NH4)	Organic matter
		µeq/kg soil	µmol/kg soil	µmol/kg soil	%
Wet heath*	4.4 (3.8-5.5)	3851 (470-18788)	100-600	98 (0-531)	5.9 (0.4-21.7)
DV1	4.41	6216	445	2111	14.21
DV 2	4.92	4657	354	1762	9.72
DV 3	4.17	21578	1236	7590	56.87
Dry Heath *	4.4 (3.8-4.9)	1527 (845-7690)	100-700	33 (1-221)	4.8 (1.6-11.9)
DV 4	5.35	3919	652	783	11.9
DV 5	4.83	1256	409	241	4.1
DV 6	4.76	3421	871	1042	9.91

Experimental site	Soil pH-H2O	Exchangeable base cations	Plant available phosphorus	N-Total (NO3+NH4)	Organic matter
		µeq/kg soil	µmol/kg soil	µmol/kg soil	%
Wet site	5.5	10482	494	60	2.93
Dry site	5.5	10304	296	41	2.11