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The suppression of *Cirsium arvense* and *Elytrigia repens* exerted by competitive crops plays a key role for their management in organic cropping systems

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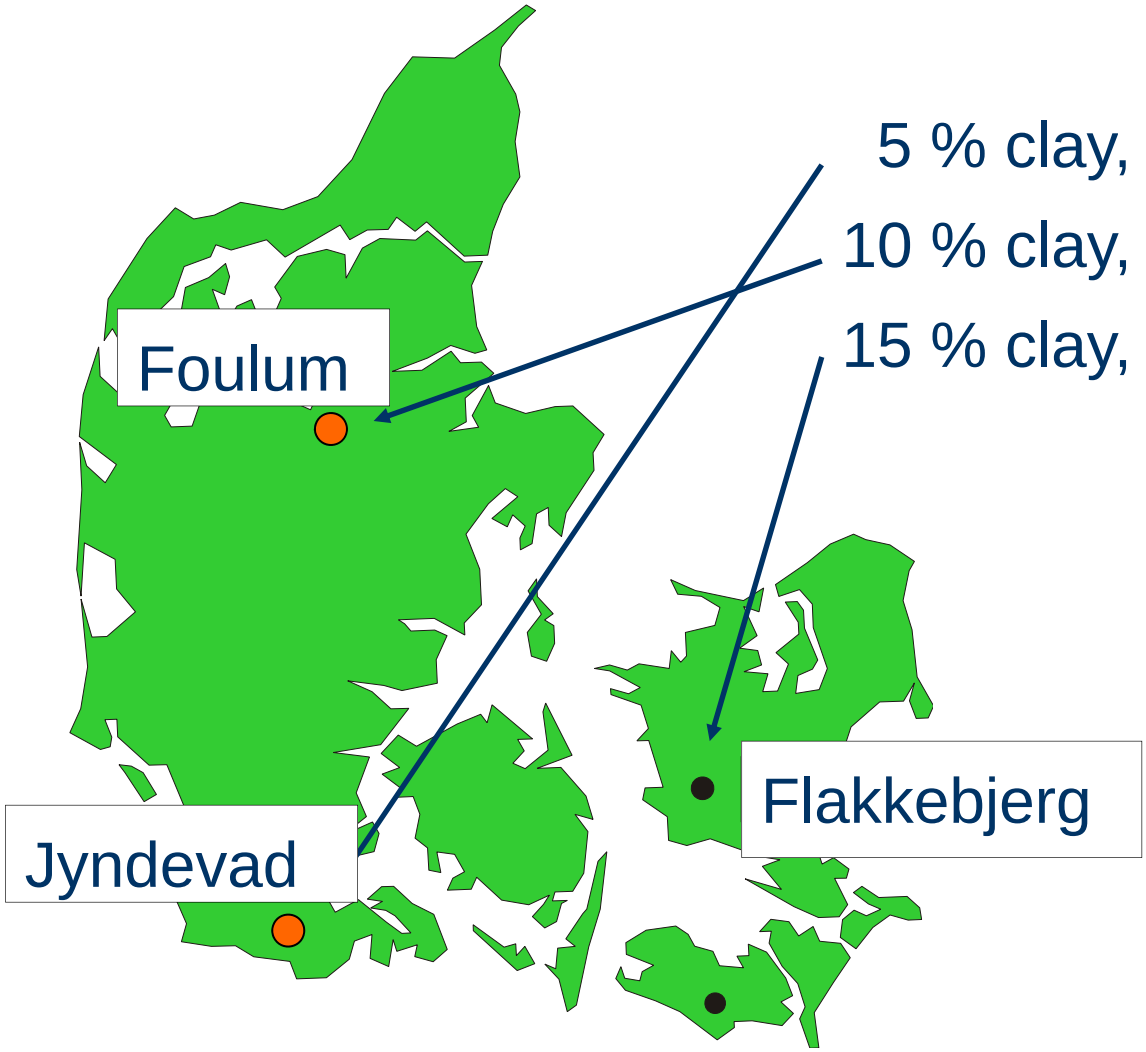
Results from long-termed organic crop rotation experiments at three locations

Treatments:

- Crop rotation
- Entry point / sequence
- Manuring
- Catch crop
- Various control tactics

Organic cropping systems at three locations in DK, 1997-2009

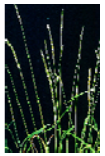


5 % clay, 950 mm

10 % clay, 700 mm

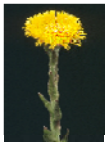
15 % clay, 600 mm

Major perennial weeds in Danish organic farming



Common couch grass (*Elytrigia repens*)

Creeping thistle (*Cirsium arvense*)



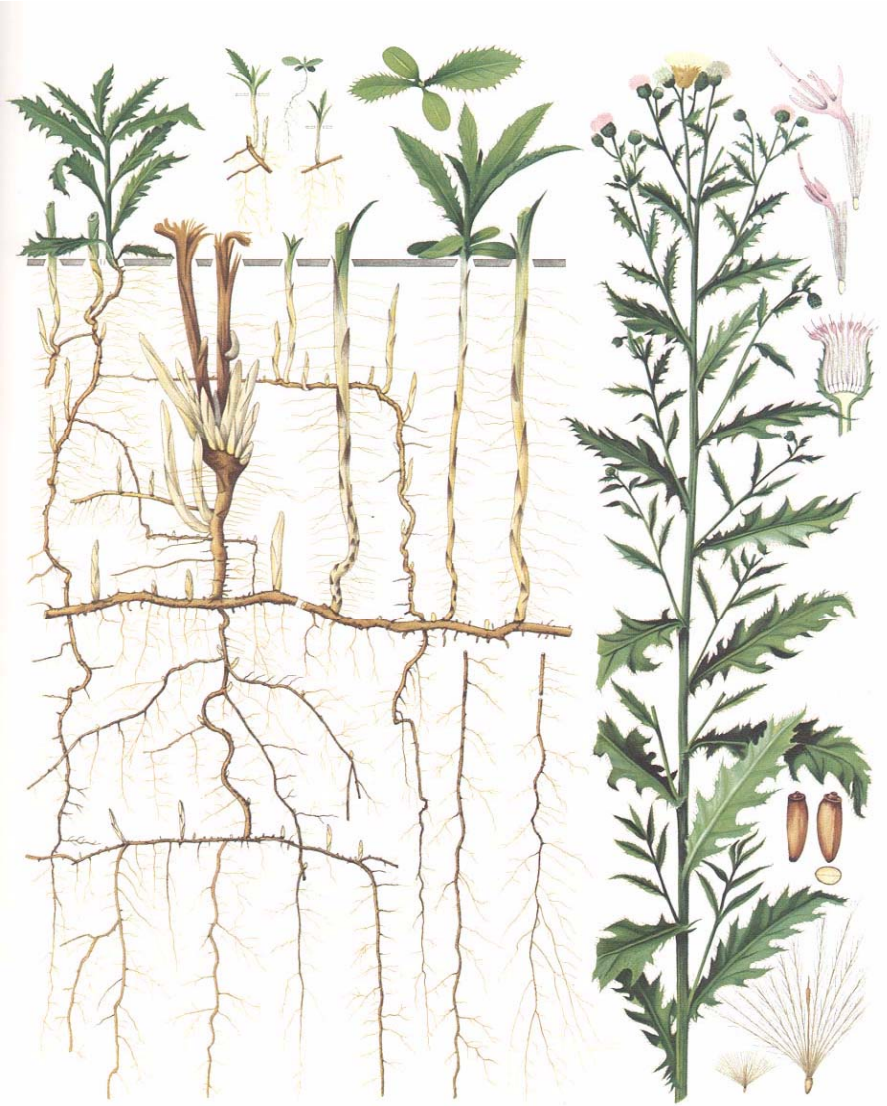
Coltsfoot (*Tussilago farfara*)

Sow-thistle (*Sonchus arvensis*)

Docks (*Rumex* spp.)

Couch grass

Creeping thistle

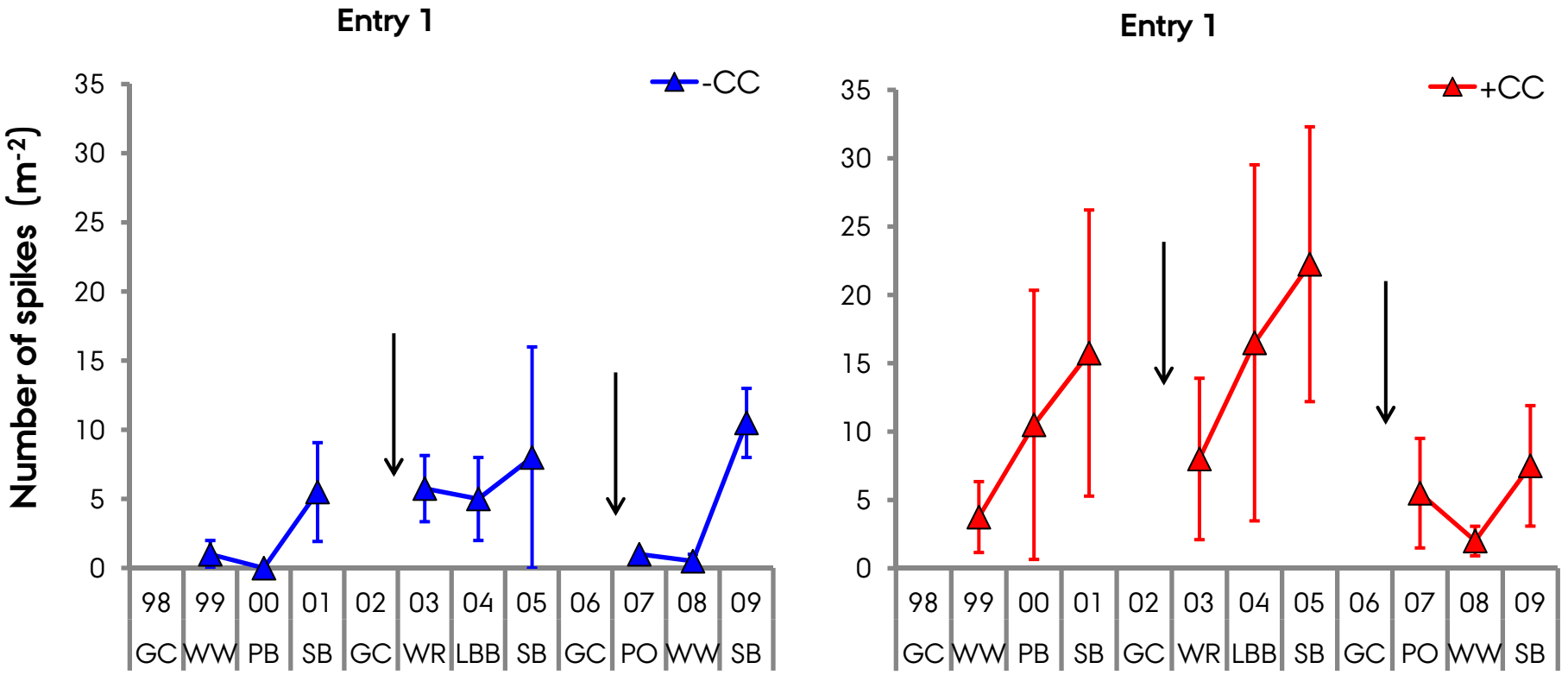


The cropping systems at Jyndevad, a coarse sand

Cycles	Crop rotation O1	Crop rotation O2
1997-2000	S. barley:ley Grass-clover S. wheat Lupin	S. barley:ley Grass-clover W. wheat Pea:barley
2001-2004	S. barley:ley Grass-clover S. oats Pea:barley	S. barley:ley Grass-clover W. rye Lupin:bean:barley
2005-2009	S. barley Pulse crop Potato W. wheat	S. barley:ley Grass-clover Potato W. wheat

± catch crops, ± manure (slurry)

Couch grass development in rotation O2 on coarse sand

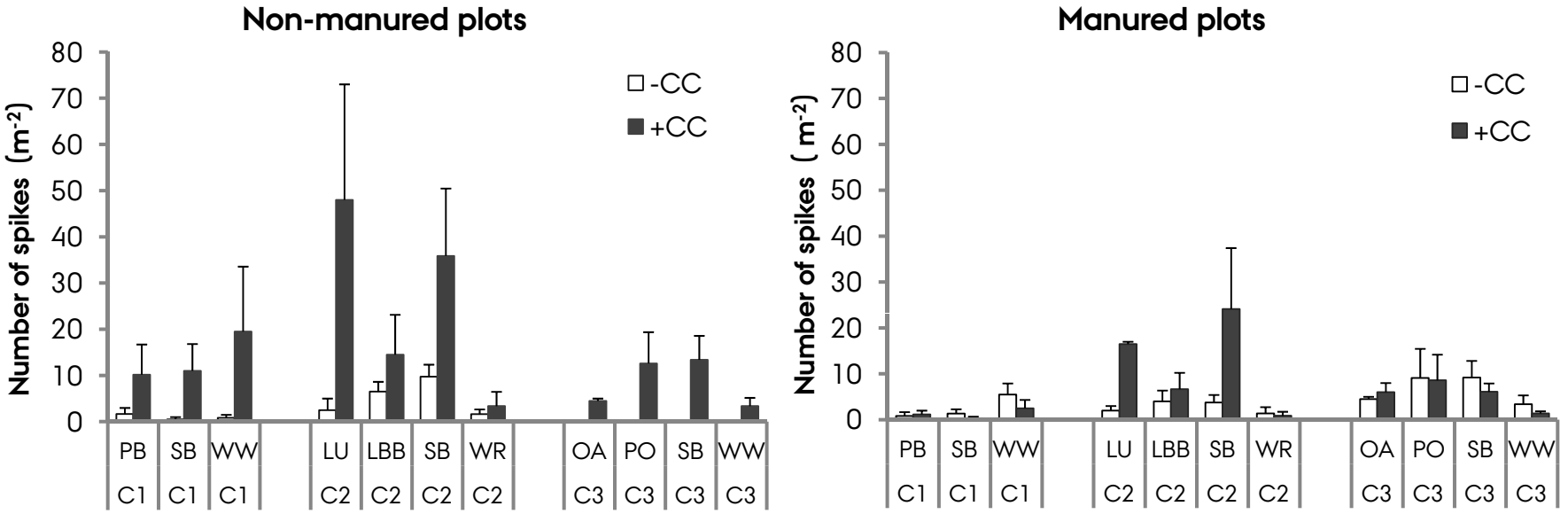


Couch grass development in three cycles in rotation
O2 on coarse sand

C1: 1997-00

C2: 2001-04

C3: 2005-09



Multiplicative model for calculating the effects of the experimental factors on *E. repens* proliferation

$$Y_t = \alpha \prod_{k=1}^{t} \left\{ \beta_{i(k)} \coprod_{j=1}^{3} \gamma_{j(k)}^{n_{jk}} \right\} \quad (1)$$

$$\ln(Y_t + 0.5) \approx \ln(\alpha) + \sum_{k=1}^{t} \ln(\beta_{i(k)}) + \sum_{k=1}^{t} \sum_{j}^{3} n_{jk} \ln(\gamma_{j(k)}) + E_t \quad (2)$$

Y_t is the number of spikes in the plot at time t

α is the initial number of spikes in the plot

β_{ik} is the effect of crop type i for year k

γ_{jk} is the effect of cultivation category j for year k

n_{jk} is the number of cultivations of category j in year k

E_t is a random effect of year t.

Statistical output

Effect	Estimate	SE	DDF	*t*-value	Probt.	Factor
Intercept:	-1.724[a]	0.803	3.83	-2.15	0.1013	
Feff	-0.224	0.034	155	-6.59	<.0001	0.799
Meff	-0.969	0.443	208	-2.19	0.0297	0.379
Seff(-CC)	-0.157	0.018	200	-8.91	<.0001	0.854
Seff(+CC)	-0.306	0.049	276	-6.27	<.0001	0.736
Fab	0.342	0.261	386	1.31	0.1906	1.408
LupG	1.604	0.410	239	3.91	0.0001	4.975
LupC	1.080	0.234	303	4.61	<.0001	2.945
LBB	2.124	0.251	281	8.45	<.0001	8.363
OatG	0.950	0.367	178	2.59	0.0104	2.587
OatC	1.109	0.386	475	2.87	0.0042	3.032
Pea/Sba	1.275	0.162	290	7.89	<.0001	3.578
SbaB	0.932	0.149	82.6	6.26	<.0001	2.541
SbaC	0.806	0.151	291	5.33	<.0001	2.240
Swh	1.794	0.325	131	5.52	<.0001	6.012
Wry(-CC)	0.536	0.515	239	1.04	0.2992	1.709
Wry(+CC)	-0.355	0.500	237	-0.71	0.4783	0.701
WwhG	1.694	0.343	150	4.93	<.0001	5.440
WwhB	0.710	0.286	254	2.48	0.0136	2.034
FertAll	-0.323	0.126	74.3	-2.56	0.0126	0.724

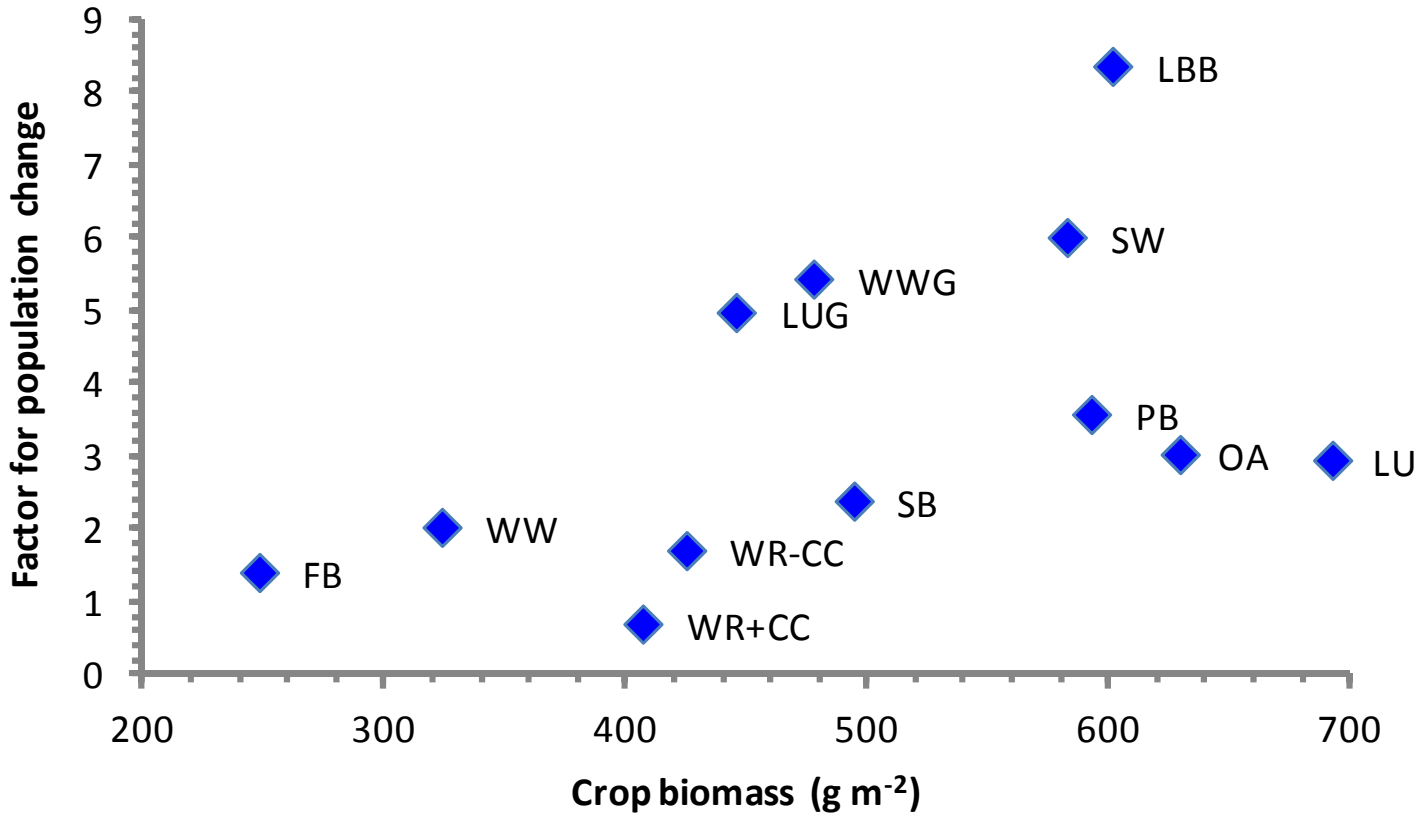
Factors that promoted Couch-grass growth

No	Factors	Effects
1	Pulse:barley mixture	+736%
2	Spring wheat	+501%
3	Winter wheat / grass-clover as the preceding crop	+444%
4	Lupin / grass-clover as the preceding crop	+397%
5	Oat / cereals as the preceding crop	+203%
7	Lupin / cereals as the preceding crop	+195%
8	Oat / grass-clover as the preceding crop	+158%
9	Spring barley / no cereals as the preceding crop	+154%
10	Spring barley / cereals as the preceding crops	+124%
11	Winter wheat / spring barley as the preceding crop	+103%
12	Winter rye	0%
13	Potatoes	0%

Factors that reduced the Couch-grass population

No	Factors	Effects
1	Mini summer fallow	-62%
2	Stubble cultivation followed by a catch crop	-26%
3	Tine cultivation in spring	-20%
4	Fertilisation	-18%
5	Stubble cultivation without a subsequent catch crop	-14%

Factor f. population change versus crop biomasses

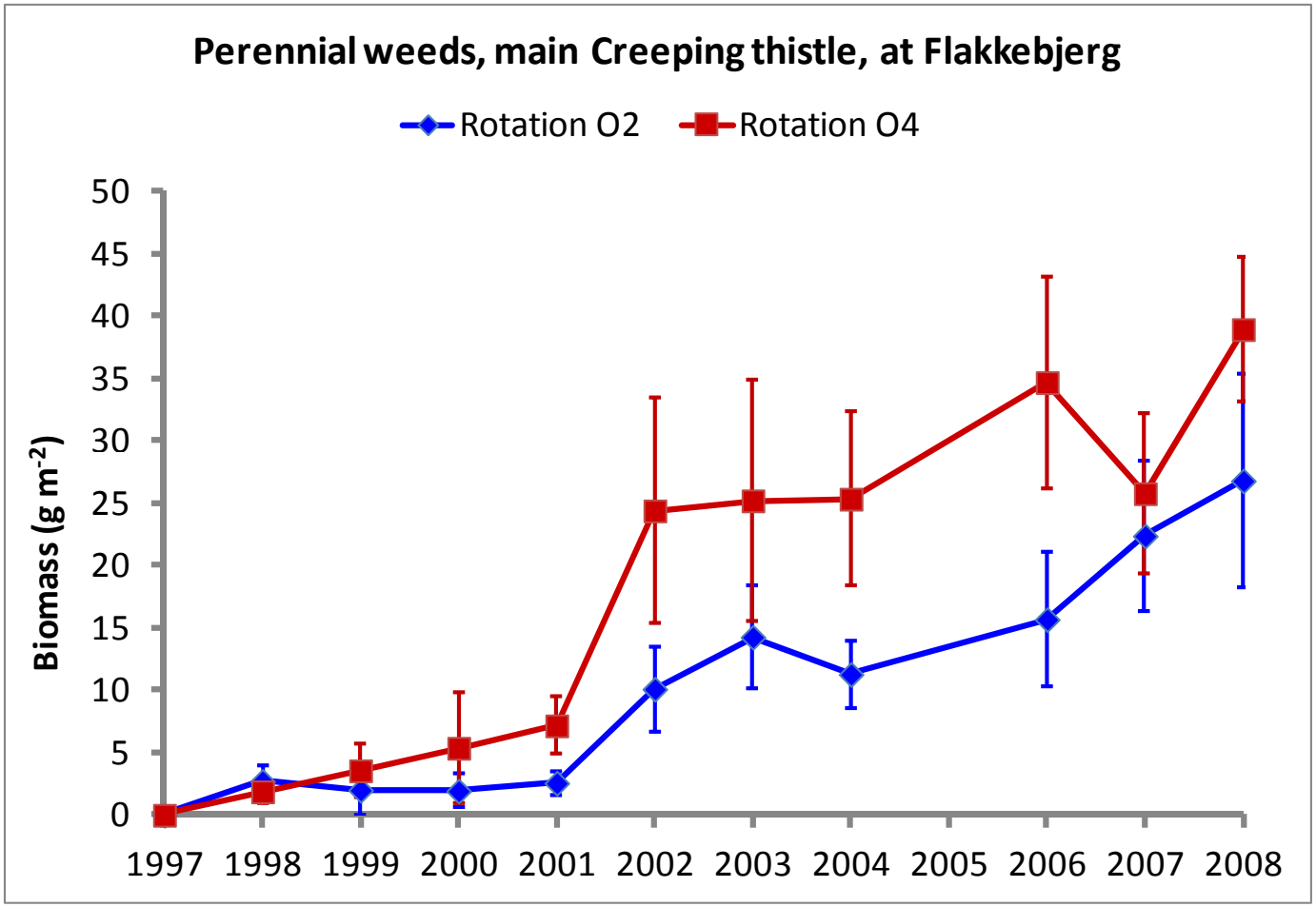


The cropping systems at Flakkebjerg, a sandy loam

Cycles	Crop rotation O2	Crop rotation O4
1997-2000	S. barley:ley Grass-clover W. wheat Pea:barley	Oat W. wheat W. wheat[1] Pea:barley
2001-2004	S. barley:ley Grass-clover W. wheat Lupin:barley	W. wheat Oat S. barley Lupin[3]
2005-2008	S. barley:ley Grass-clover Potato W. wheat	S. barley Faba bean Potato W. wheat

± catch crops, ± manure (slurry)

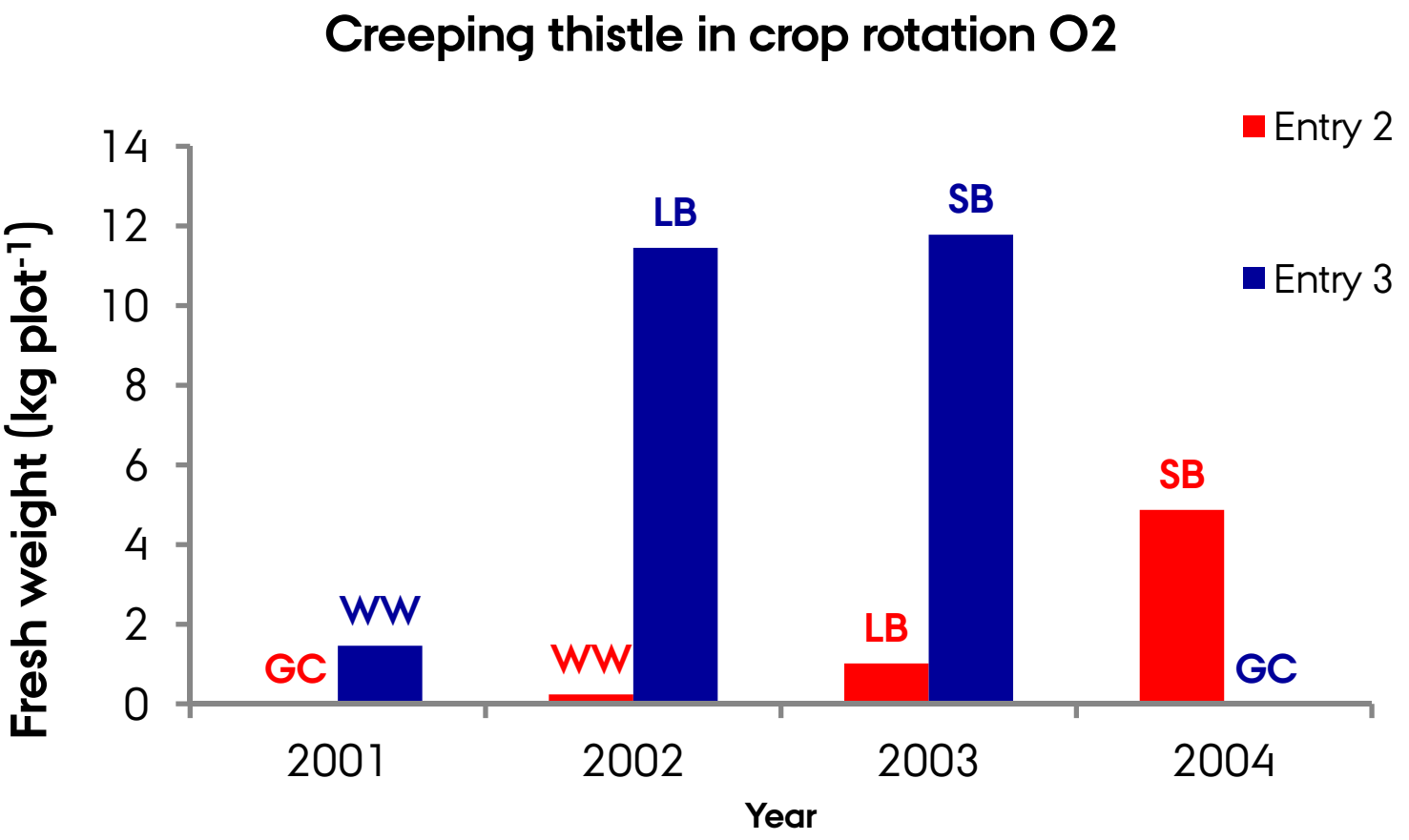
Proliferation of perennial weeds at Flakkebjerg



Main factors affecting the growth of creeping thistle

- ✓ Crop rotation
- ✓ Entry point, i.e. the specific crop sequence
- – Catch crop
- – Manure
- – Stubble cultivation

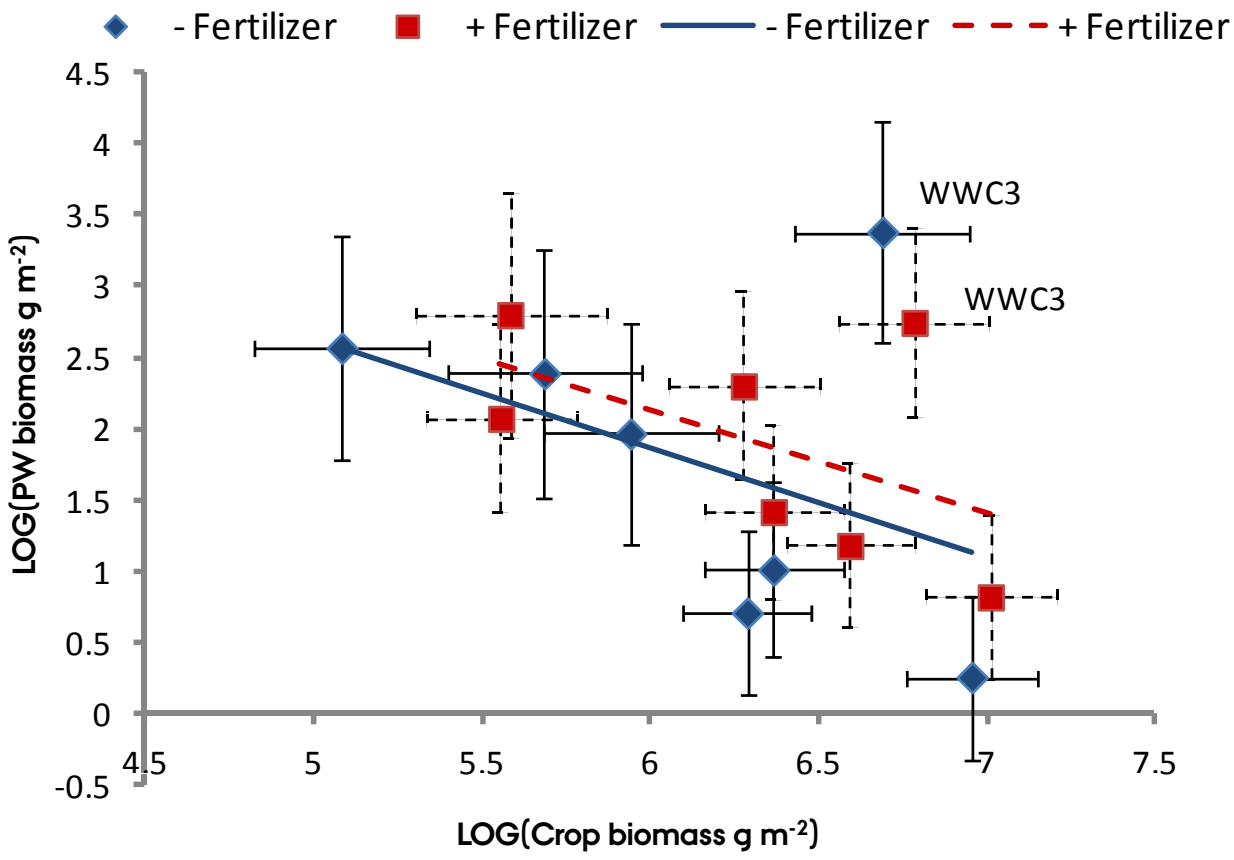
The importance of entry point / crop sequence



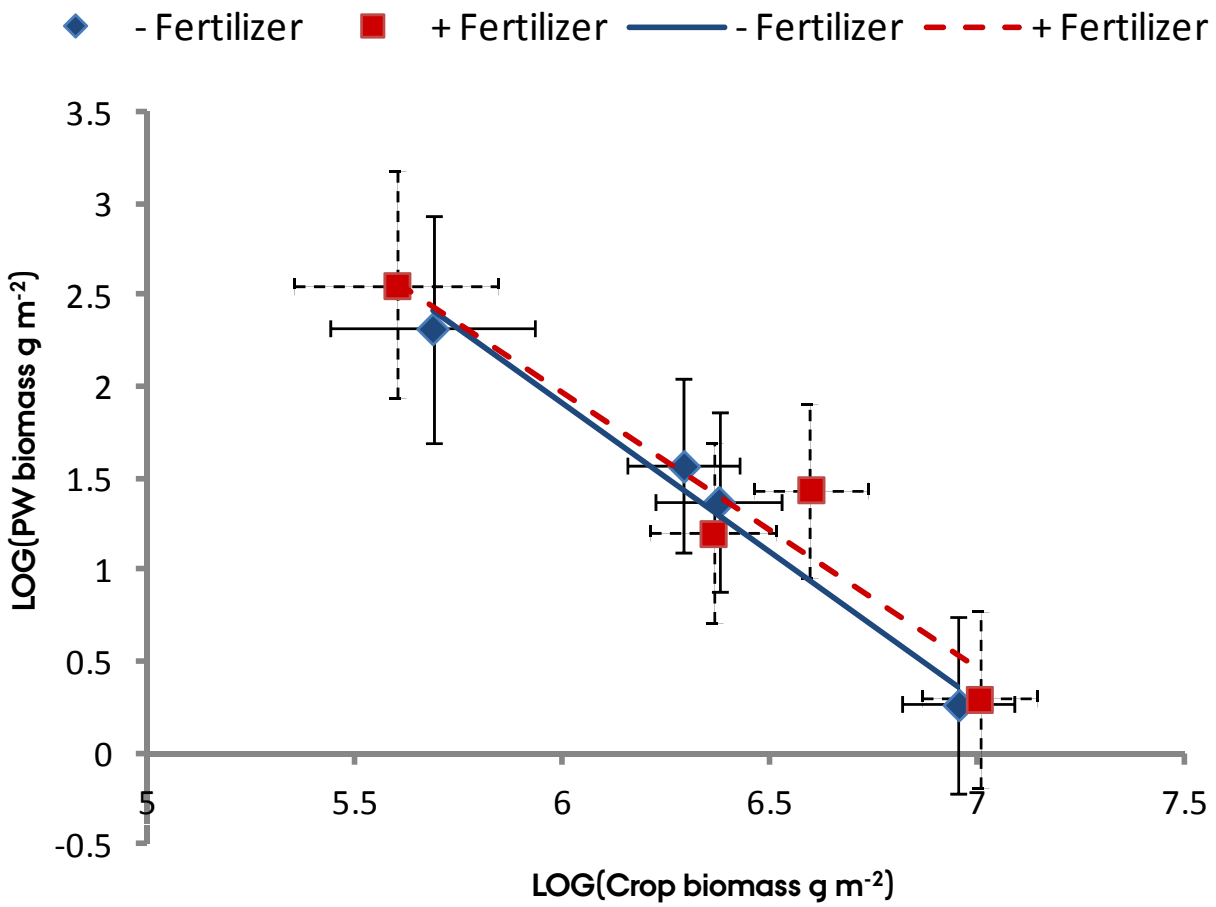
Crop effects on creeping thistle

Crop	Effects
Lupin	8.9
Lupin:barley	2.6
Winter wheat	2.0
Spring barley	1.0

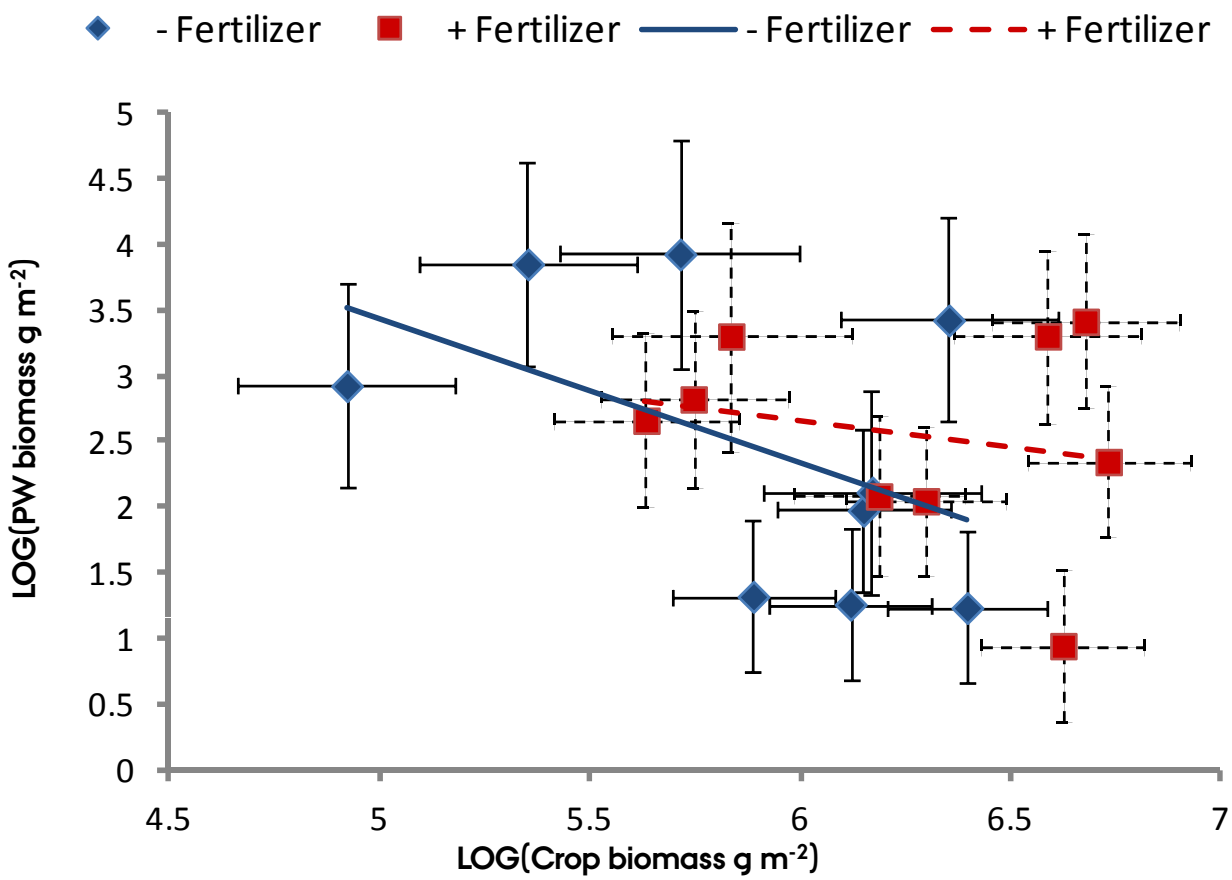
Perennial weeds biomass versus crop biomass in O2 with grass-clover



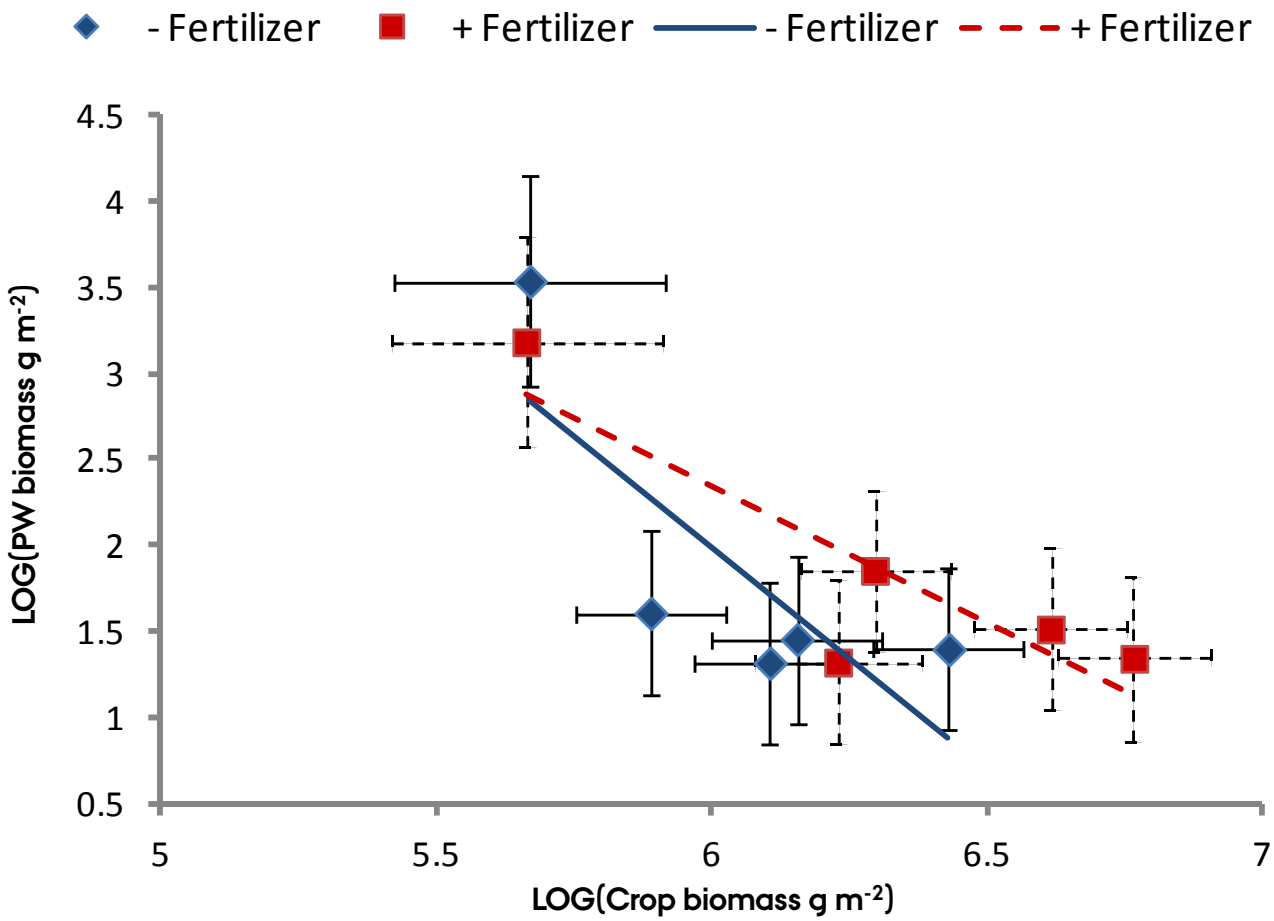
C. arvense fresh biomass versus crop biomass in O2 with grass-clover



Perennial weeds biomass versus crop biomass in O4



C. arvense fresh biomass versus crop biomass in O4



Competitive crops and biomass

Competitive crops and catch crops to suppress *C. arvense*

***Cirsium arvense* number, weight and length at different times during the experiment**

Crop 2009	*C. arvense*, # m^{-2}		*C. arvense*, $g\ m^{-2}$		*C. arvense*, mean length in cm
	June 2009	*July 2010*	*Nov. 2009*	*July 2010*	*July 2010*
Oilseed rape	14.5[a]	49.0[a]	21.8[a]	453.8[a]	33.2[a]
Fibre hemp	1.3[b]	5.3[b]	0[a]	61.8[a]	17.7[a]
1st year grass-clover	0.3[b]	6.5[b]	2.3[a]	110.2[a]	32.8[a]
2nd year grass-clover	0.1[b]	7.3[b]	1.1[a]	72.1[a]	34.8[a]

Results within the same column with the same letter are not significantly different at $P<0.05$.

Conclusions

- ✓ Species specific dynamics
- ✓ Crop suppression important but different responses to crop attributes
- ✓ Crop sequencing crucial to avoid or minimize 'weak gaps' and make room for mechanical control
- ✓ Fertilization and catch crop