Overview of the clubroot incidence and variation in the pathotypes of *Plasmodiophora brassicae* populations in Europe

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International Clubroot Workshop, 07-09.08.2018, Edmonton/Canada

a registered resistant cultivar

Clubroot (*Plasmodiophora brassicae*)

Current reports stated the frequent outbreaks of clubroot in districts growing OSR crops in recent years

Reasons for increasing occurrence of the disease

- Increasing in oilseed rape cultivation area
- Relatively short crop rotation
- Propagation of the pathogen in volunteer OSR and weeds after harvest in clubroot infested fields
- Favourable weather and soil conditions for the infection

Monitoring of clubroot pathotypes

Plasmodiophora brassicae

✓A field collection is frequently a mixture of separate populations with different pathogenicity each capable of differential interaction (Honig, 1931) (**Pathotype**: Any of a group of organisms (of the same species) that have the same pathogenicity on a specified host)

✓Numerous sets of differential hosts have been proposed for the assessment of virulence in the pathogen

Differential Brassica genotypes used to classify *P. brassicae* pathotypes

Differential Nr.	Differential cultivar/line
	Brassica rapa
ECD 01	subsp. *rapifera* line aaBBCC
ECD 02	subsp. *rapifera* line AAbbCC
ECD 03	subsp. *rapifera* line AABBcc
ECD 04	subsp. *rapifera* line AABBCC
ECD 05	var. *pekinensis* cv. Granaat
	Brassica napus
ECD 06	var. *napus* cv. Nevin
ECD 07	var. *napus* cv. Giant Rape
ECD 08	var. *napus* selection ex. 'Giant Rape'
ECD 09	var. *napus* New Zealand clubroot resistant rape
ECD 10	var. *napobrassica* cv. Wilhemsburger
	Brassica oleracea
ECD 11	var. *capitata* cv. Badger Shipper
ECD 12	var. *capitata* cv. Bindsachsener
ECD 13	var. *capitata* cv. Jersey Queen
ECD 14	var. *capitata* cv. Septa
ECD 15	var. *acephala* subvar. laciniata cv. Verheul
	Brassica napus var. napobrassica (Laurentian)
-	*Brassica napus* cv. Brutor (spring oilseed rape)
-	*Brassica napus* cv. Mendel

- **Differentials of Williams (1966)**
  4 cultivars: 32 combinations
- **European Clubroot Differential (ECD)**
  Buczacki et al. (1975)
  15 cultivars: 32,768 combinations
- **Differentials series of Somé (1996)**
  3 cultivars: 8 combinations
- To check the degree of virulence of the collected isolates

⇩

Mendel: 1st clubroot-resistant OSR
a race-specific clubroot resistance
B. rapa ECD-04 x *B. oleracea* ECD-15

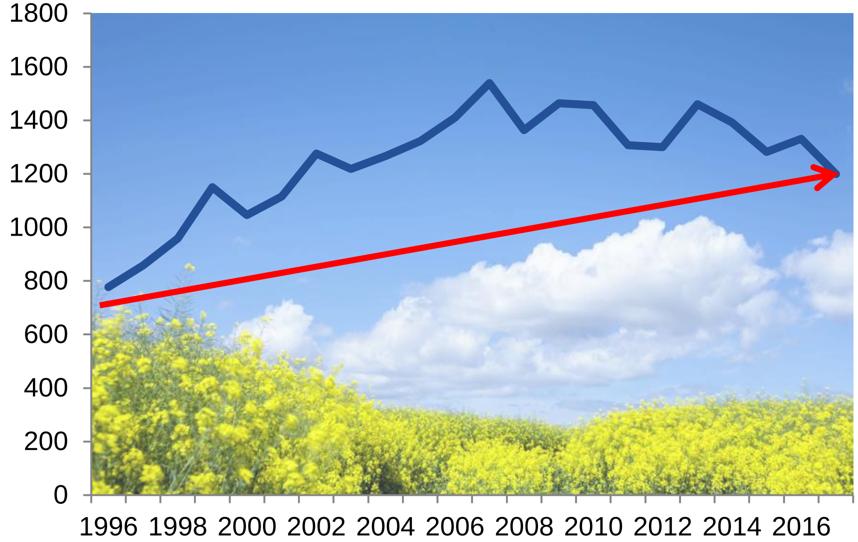
Monitoring of clubroot pathotypes in some of European countries

Germany

Nazanin Zamani Noor

(Julius Kuehn-Institute, Institute for Plant Protection in Field Crops and Grassland)

Cultivated area in 1000 ha



- Increasing in oilseed rape cultivation area in Germany up to 1.5 million ha

- The frequent outbreaks of clubroot in districts growing OSR crops

Monitoring of clubroot pathotypes in Germany

Name and address of the sender	
Name, First name:	
Institution:	
Address:	
Telephone:	
E-Mail:	
Date of sampling:	
Information about the infected field	
Address, State:	
Farmer's name:	
GPS Data (Width, Length):	
Soil type:	
pH Value (checking at JKI):	
Plant host (cultivar):	
Field rotation regime:	
Disease incidence (%)	
Pathotypeneinstufung	
ECD:	
INRA:	

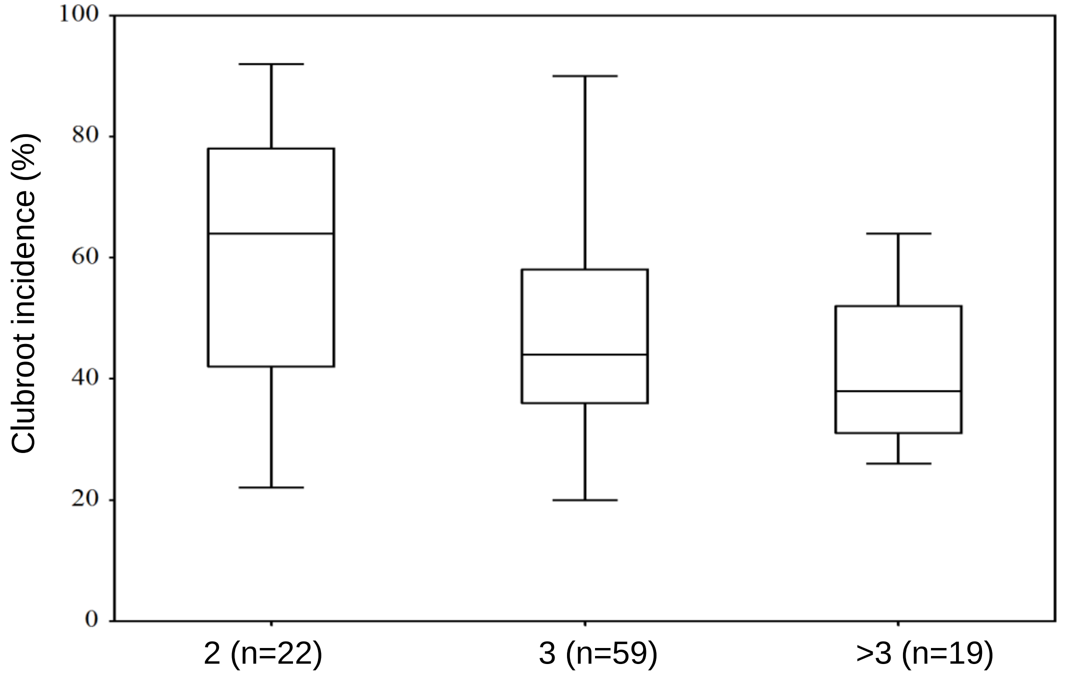
- Since 2013 farmers, OSR breeders and agricultural consultants were asked to send galls and soil samples from first reported clubroot infected fields in different federal states of Germany

- Disease incidence was calculated from 50 plants randomly sampled in each clubroot-infected field. The roots were evaluated as healthy (without any swelling or gall formation) or infected

- Till date, in total, 110 infected samples were obtained from 12 German federal states

Crop Rotation in Germany

Within clubroot-infected fields clubroot disease incidence varied from **20%-92%**



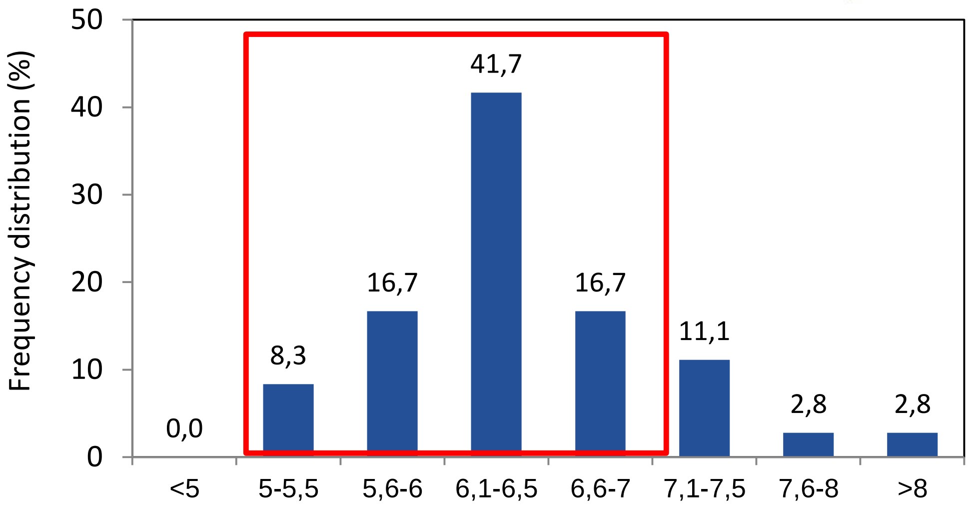
Year	Rotation regime
2	Winter wheat / Winter oilseed rape
3	Winter wheat / Winter wheat / Winter oilseed rape
	Winter wheat / Winter barley / Winter oilseed rape
>3	Sugar beet / Winter wheat / Winter oilseed rape / winter wheat
	Maize / Winter wheat / Winter oilseed rape / Winter wheat
	Winter oilseed rape / Maize / Winter triticale / Winter Barley

Frequency of OSR in the rotation was significantly correlated with the incidence and prevalence of clubroot disease

Relationship between soil pH and the disease incidence of clubroot-infected fields

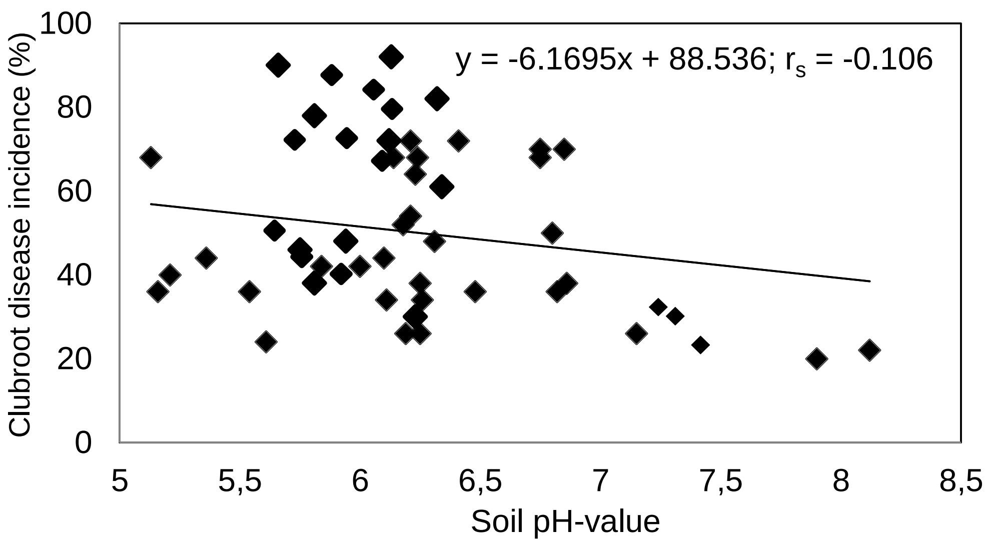
Clubroot disease could occur over a wide range of soil pH from **5.1** to **8.3**.

Acidic soils maybe most at risk

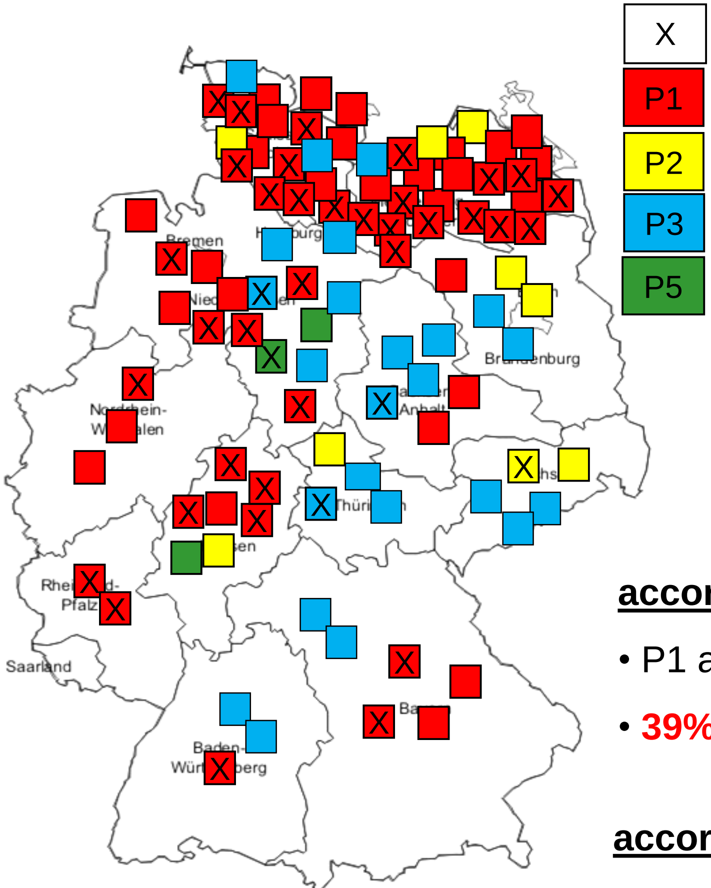


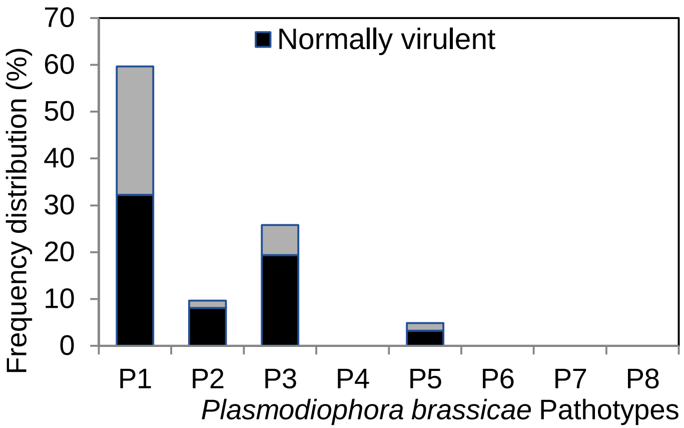
Within clubroot-infected fields:

- clubroot disease incidence varied from 20 %-92 %
- a negative correlation observed between soil pH and the disease incidence



Geographical distribution of *P. brassicae* pathotypes in Germany (2013-2017; n=85)





<u>according to Somé et al. (1996)</u>

- P1 and P3: the most widespread pathotypes among *P. brassicae* isolates
- **39%** of all isolates showed high infestation on resistant cultivar ‚Mendel'

<u>according to ECD; Buczacki et al. (1975)</u>

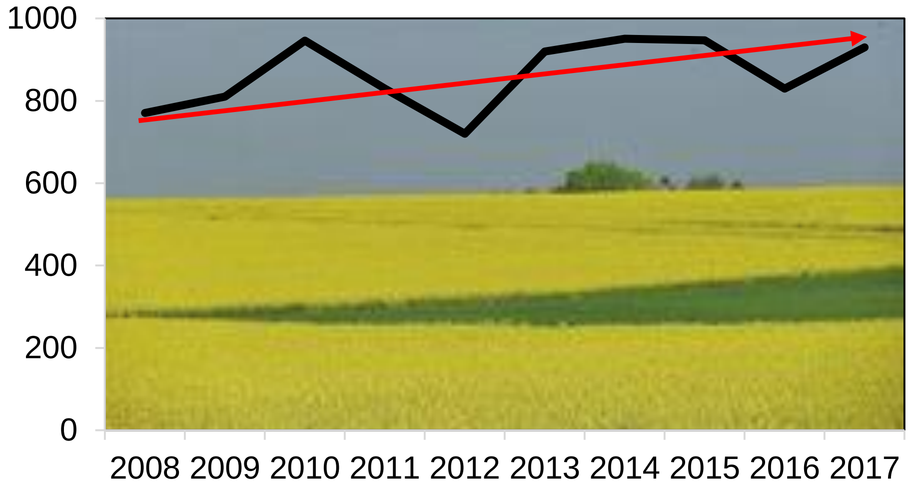
- **20** distinct virulence patterns were observed
- **12%** of all isolates showed moderate to high disease severity on ECD 01 to ECD 03

Zamani-Noor, N. 2017. Variation in pathotypes and virulence of *Plasmodiophora brassicae* populations in Germany. Plant Path. 66: 316-324

Poland

Małgorzata Jędryczka
(Institute of Plant Genetics, Polish Academy of Sciences, Poznań)

Cultivated area in 1000 ha



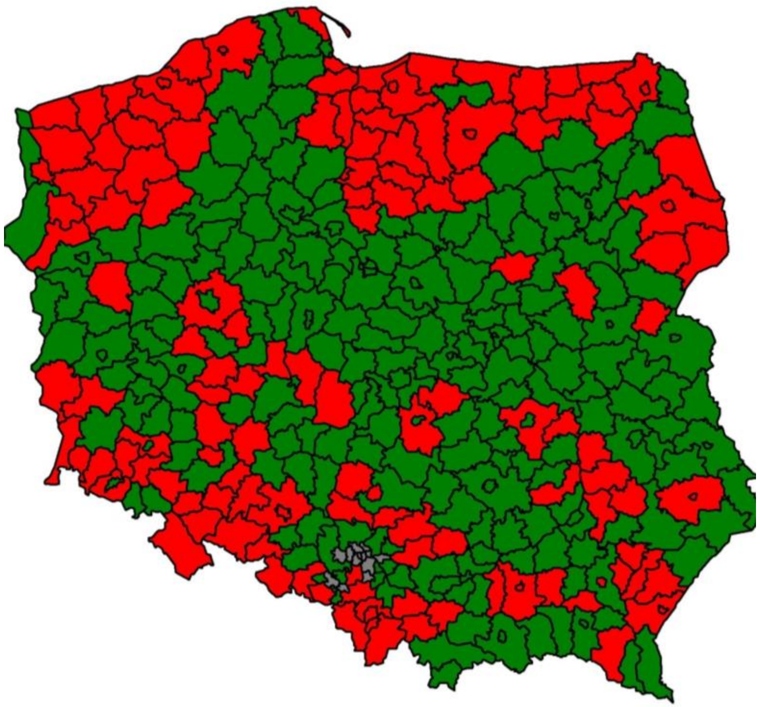
Poland is in 3rd place in OSR production, after Germany and France (≈ 880-920 thous. ha)

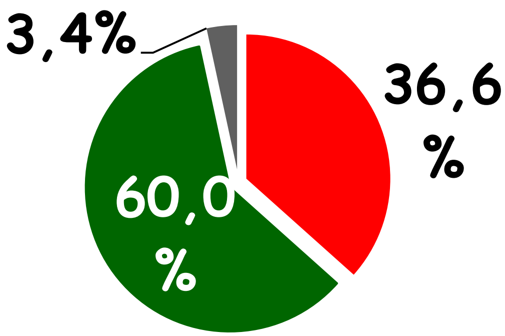
0,8 mln ha of OSR in Poland
95% of WOSR
recent huge problems with clubroot

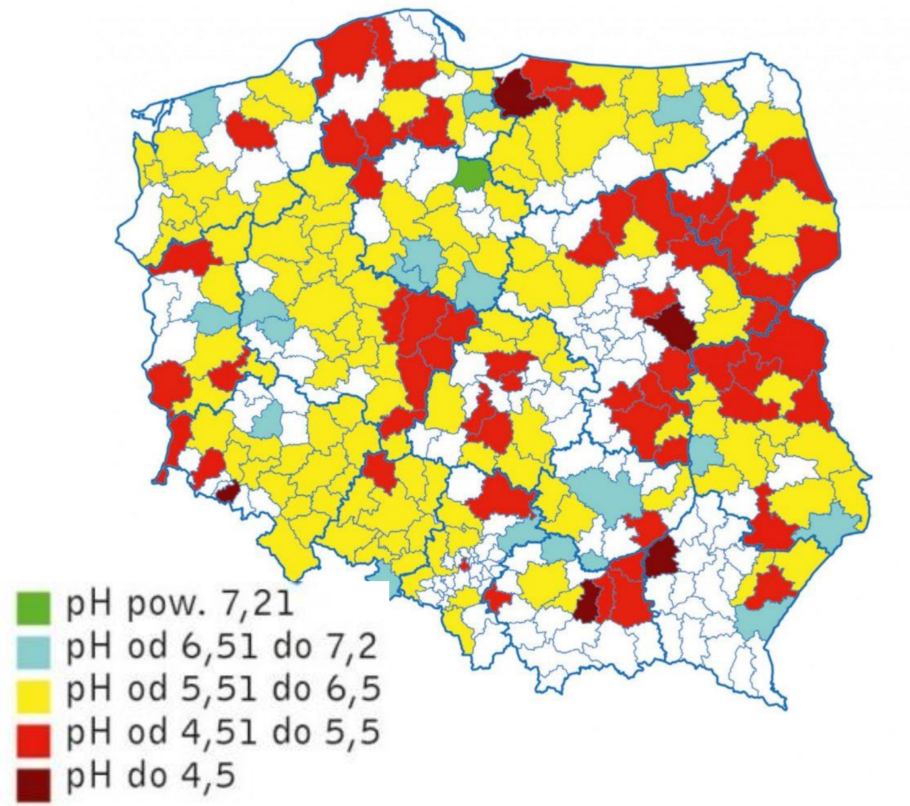
Symptoms of clubroot on WOSR in Poland, 2017

Clubroot in Polish soils

Over 3.500 samples was analyzed for bio assey







In most of the fields the soil pH is moderately (5.5 - 7) to extremely acidic (below 5.2)

Patotypes of *Plasmodiophora brassicae* in Poland

Newest data on patotypes of *Plasmodiophora brassicae* in Poland:

- based on Williams: 8 pathotypes (3, 4, 6, 7, 9, 10, 12, 16)
- based on Somé: 2 pathotypes (1, 3)
- Based on Buczacki: 9 pathotypes

			Williams	Somé	Buczacki	soil pH
1	Siemysl	West Pomerania	4	P1	16/31/31	7.6 ← Max.
2	Ramlewo		6	P3	16/7/28	6.7
3	Karlin		10	P1	16/31/31	5.8
4	Tuczno		9	P1	16/31/8	4.3
5	Karsibor		4	P1	16/31/31	6.4
6	Jablonowo		4	P1	16/31/31	7.3
7	Bielnik	Warmia	7	P3	16/31/29	5.4
8	Wegorzewo	& Masuria	6	P3	16/14/12	6.9
9	Wrzesiny	Lubusz Region	6	P3	16/14/30	7.6
10	Krotoszyn	Great Poland	16	P1	16/31/8	5.9
11	Lubań	Lower Silesia	12	P1	16/31/14	5.0
12	Ocice		3 7	P3 P3	16/2/14 16/14/15	6.2 6.8
13	Bolkow					
14	Dobromierz		7	P3	16/14/15	5.0
15	Opole	Opole Region	6	P3	16/14/12	4.4 ← Min.
16	Kiczyce	Upper Silesia	7	P3	16/14/15	6.8

Several isolates were found that could overcome the resistance in cv. Mendel

Czeck Republic

Veronika Konradyová
(Department of Plant Protection, Czech University of Life Sciences Prague)

Cultivated OSR area in 1000 ha

2016/17	Growing area (ha)	Average yield (t/ha)	Harvest (t)
Winter OSR	392,991	3,32	1,56 mil.
Spring OSR	8,000	1,57	14 000

Autumn 2017 - Holín

CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

Patotypes of *Plasmodiophora brassicae* in Czeck Republic

Newest data on patotypes of *Plasmodiophora brassicae* in CZ:

- based on Williams: 6 pathotypes (2, 3, 4, 6, 7, 9)
- based on Somé: 3 pathotypes (1, 3, 4)
- Based on Buczacki: 9 pathotypes

Patotypes of *P. brassicae*				
Isolate	**Locality**	**Williams**	**Somé**	**ECD**
1	Modlibohov	7	P3	16/14/31
2	Holany	7	P3	16/14/15
3	Bily Kostel	2	P3	16/14/13
4	Horka u Bakova	7	P3	16/14/15
5	Trebnouseves	7	P3	16/14/31
6	Miletin	2	P3	16/14/15
7	Kbelnice	6	P3	16/2/14
8	Zirovnice	3	P3	16/2/14
9	Horusice	4	P4	16/18/15
10	Hrdejovice Ves	6	P3	16/14/12
12	Pohledy	9	P1	16/31/8
13	Kozmice	7	P3	16/14/15
14	Klokocov	7	P3	16/2/15
15	Hrádek	6	P4	16/10/4
16	Terezin	7	P3	16/14/13
17	Redice	2	P3	16/14/13

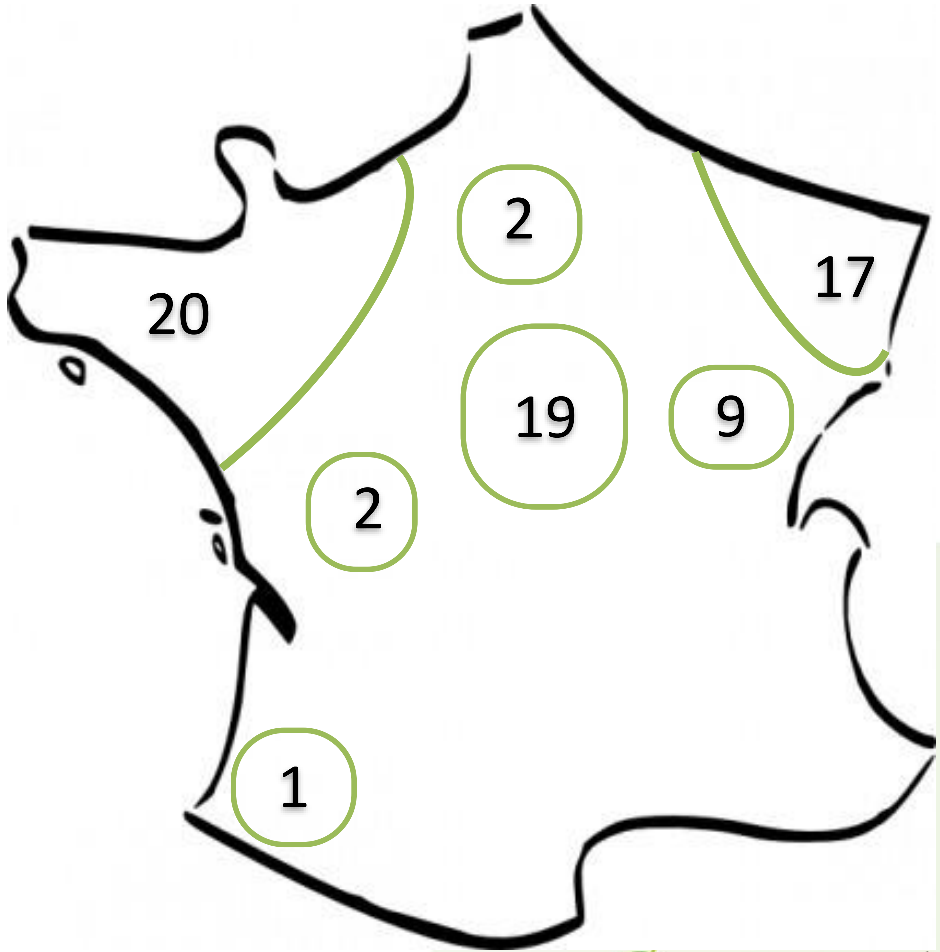
France

Geoffrey Orgeur

(Variety and Seed Study and Control Group: GEVES)

GEVES | Groupe d'Étude et de contrôle des Variétés Et des Semences

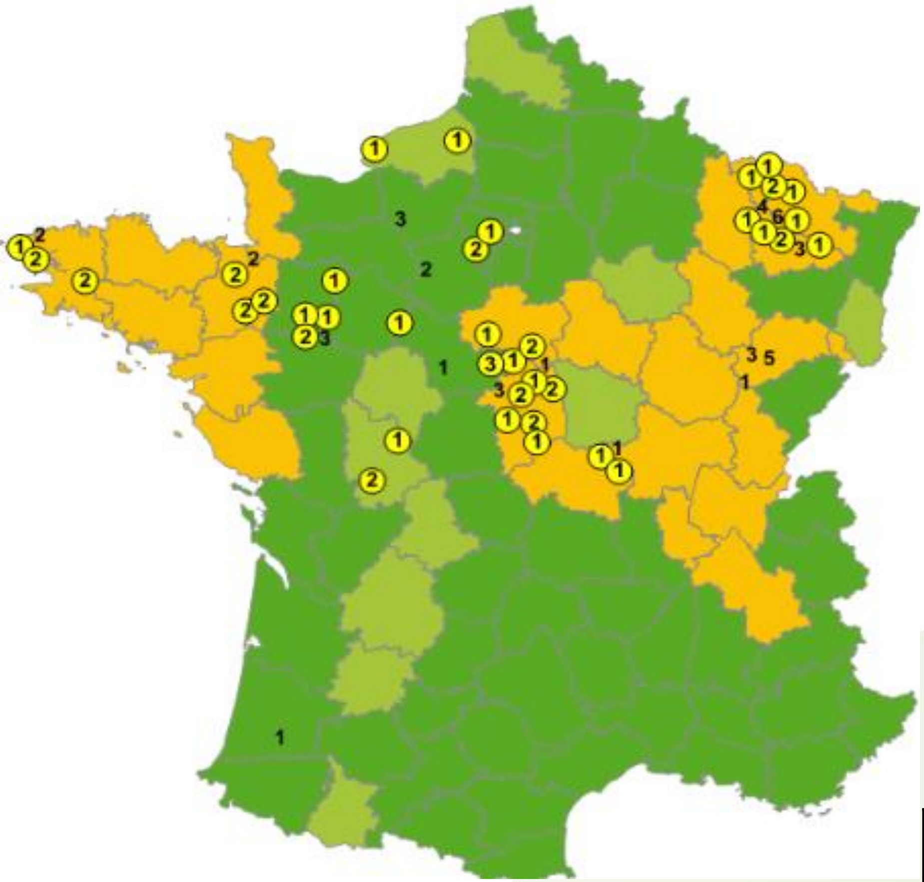
Sampling in the different oilseed rape production area

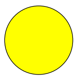


70 samples distributed in 7 areas of production

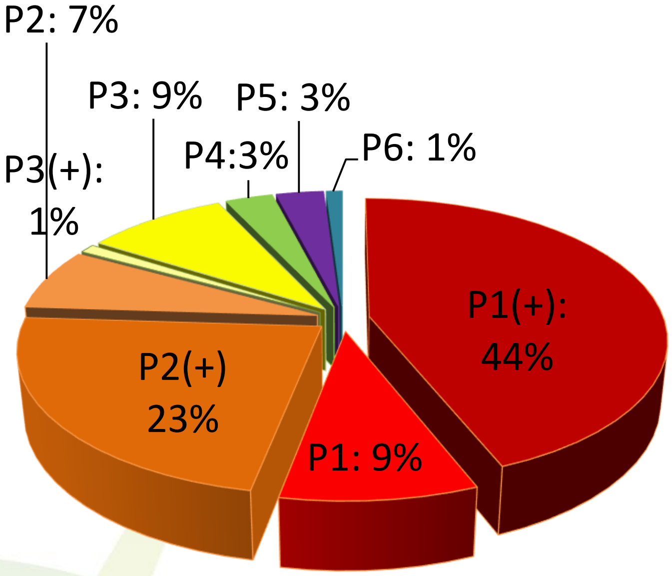
- Grand Ouest (20)
- Poitou-Charentes (2)
- Ile de France (2)
- Sud Ouest (1)
- Centre (19)
- Lorraine (17)
- Bourgogne (9)

Geograhic distribution of pathotypes





P(+): Mendel-virulent isolates



GEVES

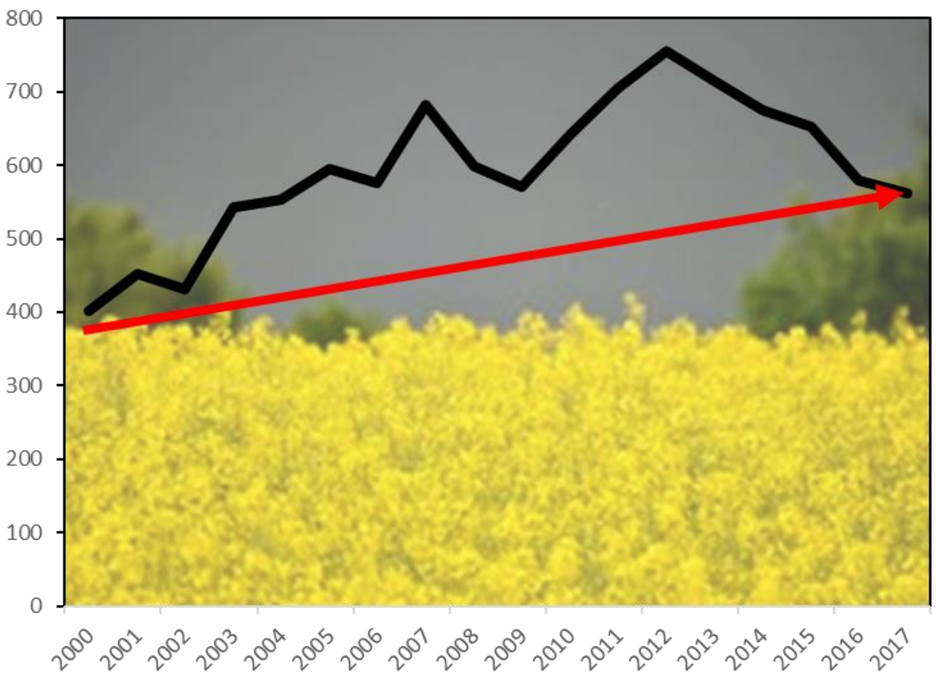
The most frequent pathotypes in France

Pathotypes (Some et al., 1996)	**Nr.**	**Frequency**
P1, P2, P3	65	92,9%
P4, P5, P6	5	7,1%
Mendel-virulent Isolates	48	68,8%

United Kingdom

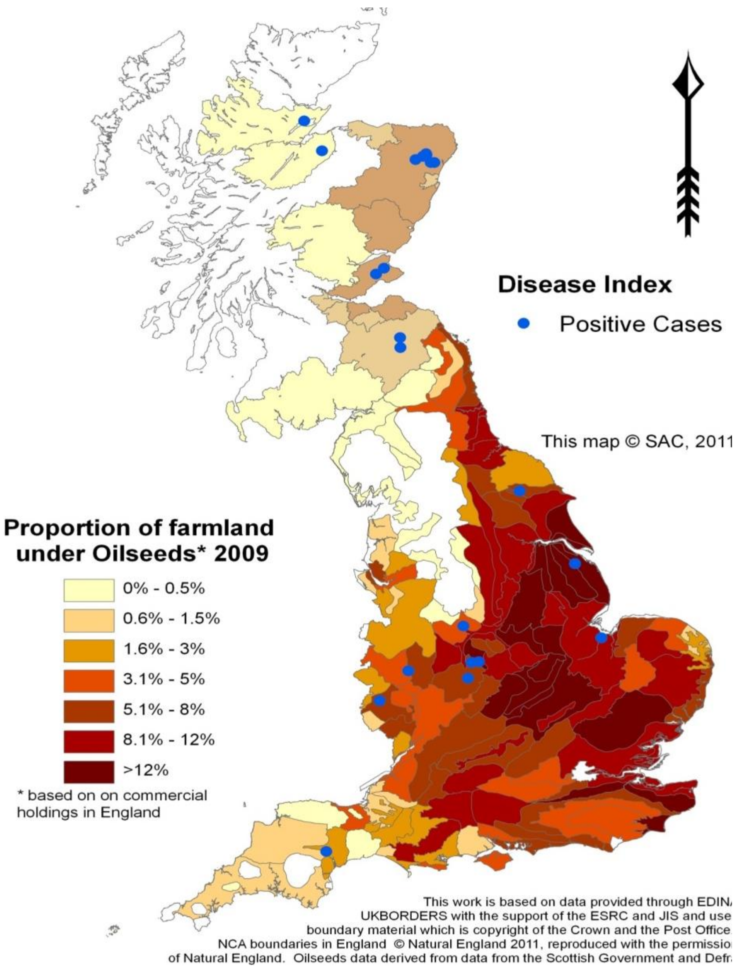
Francois Dussart (Scotland's Rural College) and
Julie Smith (Agricultural Development and Advisory Service)

Cultivated area in 1000 ha



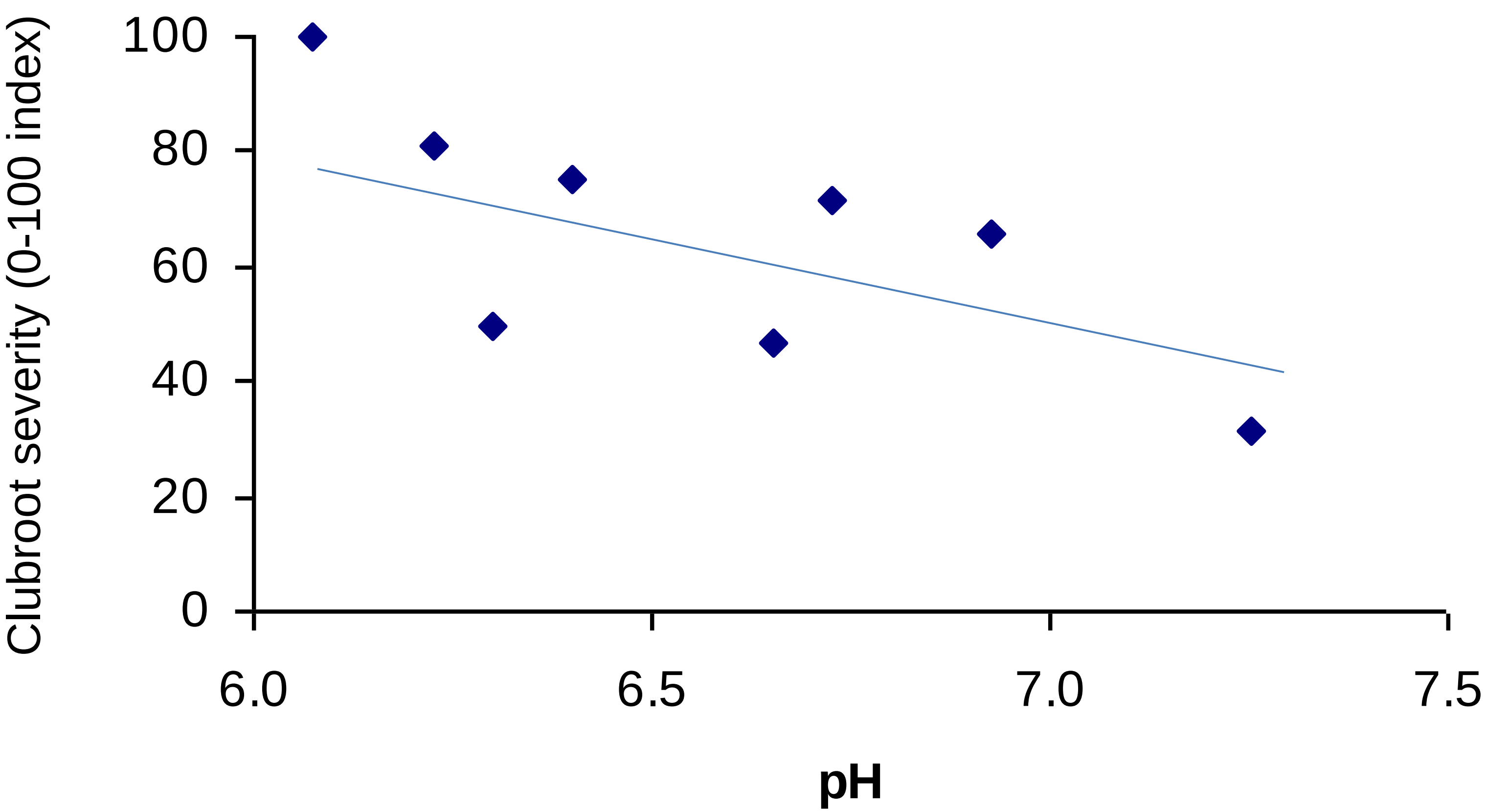
Increasing in oilseed rape cultivation area in UK up to 756 thous. ha

Clubroot distribution in the UK

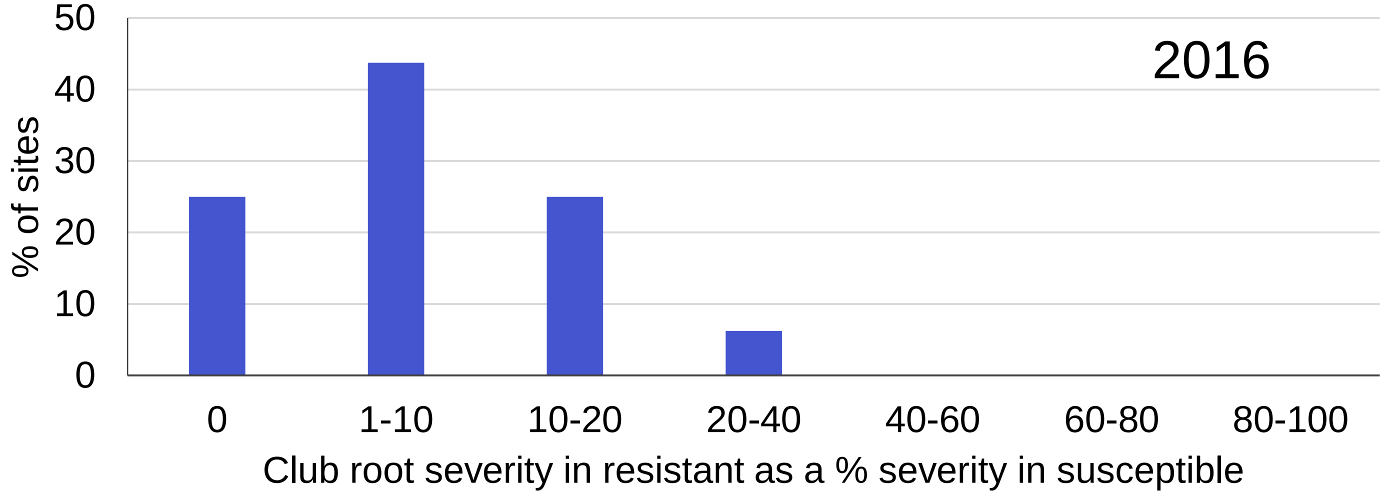


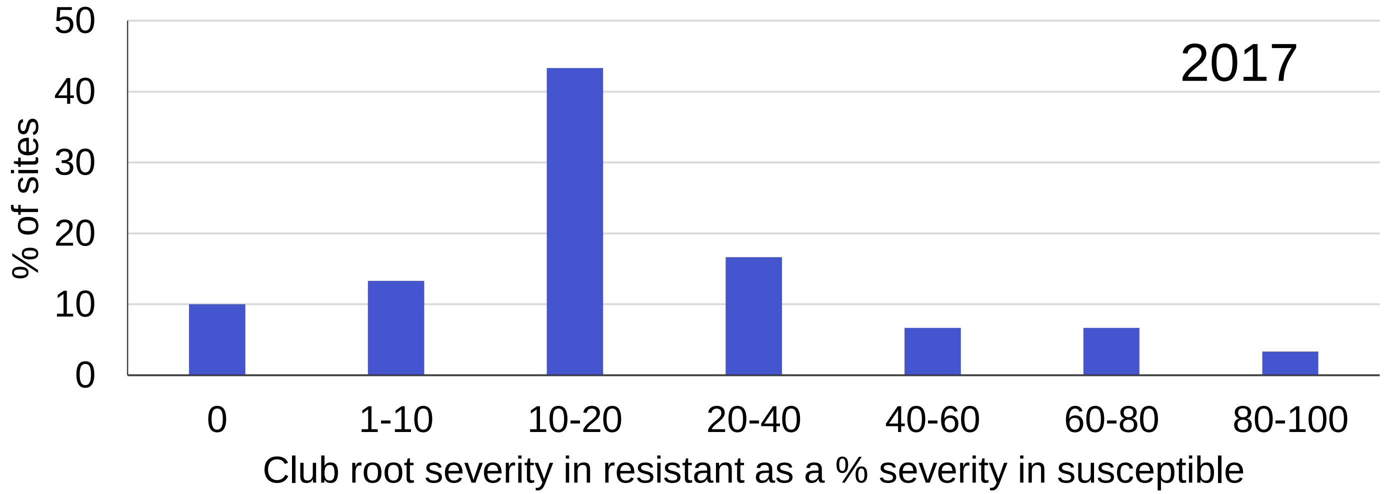
- Soil survey 100 sites
  52% sites tested positive for Pb
- Varietal screen for resistance using 31 RL varieties
  No new resistance
- Disease and climate change modelling
  Clubroot will be favoured by climate change scenarios

pH effects on clubroot



Mendel resistance breaking strains





Pathotype determination (Preliminary results)

Newest data on patotypes of *Plasmodiophora brassicae* in UK:

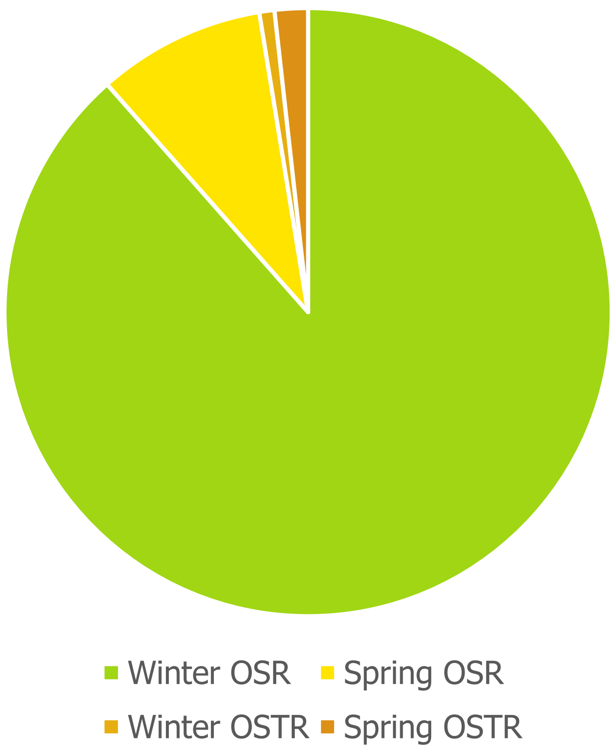
- Based on Buczacki: **11** pathotypes with high disease severity on ECD 01 to ECD 03

2016 Field	Dominant pathotypes defined by ECD
1	16/02/30
2	16/26/04
3	16/15/31
4	20/31/31
5	17/31/31
6	16/31/31
7	17/31/31
8	23/31/31
9	17/31/30
10	23/31/31

2017 Field	Dominant pathotypes defined by ECD
11	16/31/31
12	17/31/30
13	16/15/30
14	*
15	19/31/30
16	17/31/30
17	20/15/30
18	17/31/30
19	17/31/30
20	0/6/0

Sweden

Ann-Charlotte Wallenhammar
(Rural Economy and Agricultural Society, HS Konsult AB, Örebro)

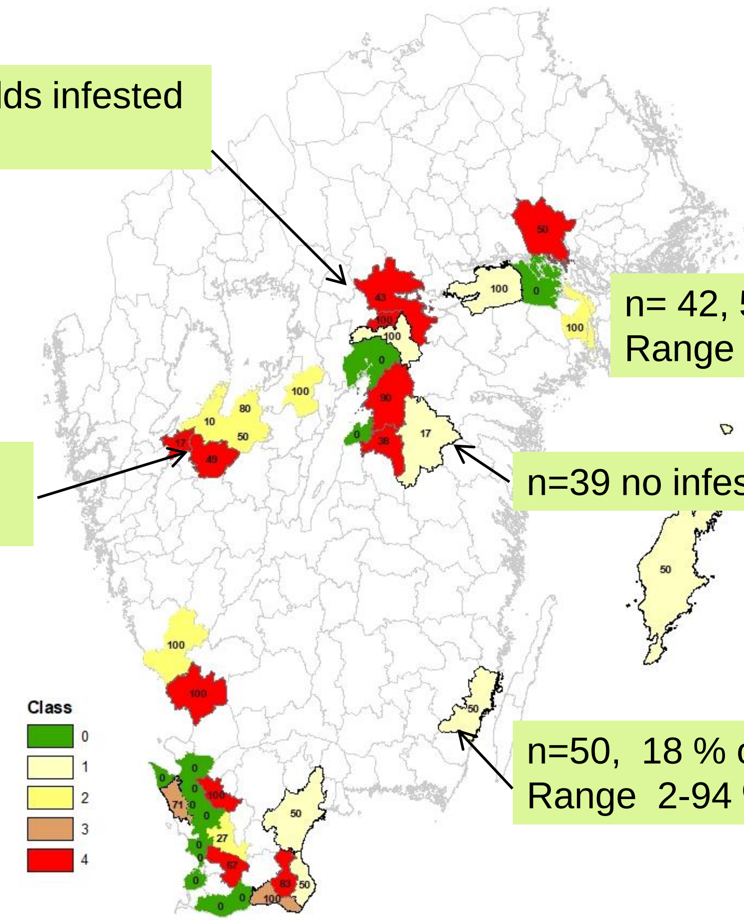


Spring OSR 9505 ha
Winter OSR 94 038 ha
Total OSR 105 375 ha

Field assessment clubroot in WOR October 2017

Andersson, G., Norrlund, L., Mellqvist, E., Arvidsson, A. Swedish Board of Agriculture and Pettersson, M. , Andersson, E. Advisory organisations REAS and the Lovang Group

The infection level of *P. brassicae* in field soil samples was determined by a greenhouse bioassay



n=10, 40 % of the fields infested
Range 70-100 %

n= 42, 5 % of the fields infested
Range 2-3 %

n=40, 15 % of the fields infested
Range 2-46 %

n=39 no infestation

n=50, 18 % of the fields infested
Range 2-94 %

- Based on Buczacki: **4** pathotypes with high disease severity on ECD 01 to ECD 04 (31/22/10, 31/16/00, **19/31/31**, 18/16/00 (Wallenhammar et al., 2011, unpublished))

Denmark

Ghita Cordsen-Nielsen
(Danish Agriculture & Food Council F.m.b.A.; SEGES)

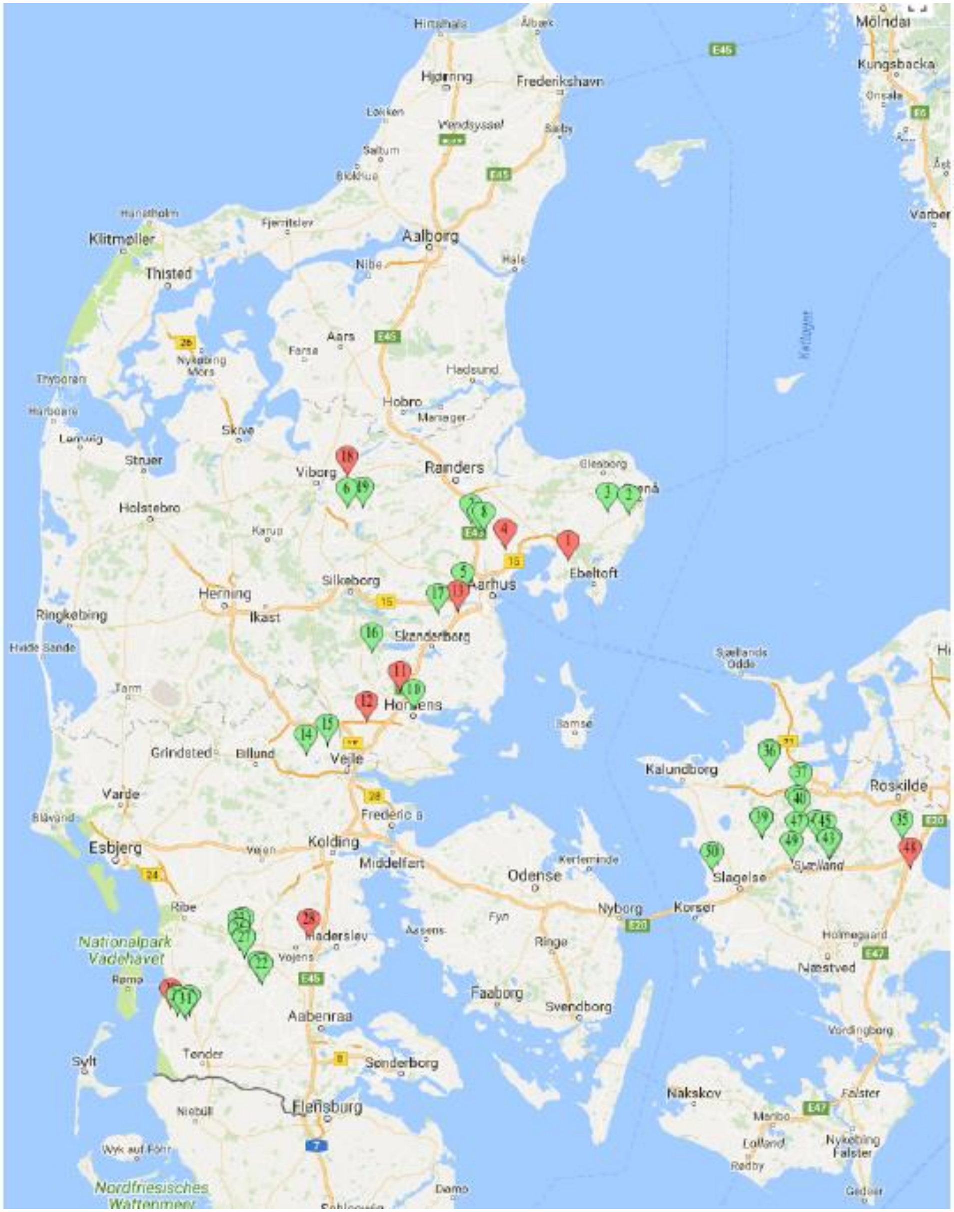
Cultivated OSR area in 1000 ha

	2012	2013	2014	2015	2016	2017
Winter oilseed rape	127	176	165	193	162	176
Spring oilseed rape	2	2	1	1	1	1

SEGES
Videncenter for Svineproduktion

Monitoring of clubroot in OSR fields, November 2016

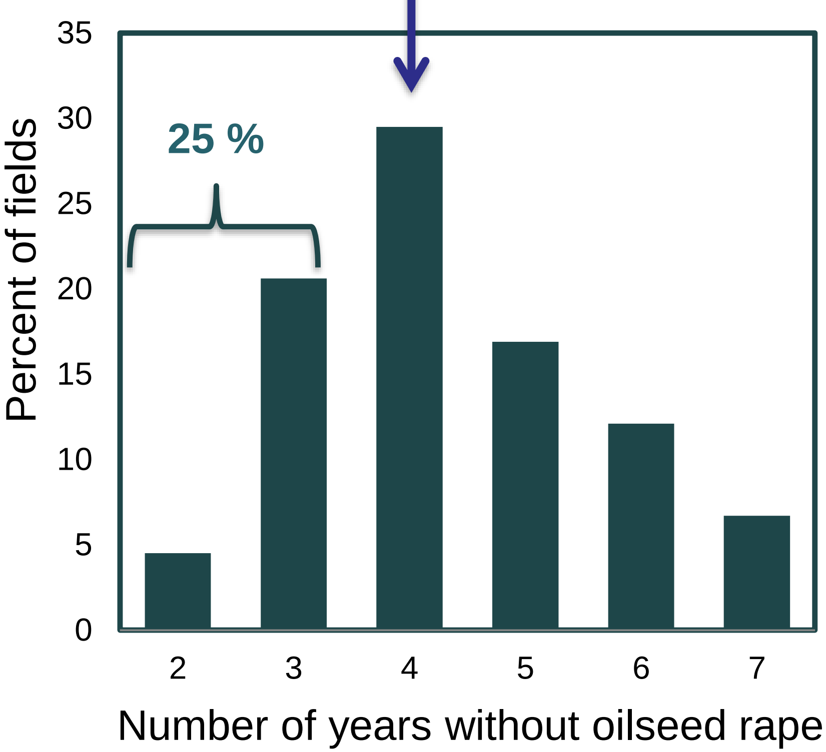
- Clubroot is an increasing problem in DK
- Monitored 50 oilseed rape fields in 10 km radius in the area around Haderslev
- Clubroot found in **57 percent** of the fields (1-78 percent infected plants)

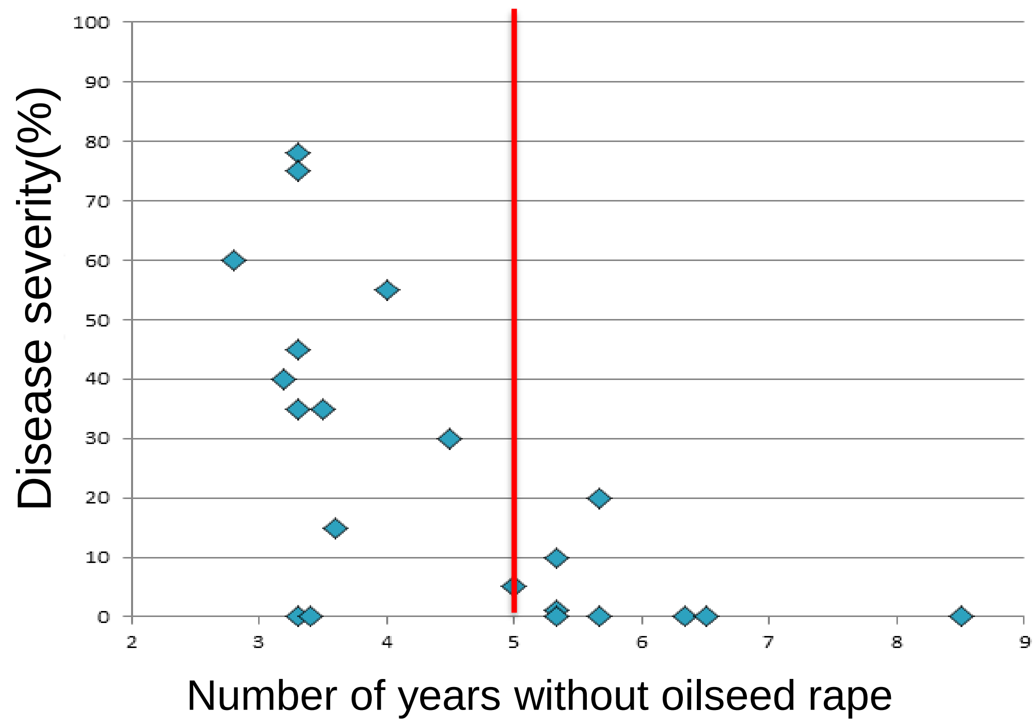


SEGES
Videncenter for Svineproduktion

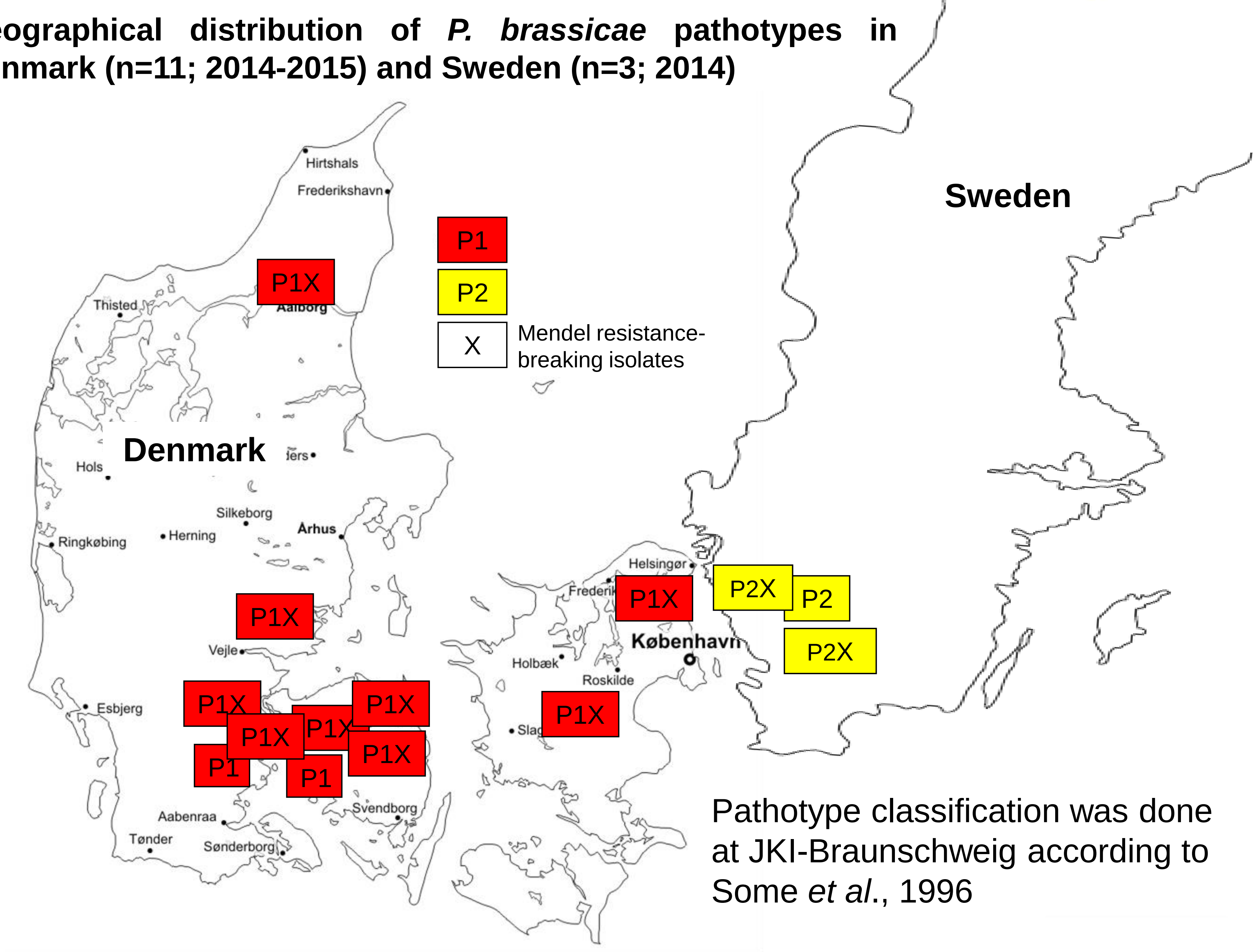
Crop rotation with oilseed rape in Denmark (N=10.660 OSR Fields)

30 % of fields have 4 years without oilseed rape





Geographical distribution of *P. brassicae* pathotypes in Denmark (n=11; 2014-2015) and Sweden (n=3; 2014)



Pathotype classification was done at JKI-Braunschweig according to Some *et al*., 1996

Summary

- Clubroot of oilseed rape is a disease of increasing economic importance in EU
- The highest clubroot infestation occurred in fields where OSR was grown in a shorter rotation
- Clubroot has been found in soils exhibiting a wide pH range from 4.4-8.1, but acidic soils maybe most at risk
- The majority of isolates in EU according to Somé (1996) were pathotypes 1 and 3, respectively, with pathotypes 2, 5 and 6 in the minority
- Behind each of the pathotypes as defined by Somé a range of different ECD triplet codes was detected. This gives hint for a extreme variation in pathogenicity of *P. brassicae* populations
- From all EU populations tested for virulence on cv. Mendel, several isolates were found to be moderately or highly virulent

Thank you for your attention