Clubroot in Poland
What's new: pyramiding of resistance and mining the soil microbiome

GOSIA

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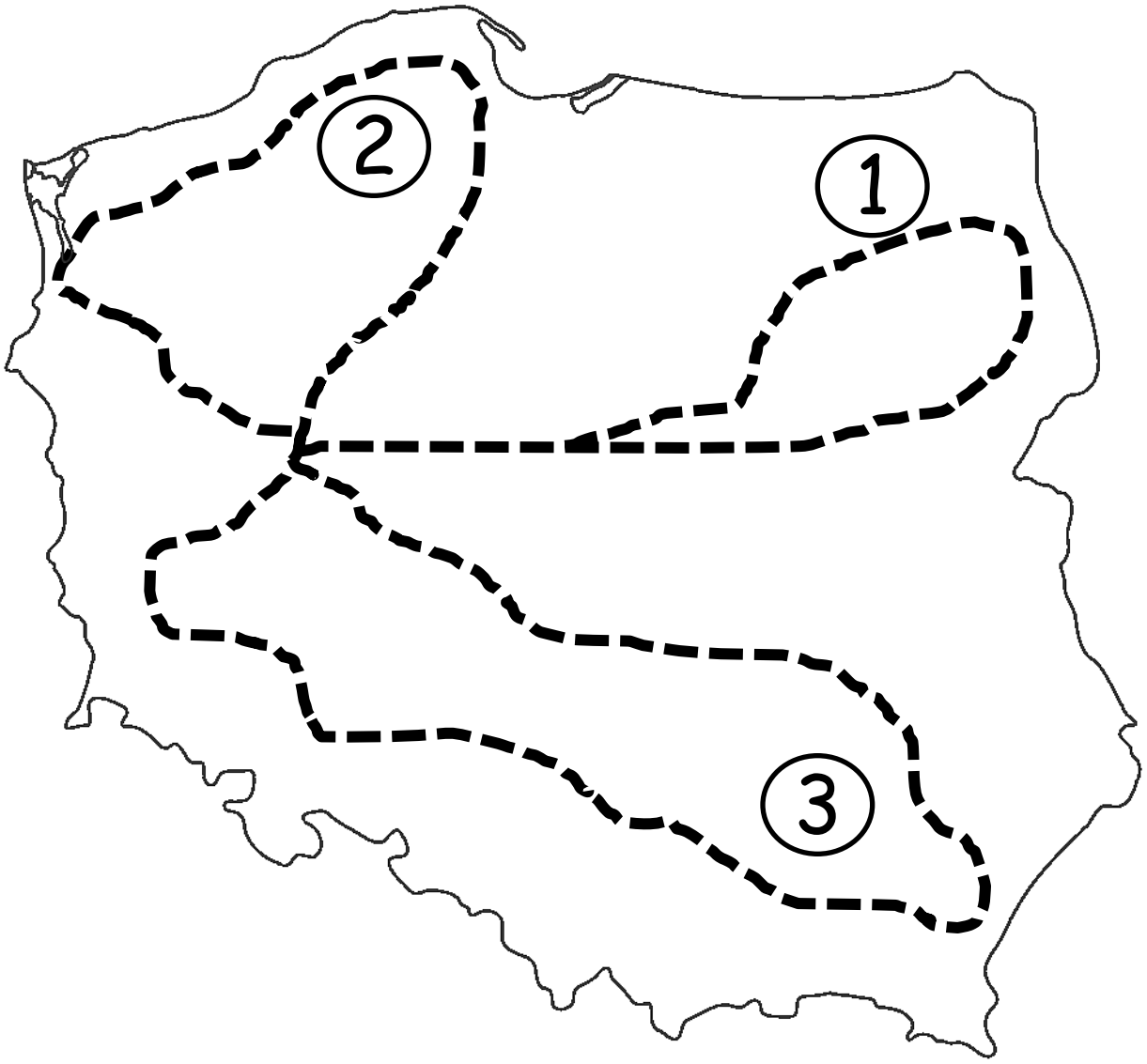
Clubroot Steering Committee, 30 April 2020

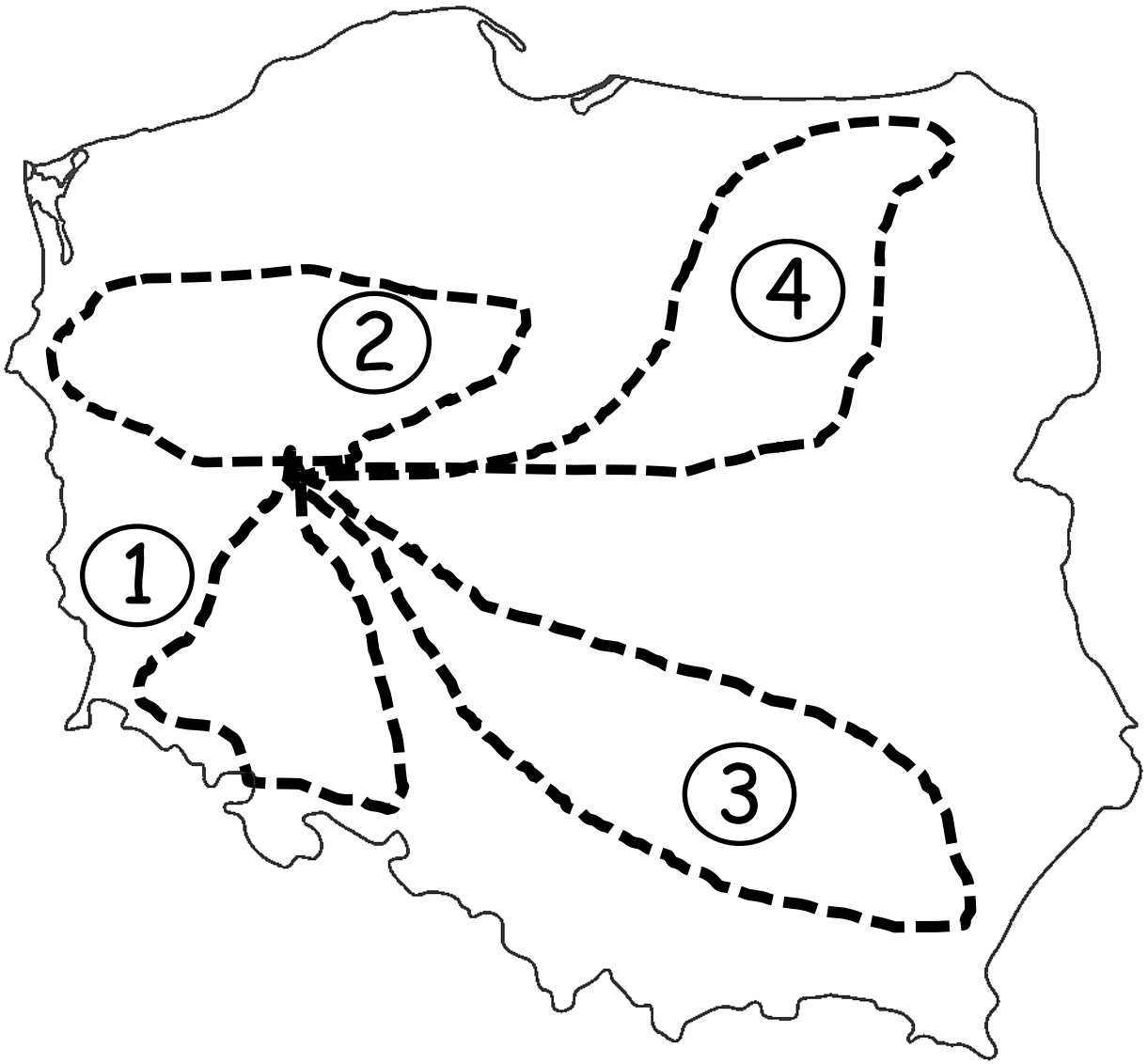
0,8 mln ha of OSR in Poland
95% of WOSR
problems with clubroot since 2000+

Plant, soil and water sampling

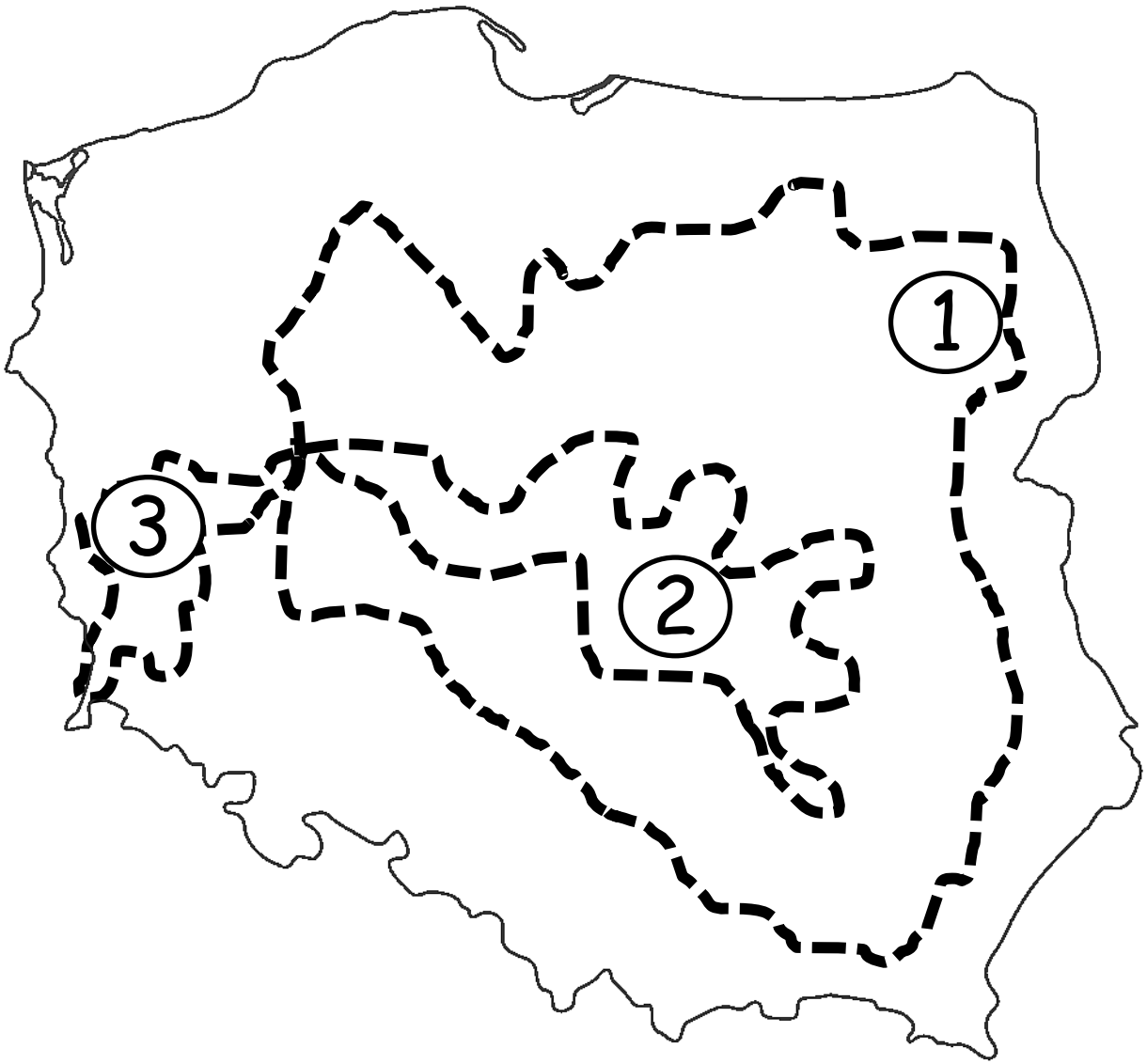
Sampling in 2016



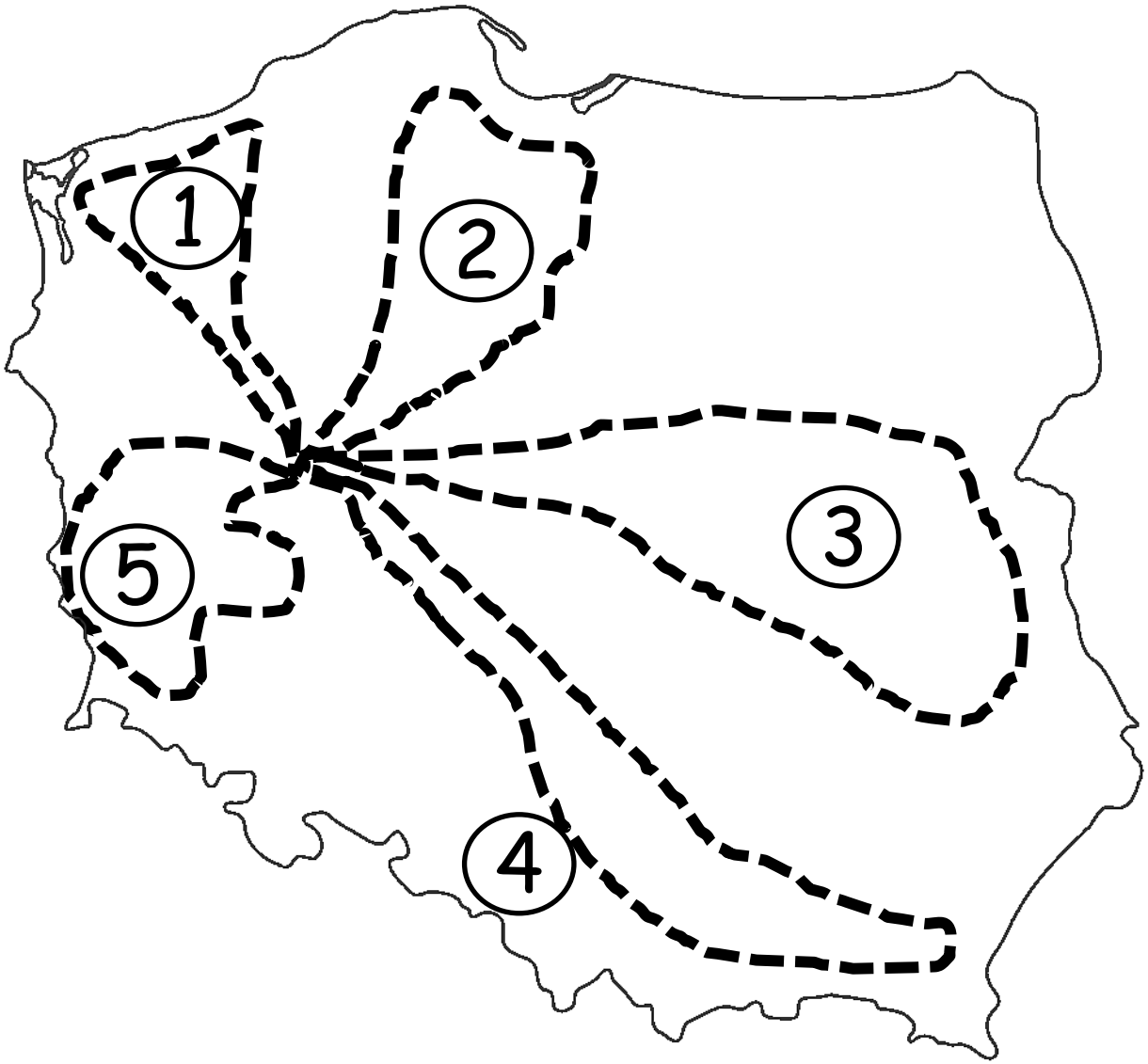
Sampling in 2017



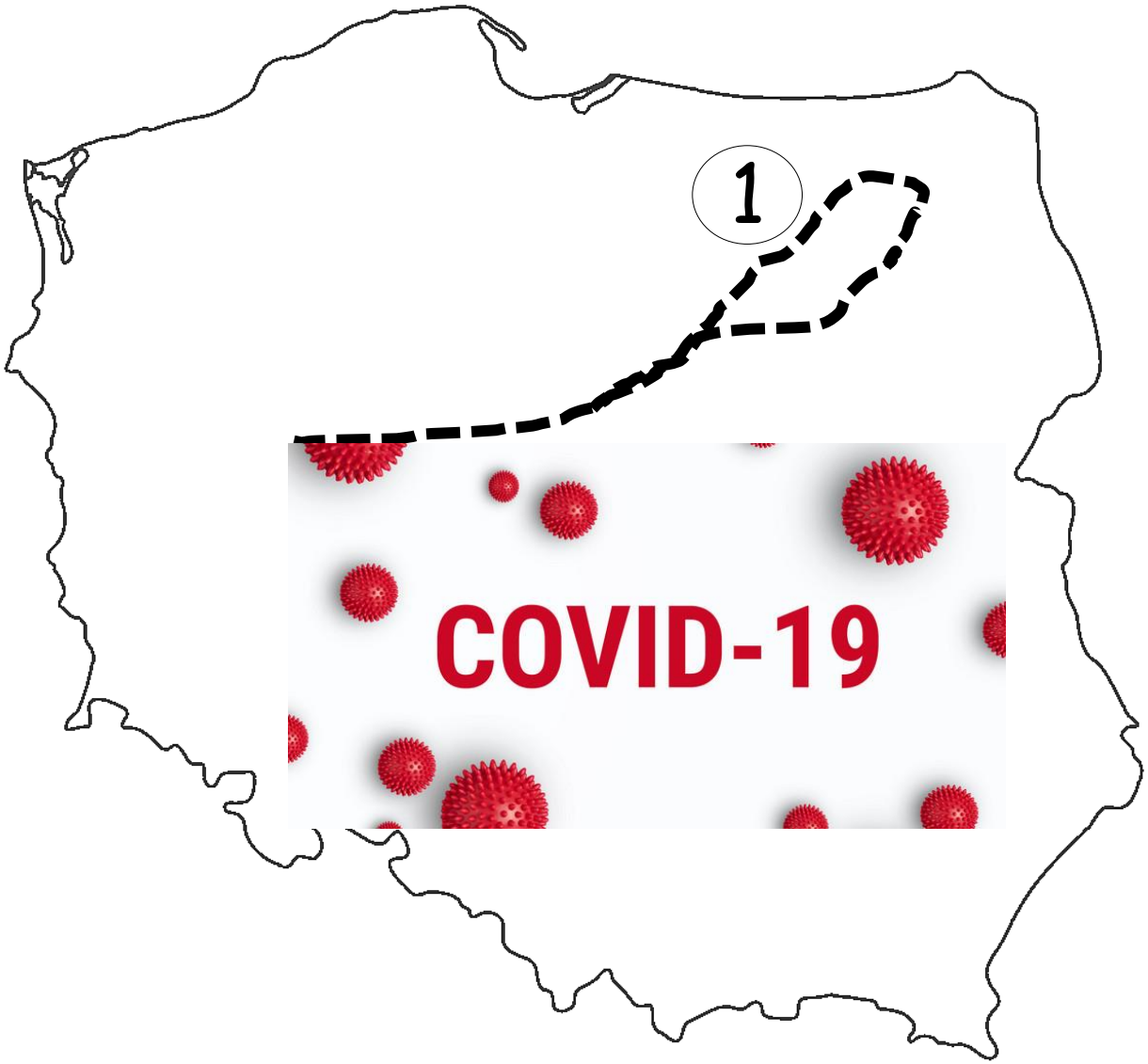
Sampling in 2018



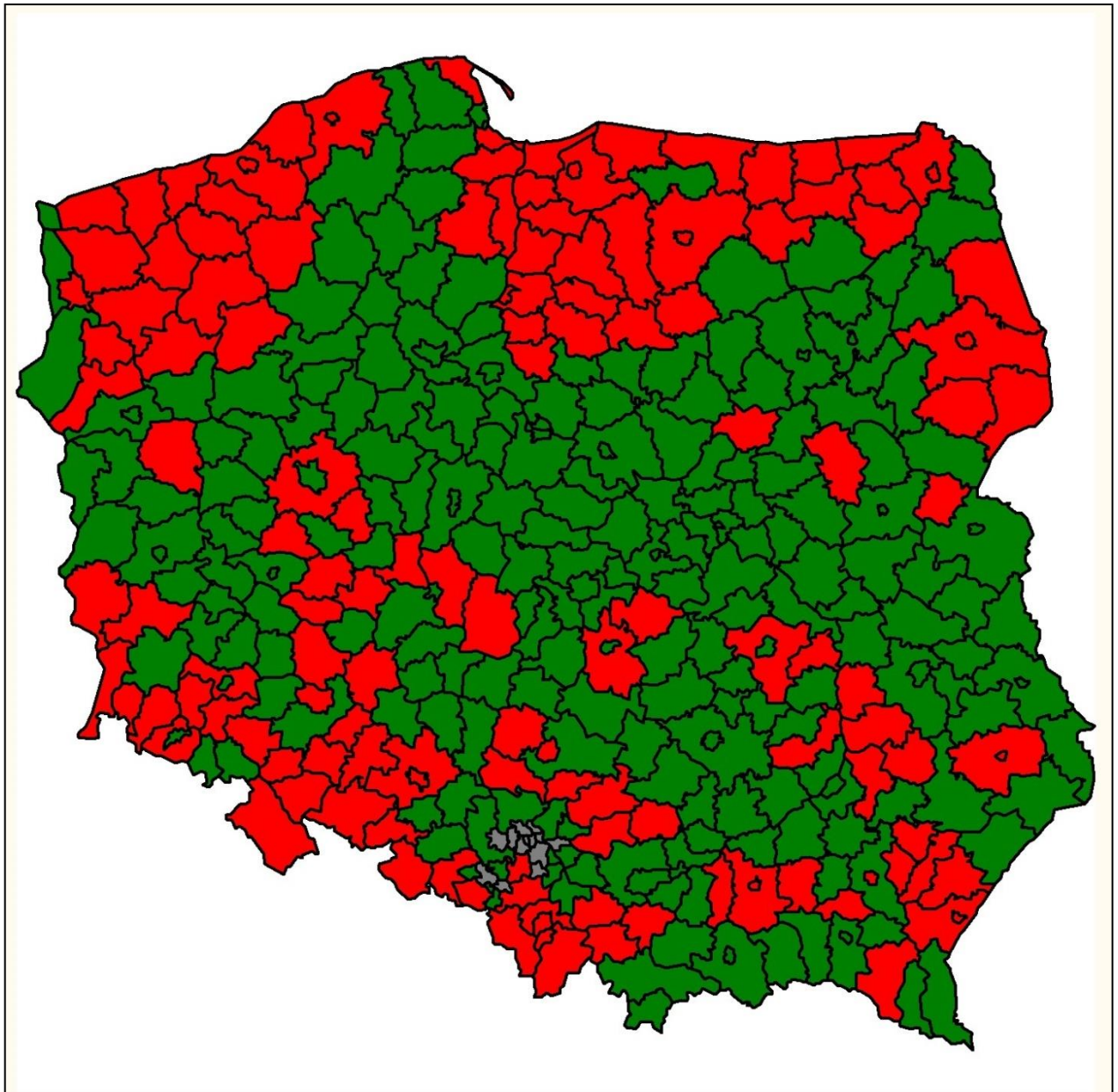
Sampling in 2019



Sampling in 2020

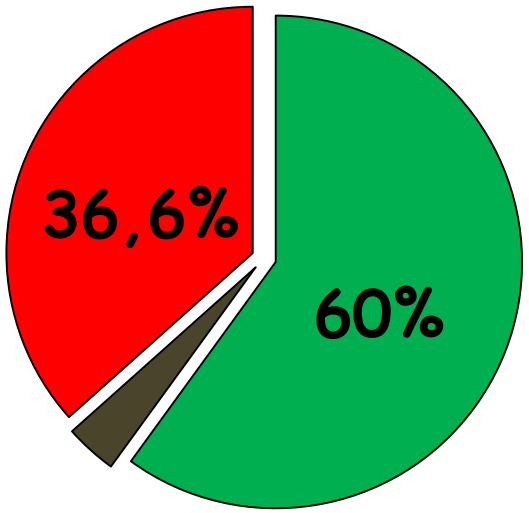


Main regions of clubroot in Poland



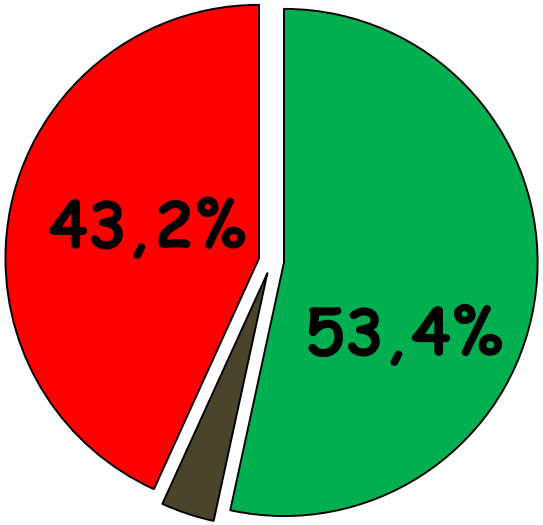
Incidence of clubroot in Poland

2018



~3.500 samples

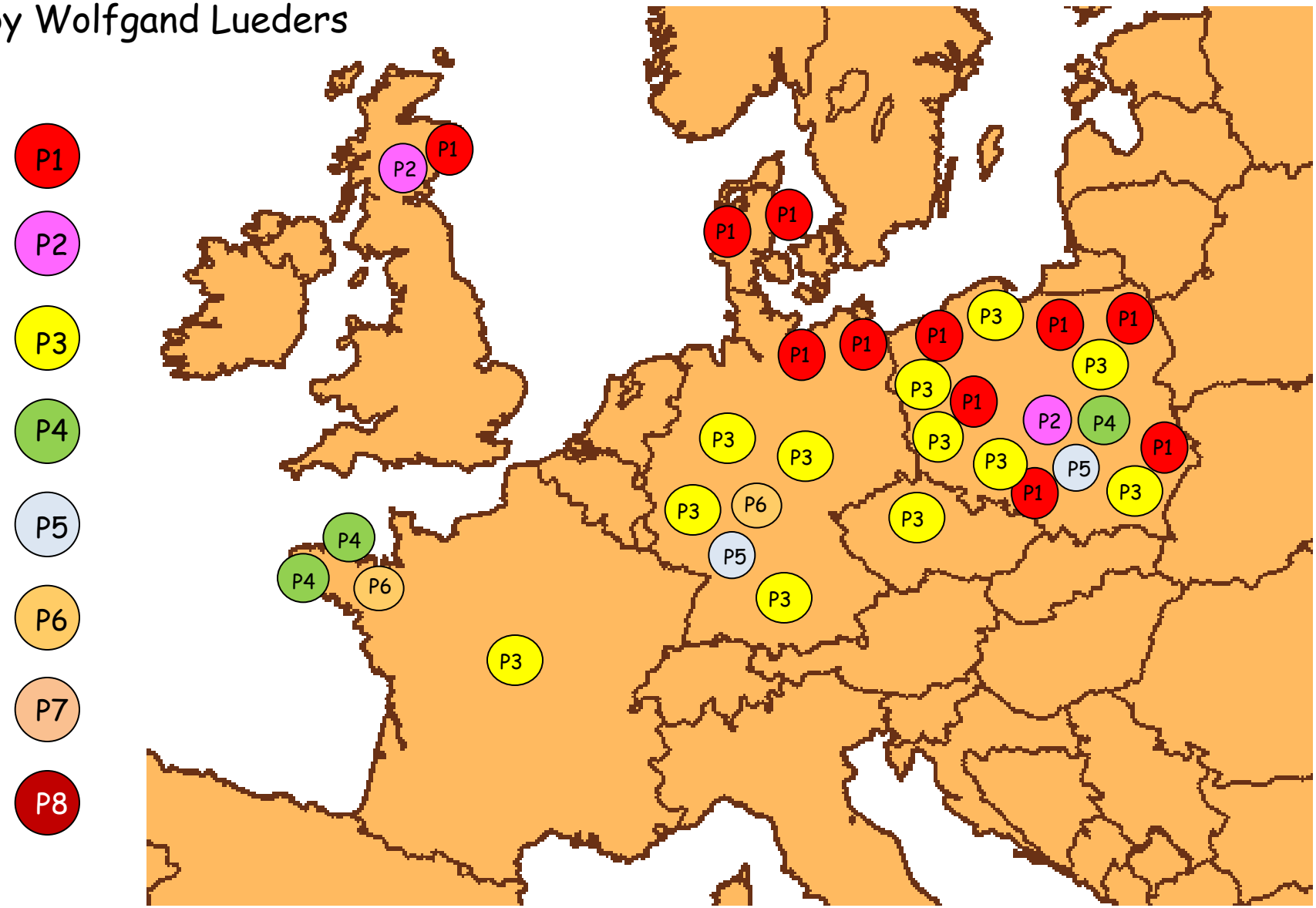
2020



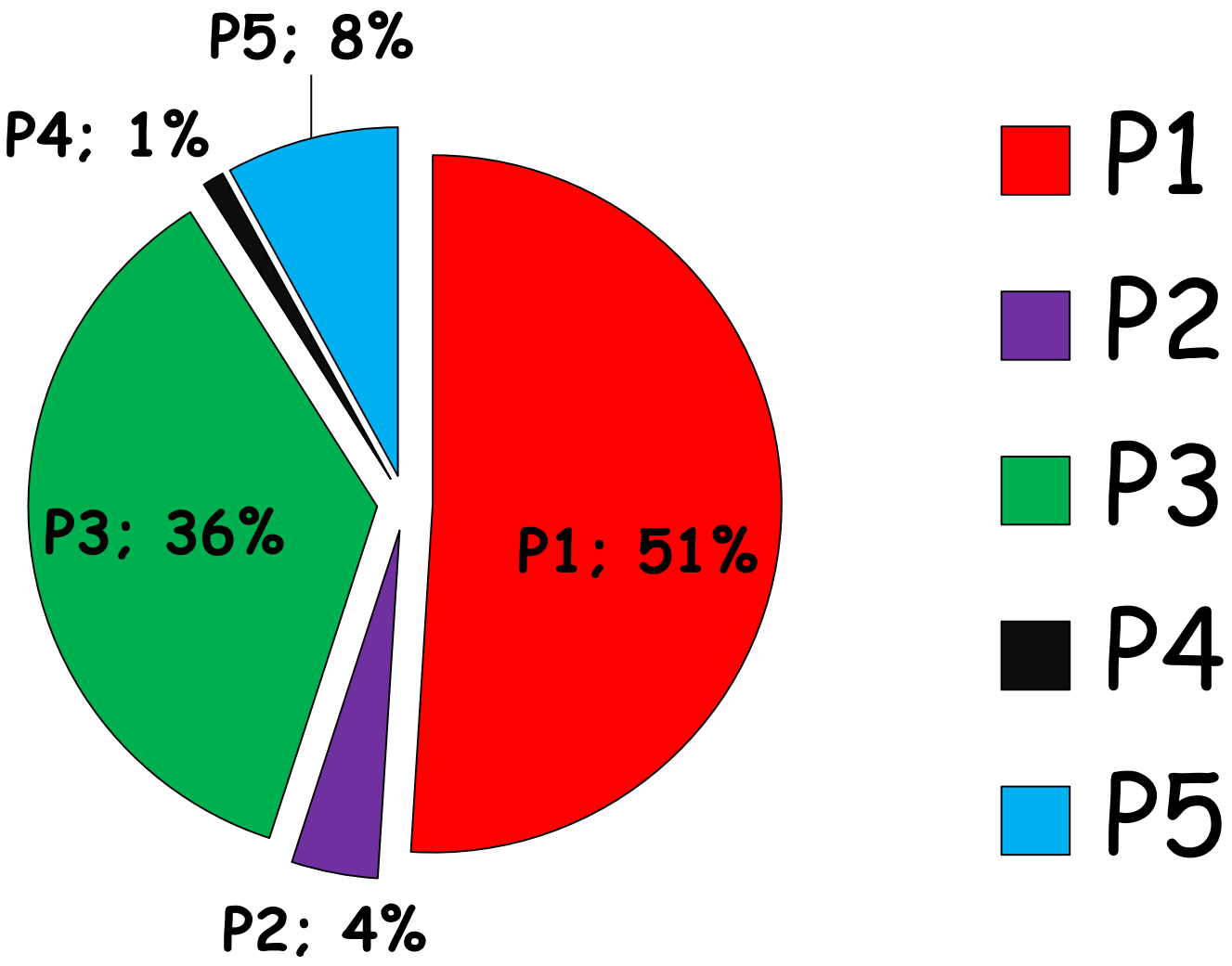
~3.850 samples

Pathotypes of *Plasmodiophora brassicae*

by Wolfgand Lueders



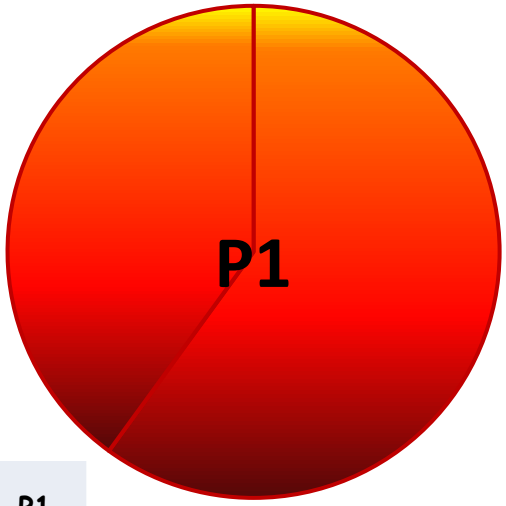
Pathotypes of *Plasmodiophora brassicae*



Pathotypes of *Plasmodiophora brassicae*

2019

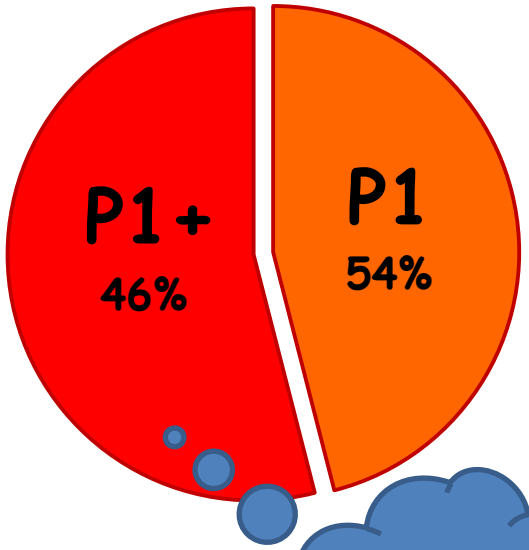
Pathotypes based on Somé et al.



	P1
ECD06	●
ECD10	●
Brutor	●

2019

Pathotypes based on Somé et al. plus cv. Mendel



affected by way of sampling

	P1	
ECD06	●	
ECD10	●	
Brutor	●	
Mendel	●	●
	P1	P1+

Severity of disease symptoms of clubroot in Poland

Severity of clubroot in Poland

Severity of clubroot in Poland

Severity of clubroot in Poland

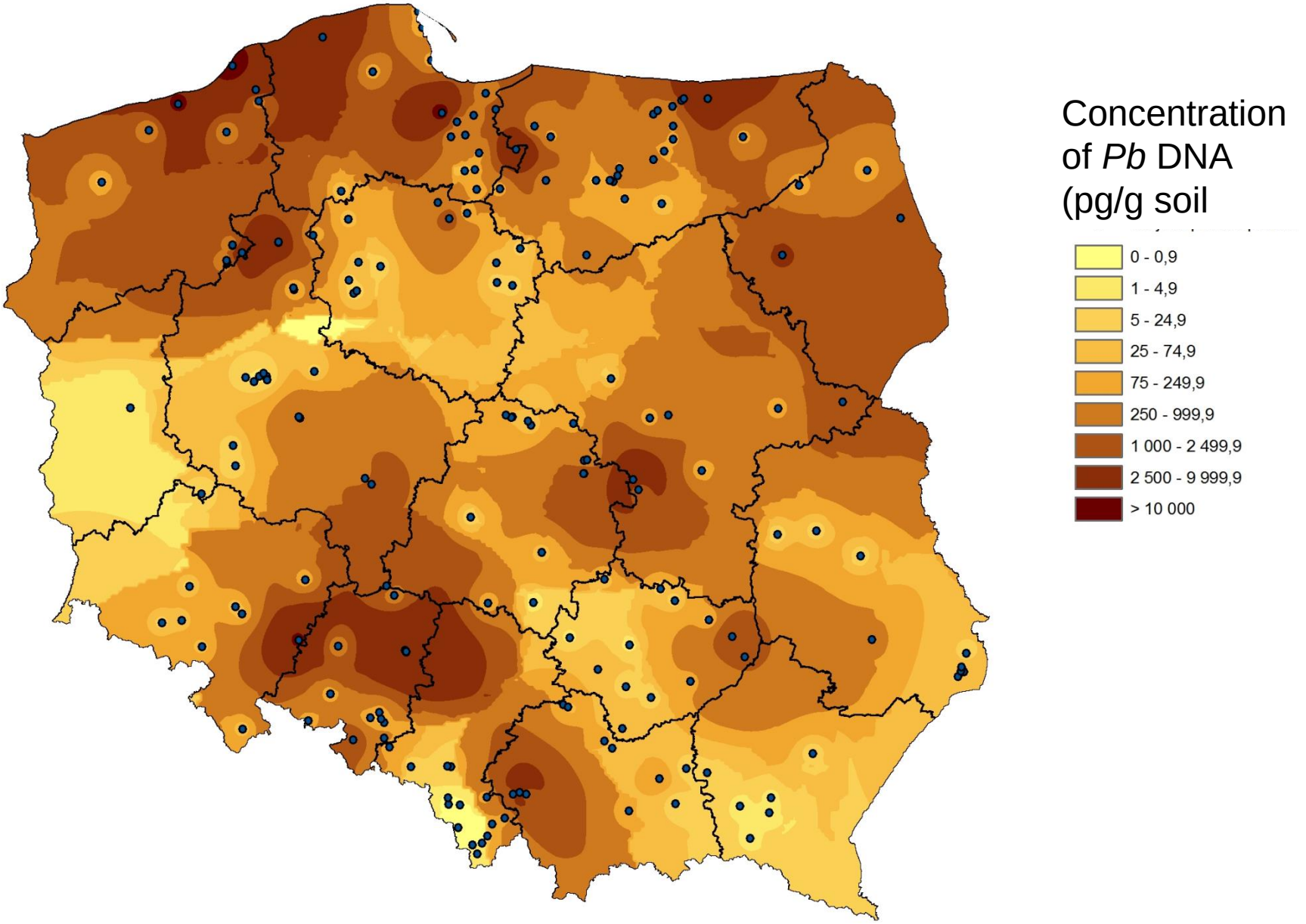
Severity of clubroot in Poland

Severity of clubroot in Poland

Severity of clubroot in Poland

Symptoms of clubroot on pennycress (*Capsella bursa pastoris*), field in north-east Poland 2017

Clubroot in Polish soils based on qPCR



Detection of *Plasmodiophora brassicae*

Biotest

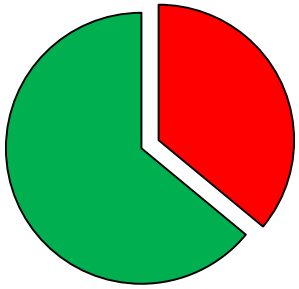
LAMP

qPCR

Detection of *Plasmodiophora brassicae*

Biotest Poland

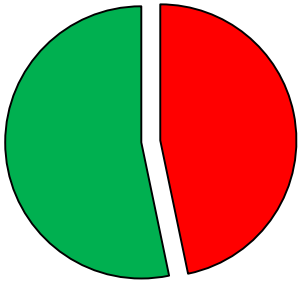
n=107



Biotest

LAMP Poland

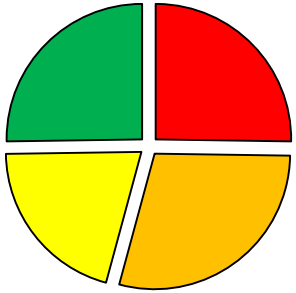
n=107



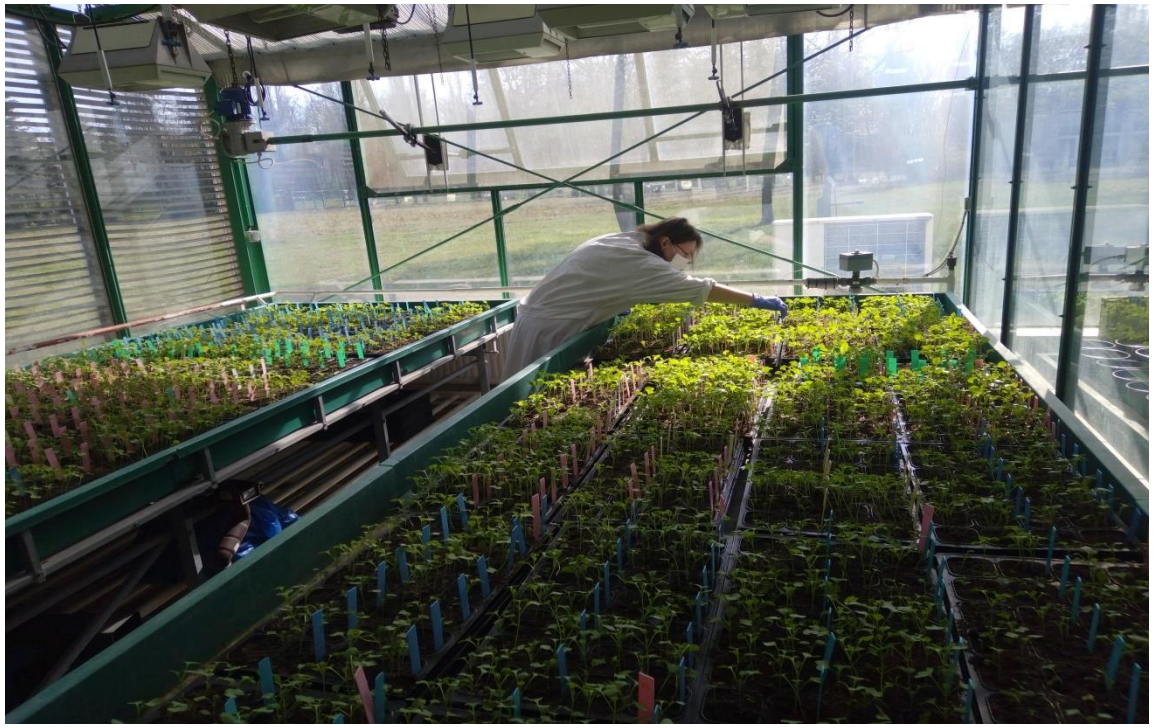
LAMP

Real-time PCR Poland

n=107



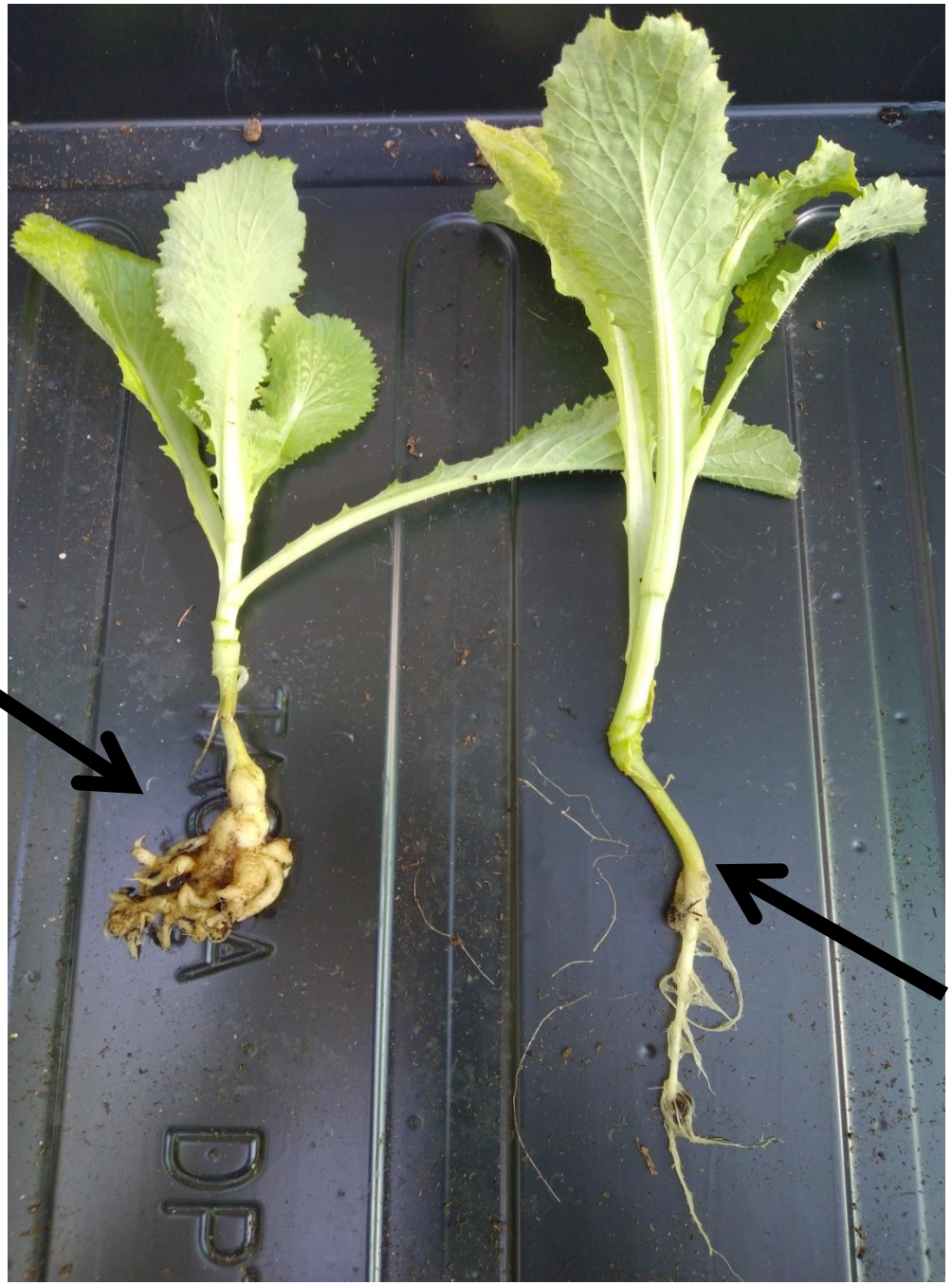
qPCR



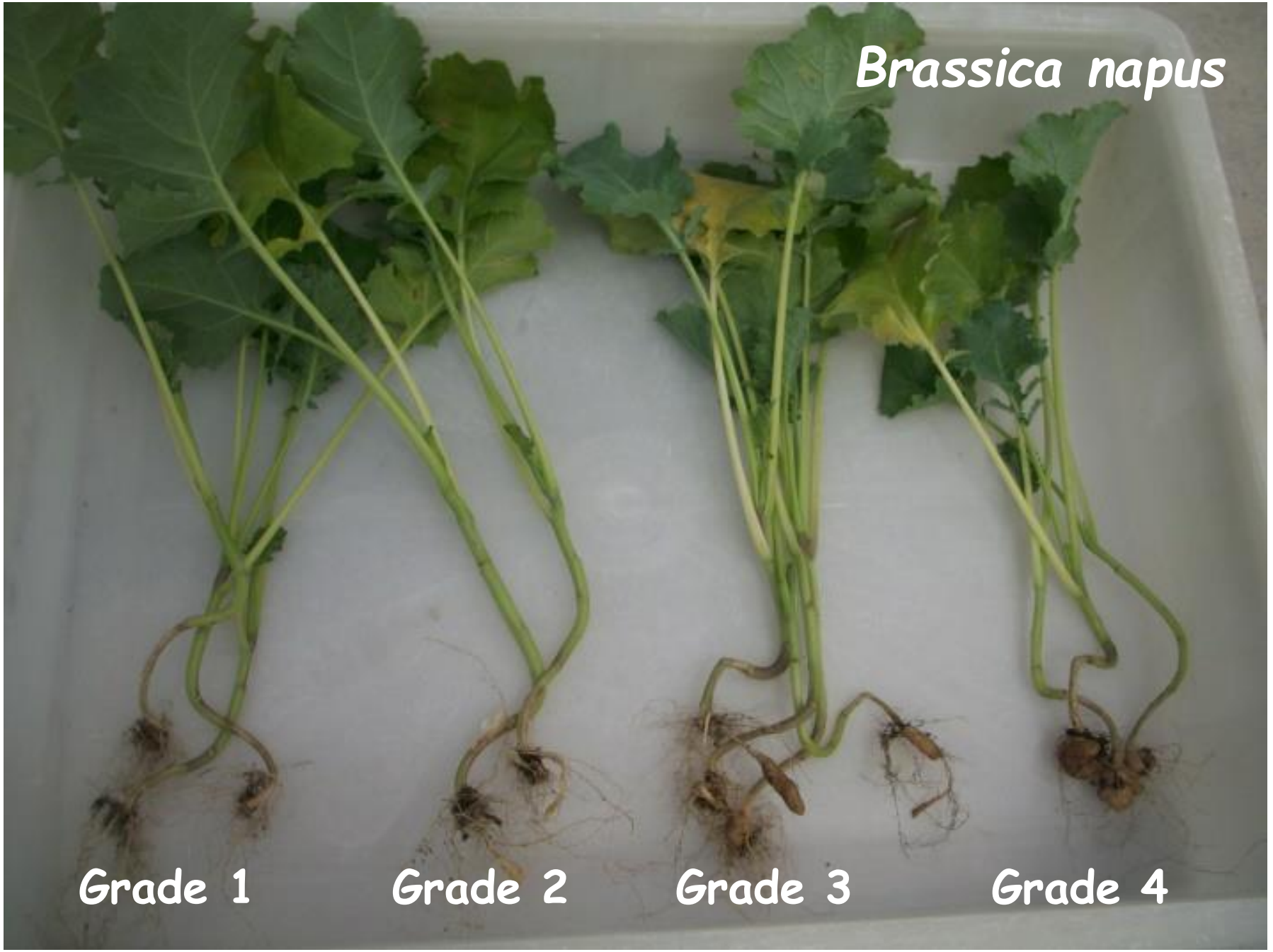
Symptoms of clubroot

field

glasshouse


Inoculated
Disease symptoms
Not inoculated
Healthy


Brassica rapa
Grade 1
Grade 2
Grade 3
Grade 4


Brassica napus
Grade 1
Grade 2
Grade 3
Grade 4

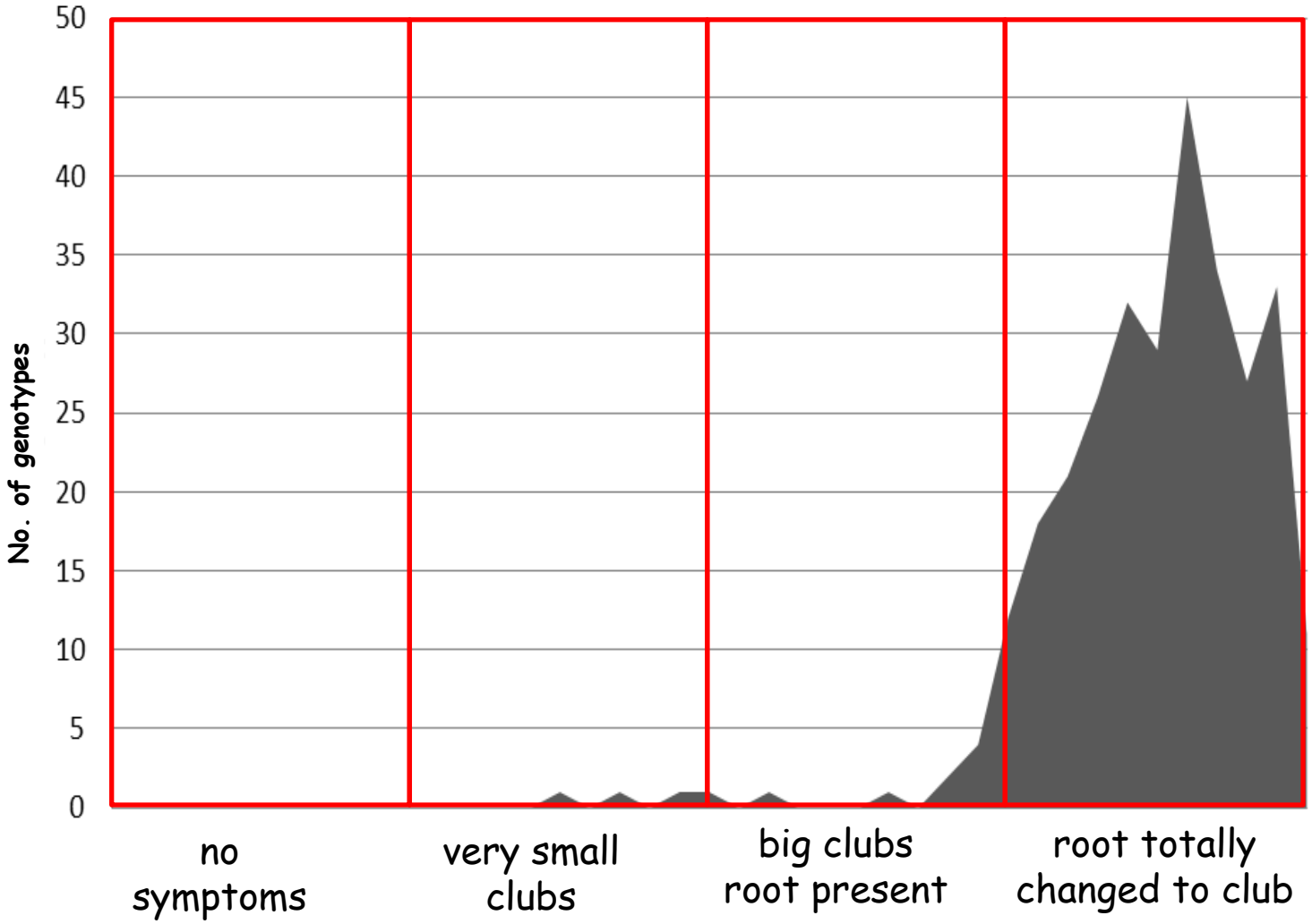
Susceptibility of selected forms to clubroot (2016)

no symptoms | small clubs | big clubs, root still existing

Very resistant		Moderately resistant		Moderately susceptible		Very susceptible	
Result	No. of genotypes	Result	No. of genotypes	Result	No. of genotypes	Result	No. of genotypes
0	0	1	0	2	1	3	10
0,1	0	1,1	0	2,1	1	3,1	8
0,2	1	1,2	1	2,2	Br j-2 Mendel	3,2	15
0,3	0	1,3	0	2,3	2	3,3	13
0,4	0	1,4	1	2,4	0	3,4	20
0,5	2	1,5	0	2,5	2	3,5	26
0,6	0	1,6	Tosca	2,6	Br 08.006.169	3,6	24
0,7	0	1,7	1	2,7	1	3,7	35
0,8	1	1,8	2	2,8	4	3,8	41
0,9	0	1,9	2	2,9	6	3,9	44
						4	42

Root changed to club

Number of the genotypes of the genus *Brassica* in sub-groups of resistance to *Plasmodiophora brassicae* (2014)



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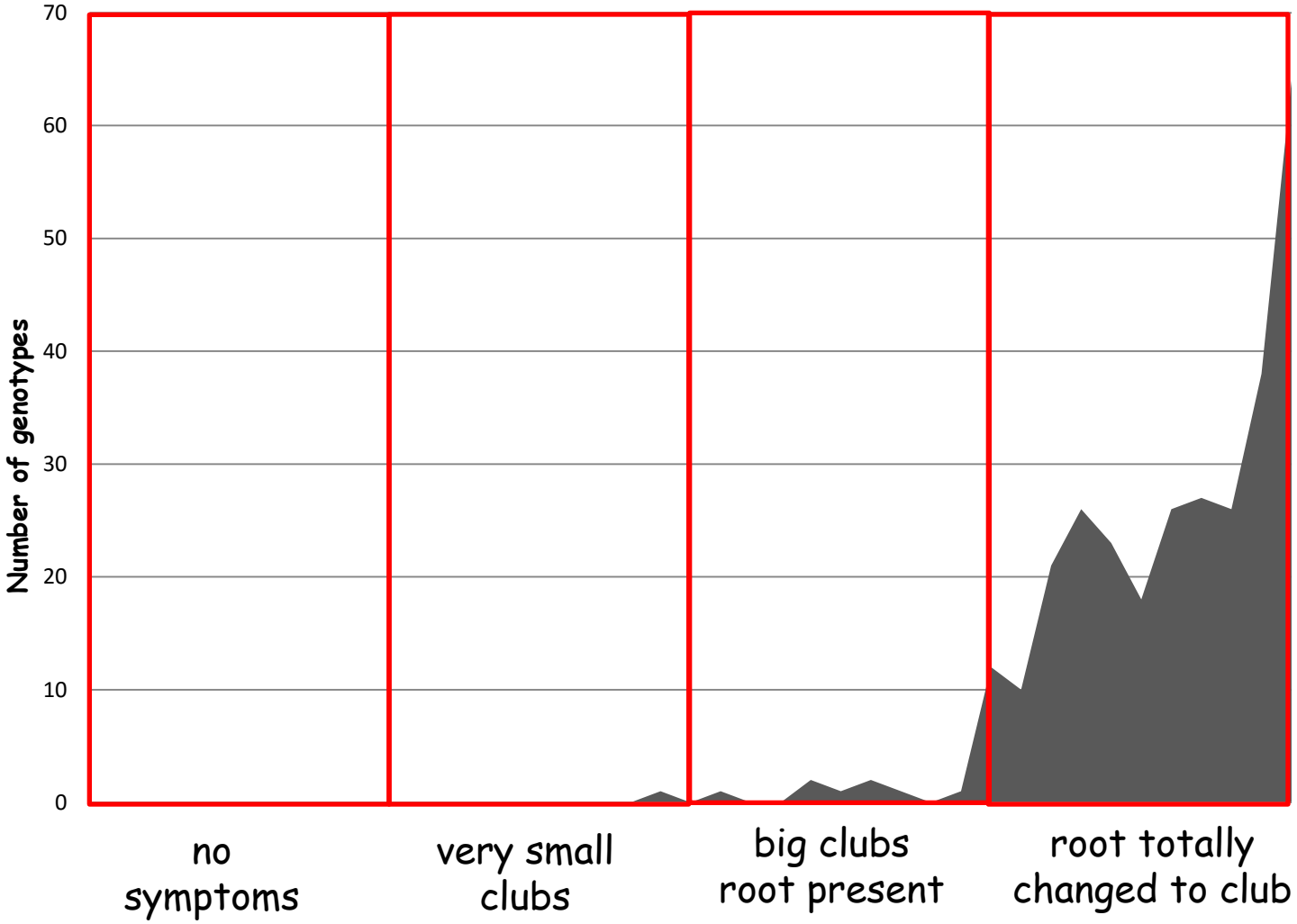
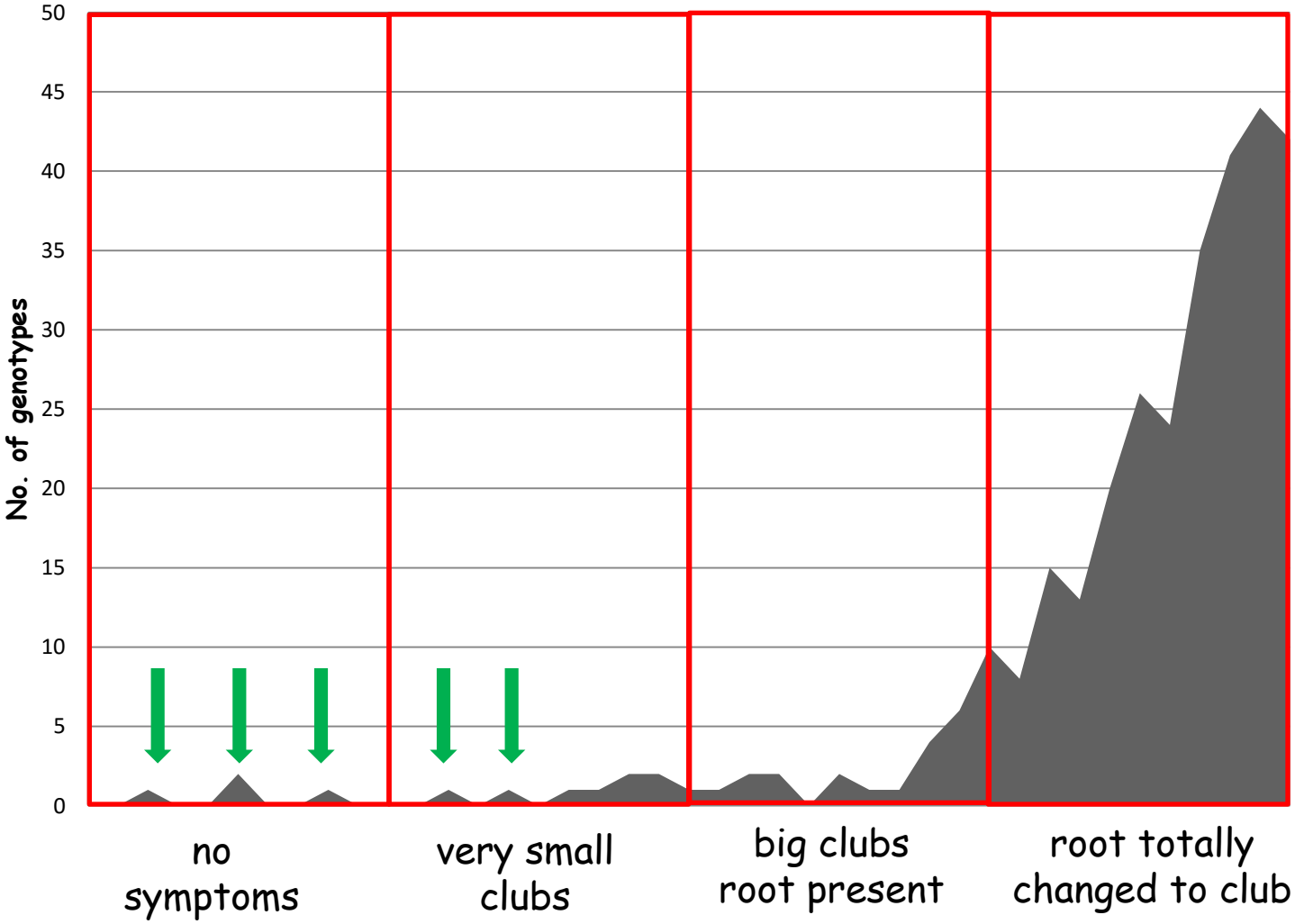
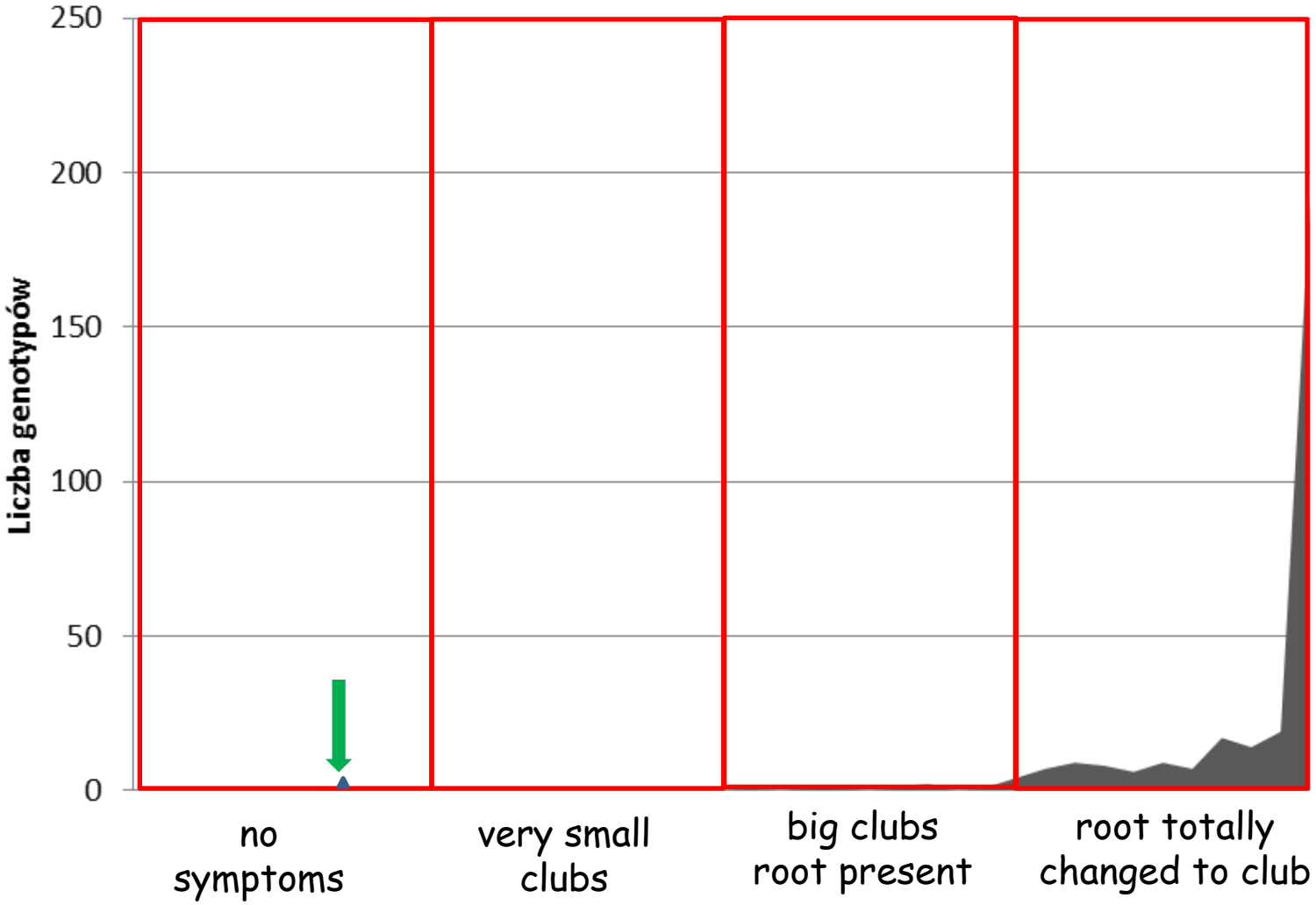


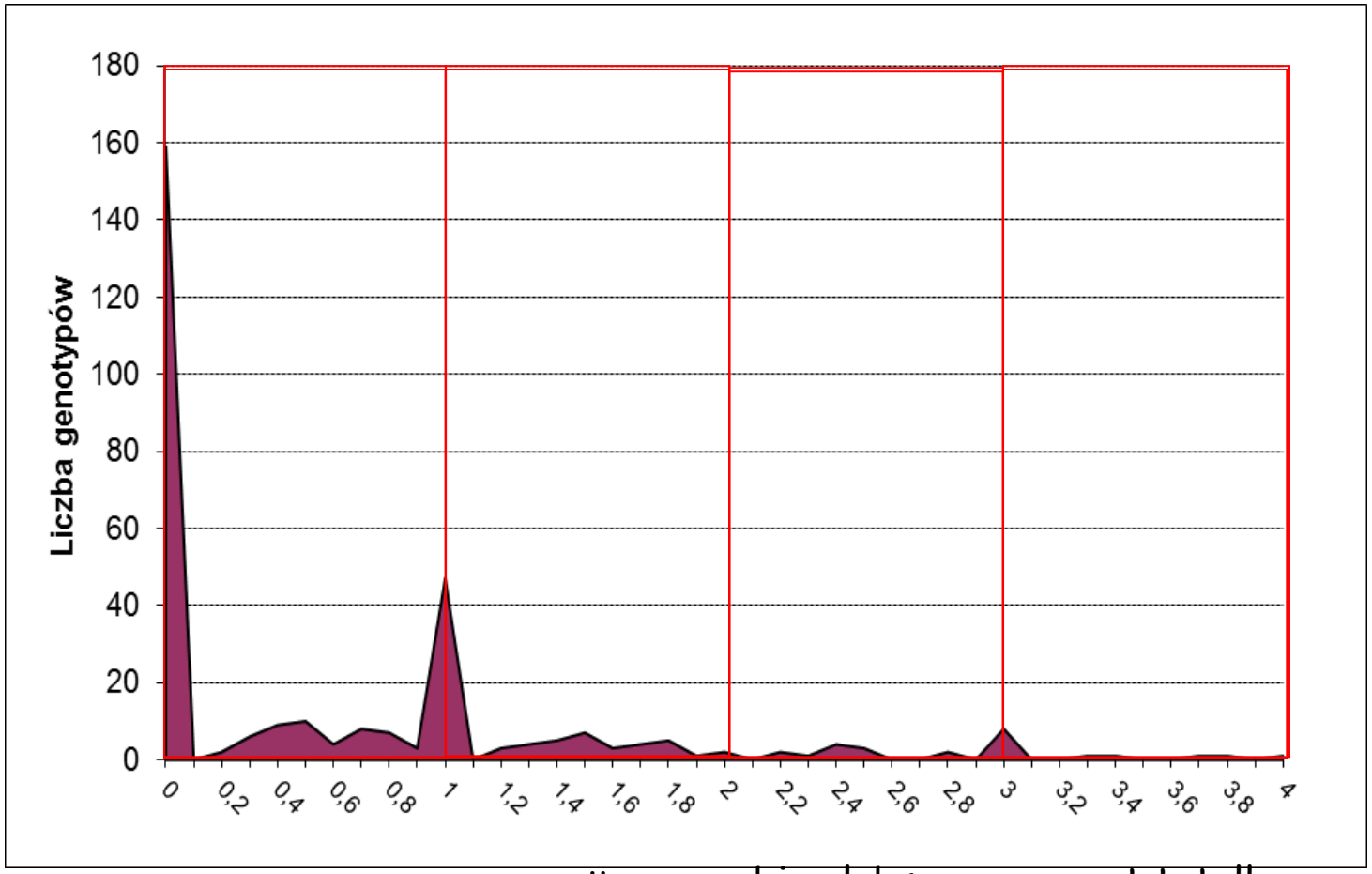
Number of the genotypes of the genus *Brassica* in sub-groups of resistance to *Plasmodiophora brassicae* (2016)



Number of the genotypes of the genus *Brassica* in sub-groups of resistance to *Plasmodiophora brassicae* (2017)

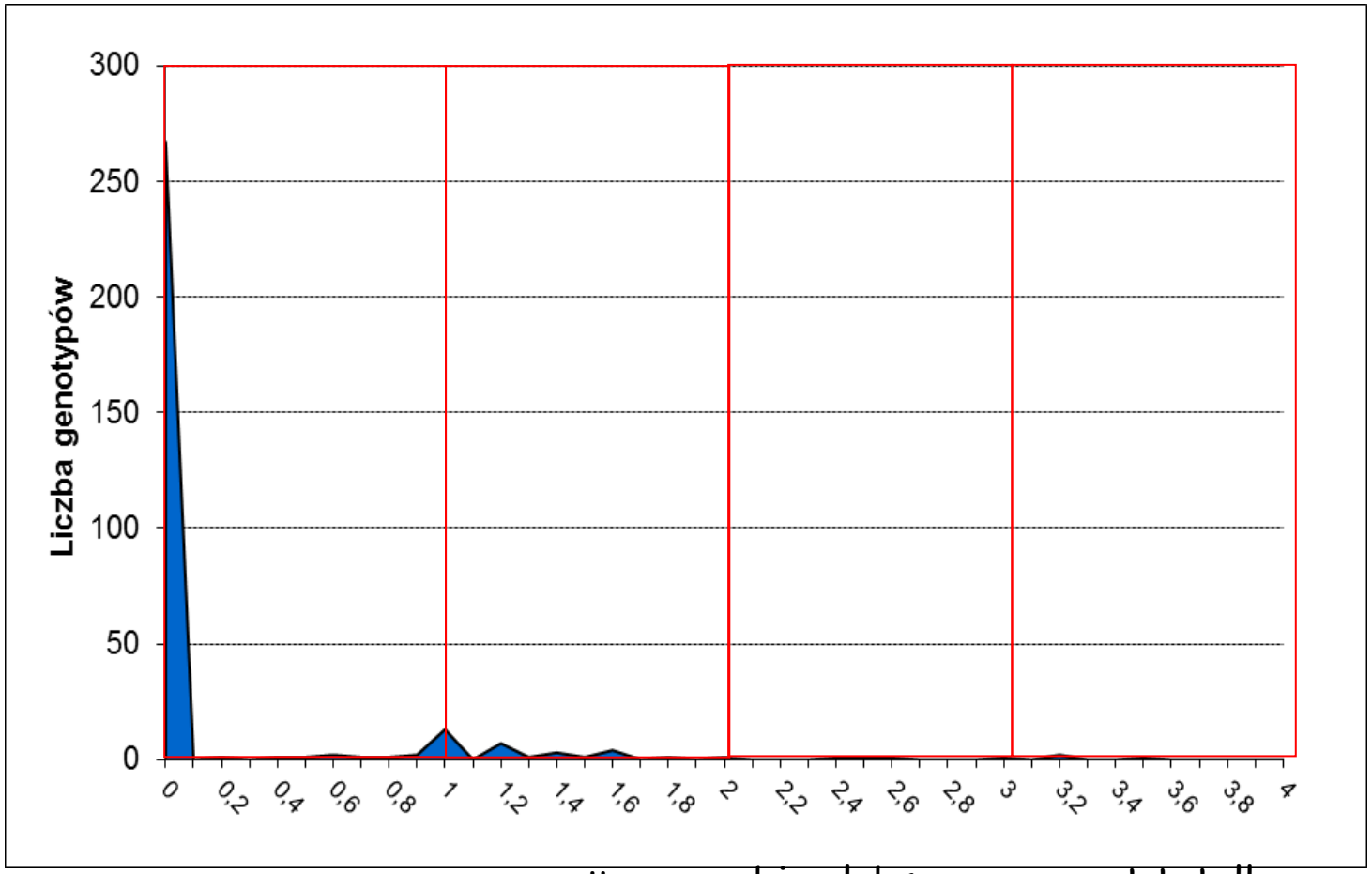


Number of the genotypes of *Raphanus sativus* in sub-groups of resistance to *Plasmodiophora brassicae* (2018)



Pathotype P1

Number of the genotypes of *Raphanus sativus* in sub-groups of resistance to *Plasmodiophora brassicae* (2019)



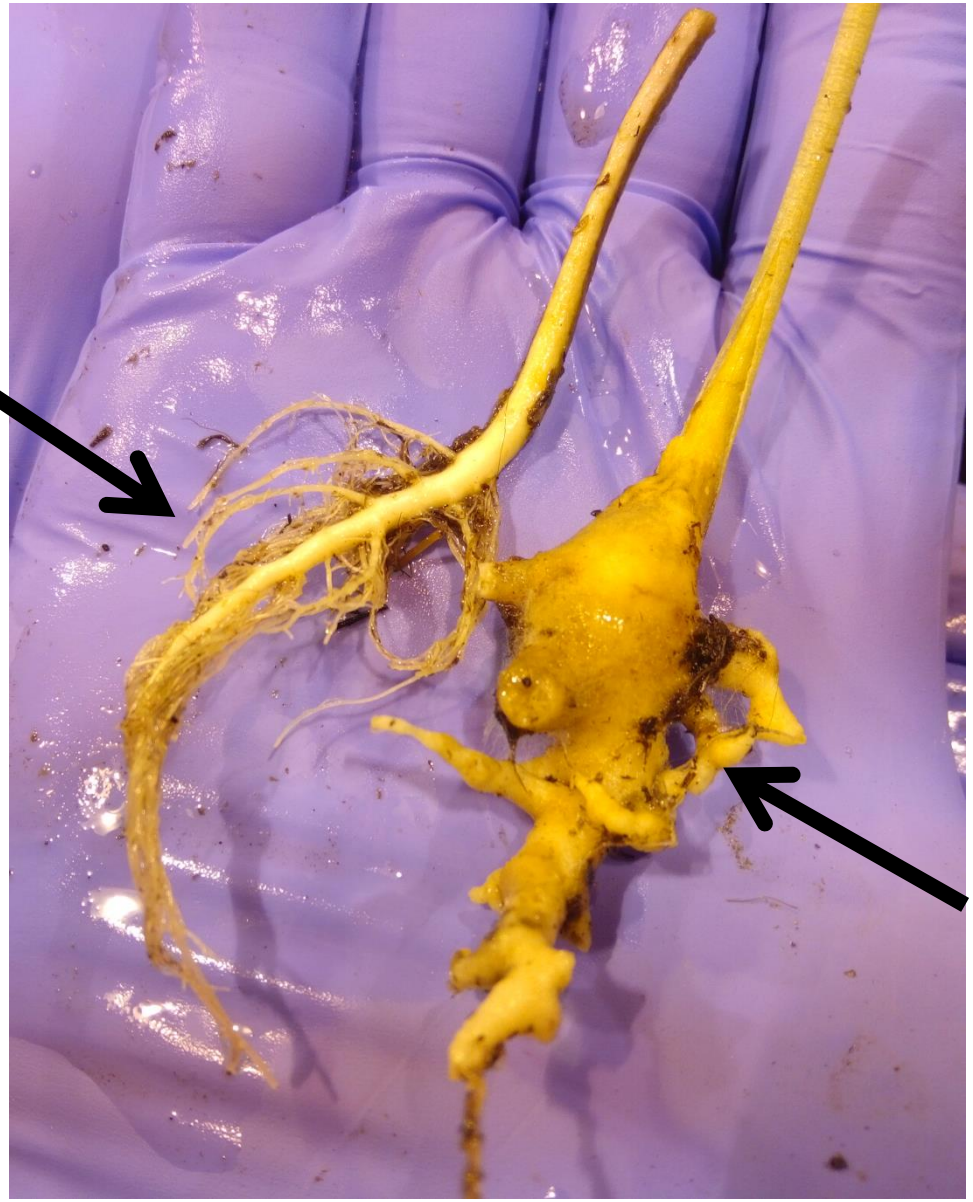
Pathotype P3

Results of resistance tests for *Brassica* infected by *Plasmodiophora brassicae*, the cause of clubroot (2016)

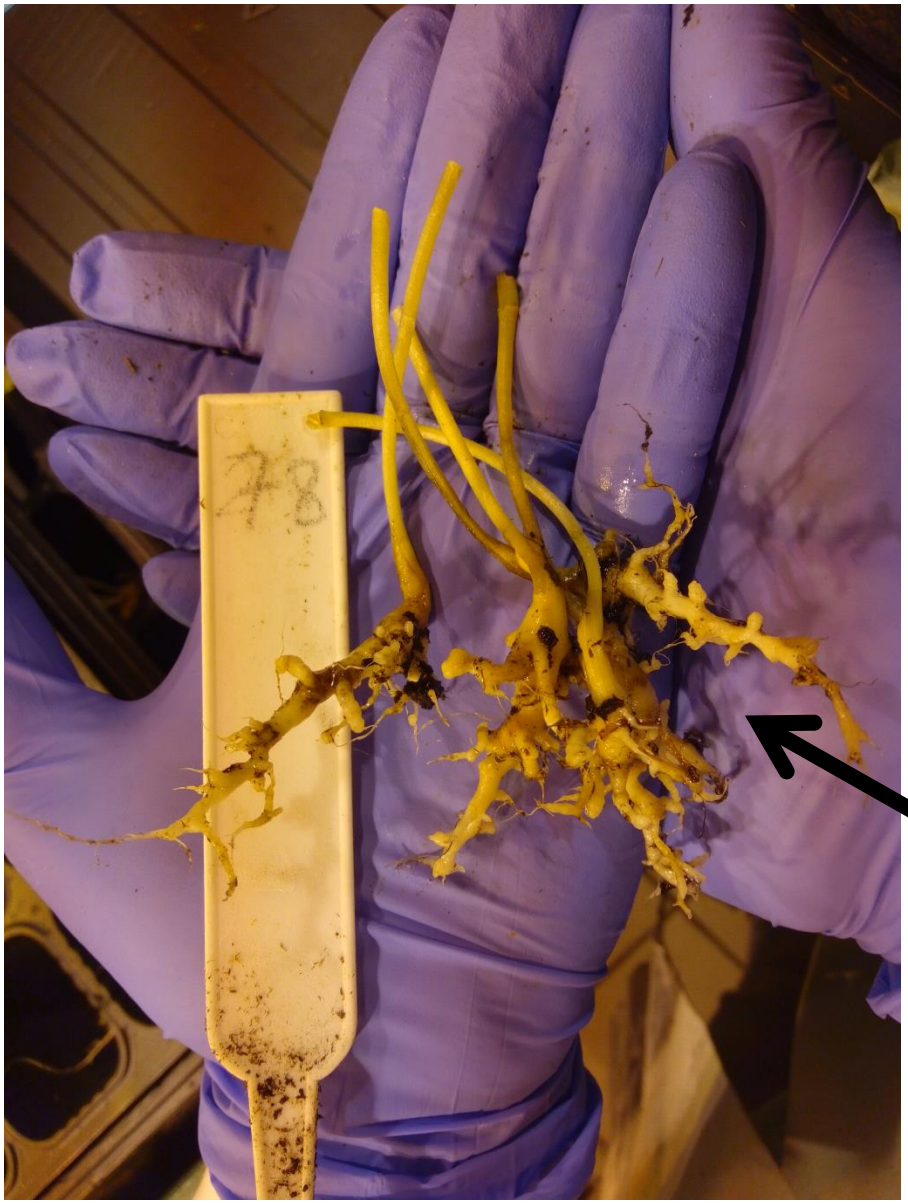
n = 310 genotypes

		Pathotype					
	line	P1A	P2A	P3A	P4A	P5A	P1B
Brassica oleracea	CGR 01	X	x	X	x	X	X
	CGR 02		x	x		X	X
	CGR 03		X		X		
	CGR 04	X					
	CGR 05						X
	CGR 06		X			x	
	CGR 07	x	x	x	x	x	x
	CGR 08	X	X		X	X	
	CGR 15		x				
	CGR 27	X	X	X	X	X	X
	CGR 32	X	X	X	X	X	x
	CGR 33	X	X	X	X	X	X
B. napus	CGR 50	X	X	X		X	
Brassica rapa	CGR 76			X		X	
	CGR 77		X	X	X	X	
	CGR 78		X	X	X		x
	CGR 79		X	X		X	
	CGR 80		X		X	X	
	CGR 82		X	X	X	X	X
	CGR 84		X			X	

Pyramiding of resistance to clubroot

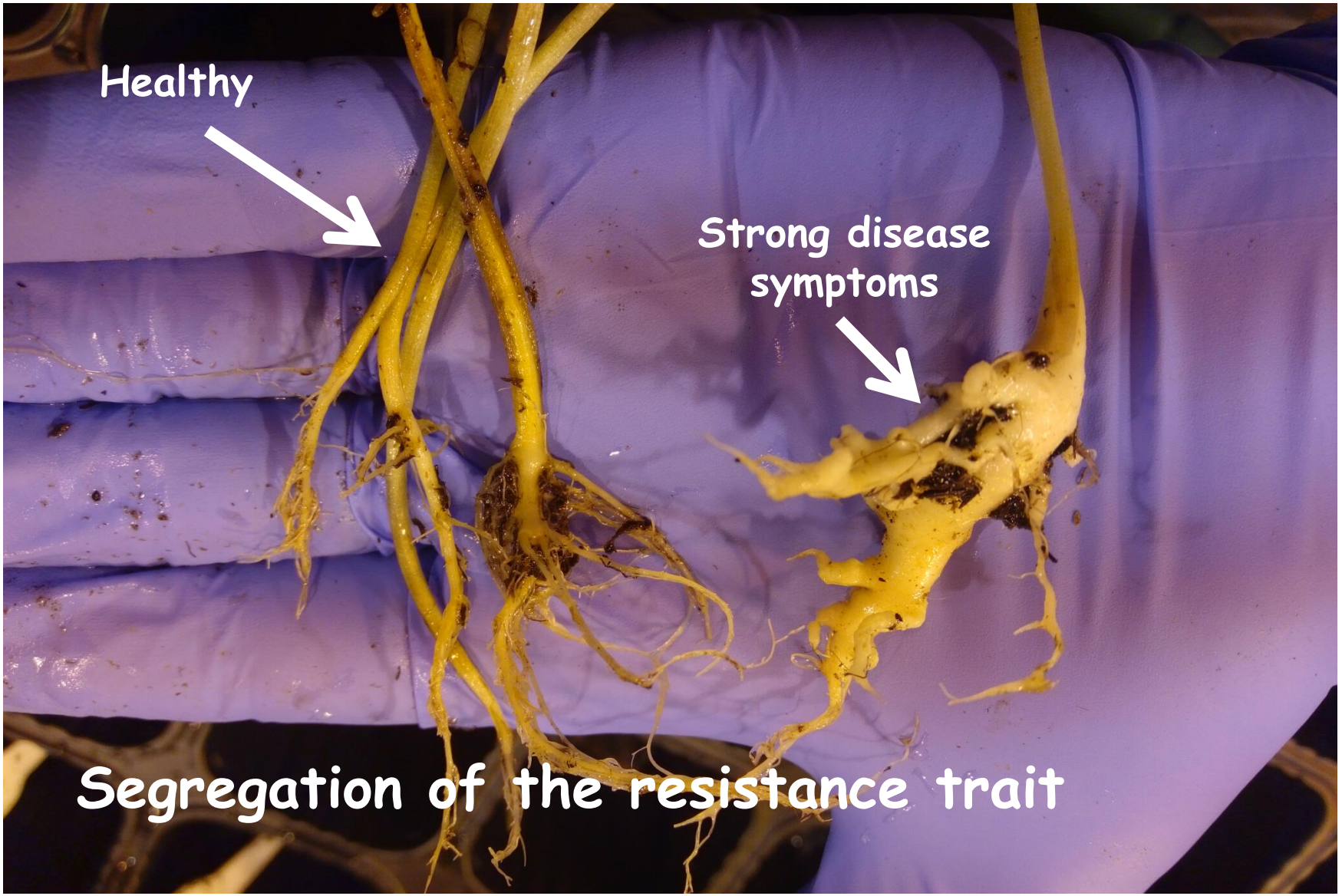


Pyramiding of resistance to clubroot

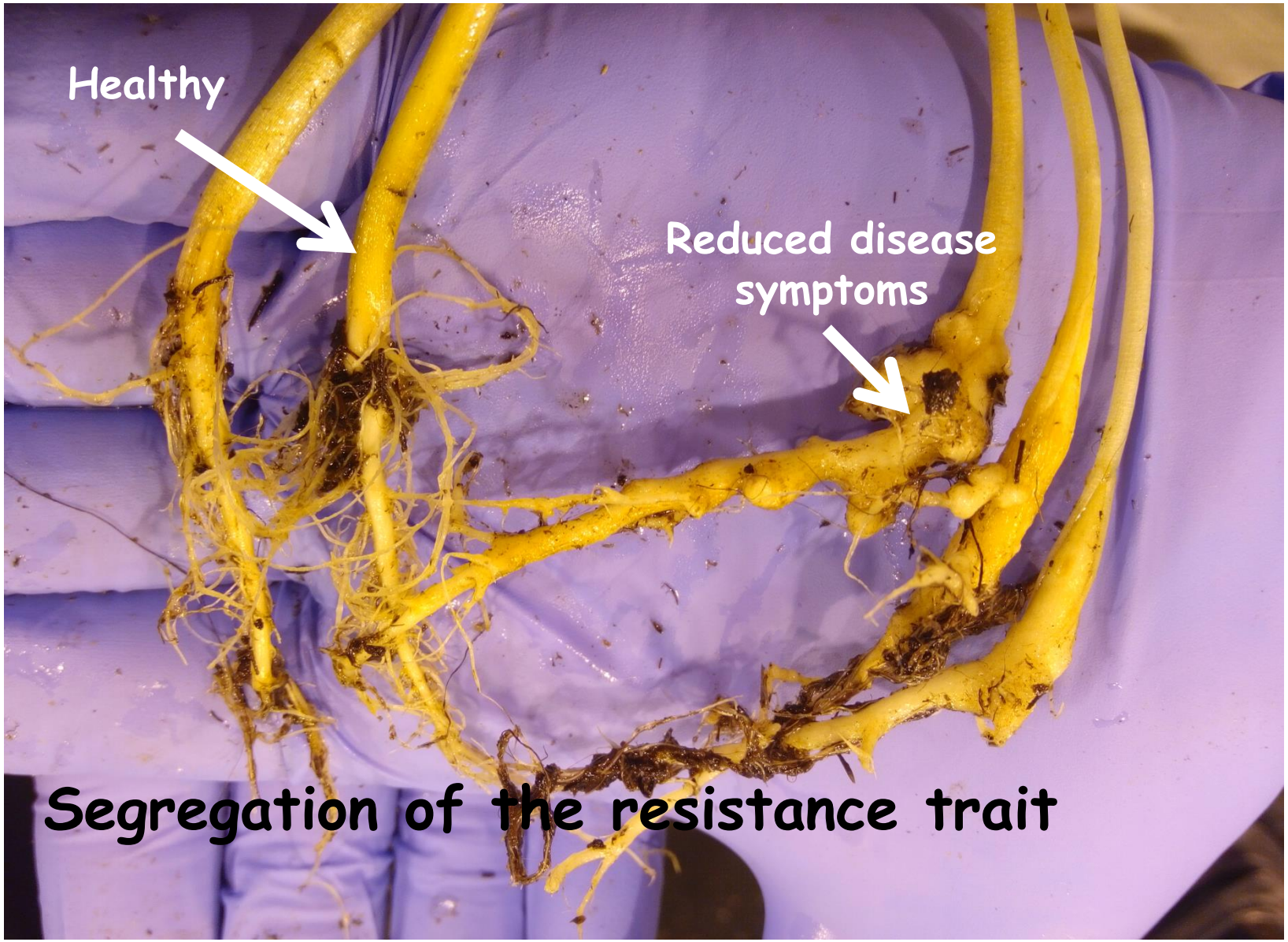


Reduced disease symptoms

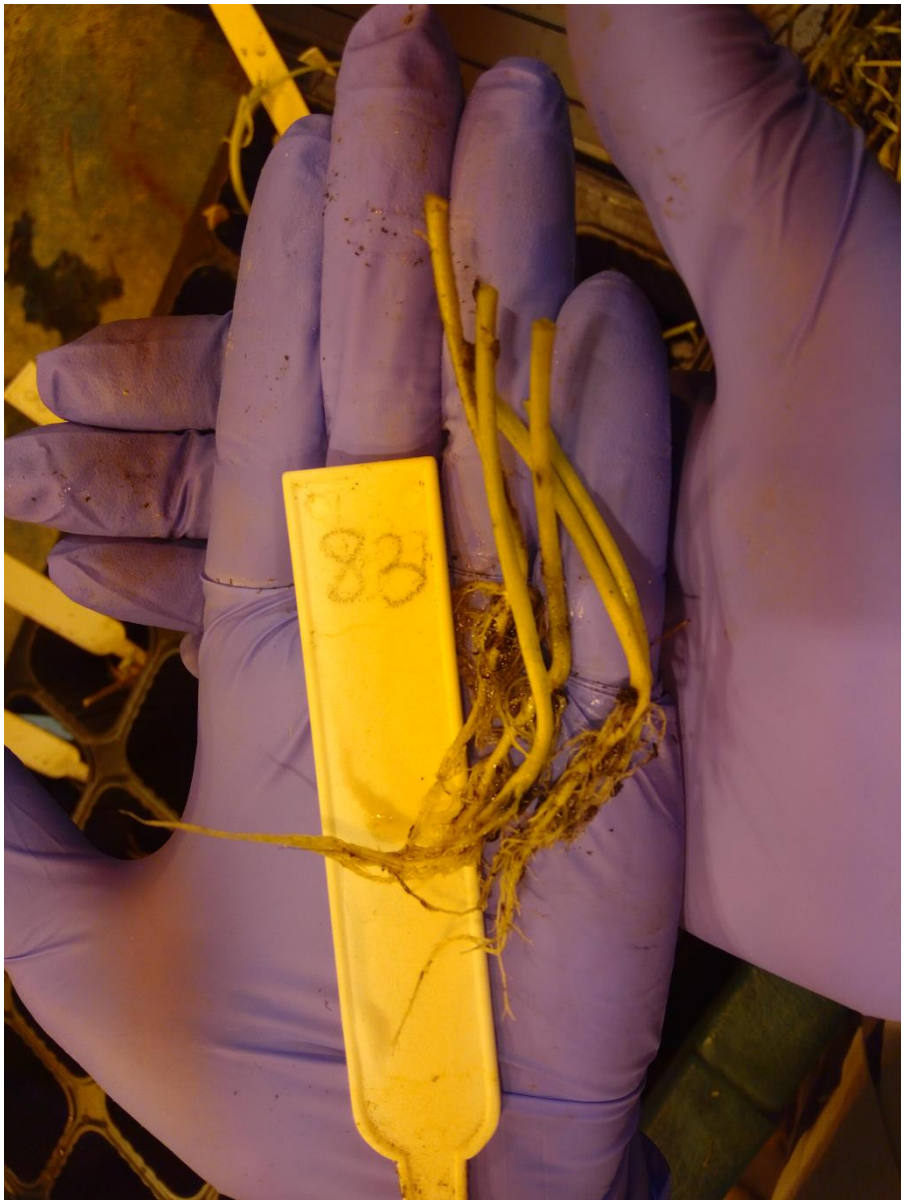
Pyramiding of resistance to clubroot



Pyramiding of resistance to clubroot



Pyramiding of resistance to clubroot



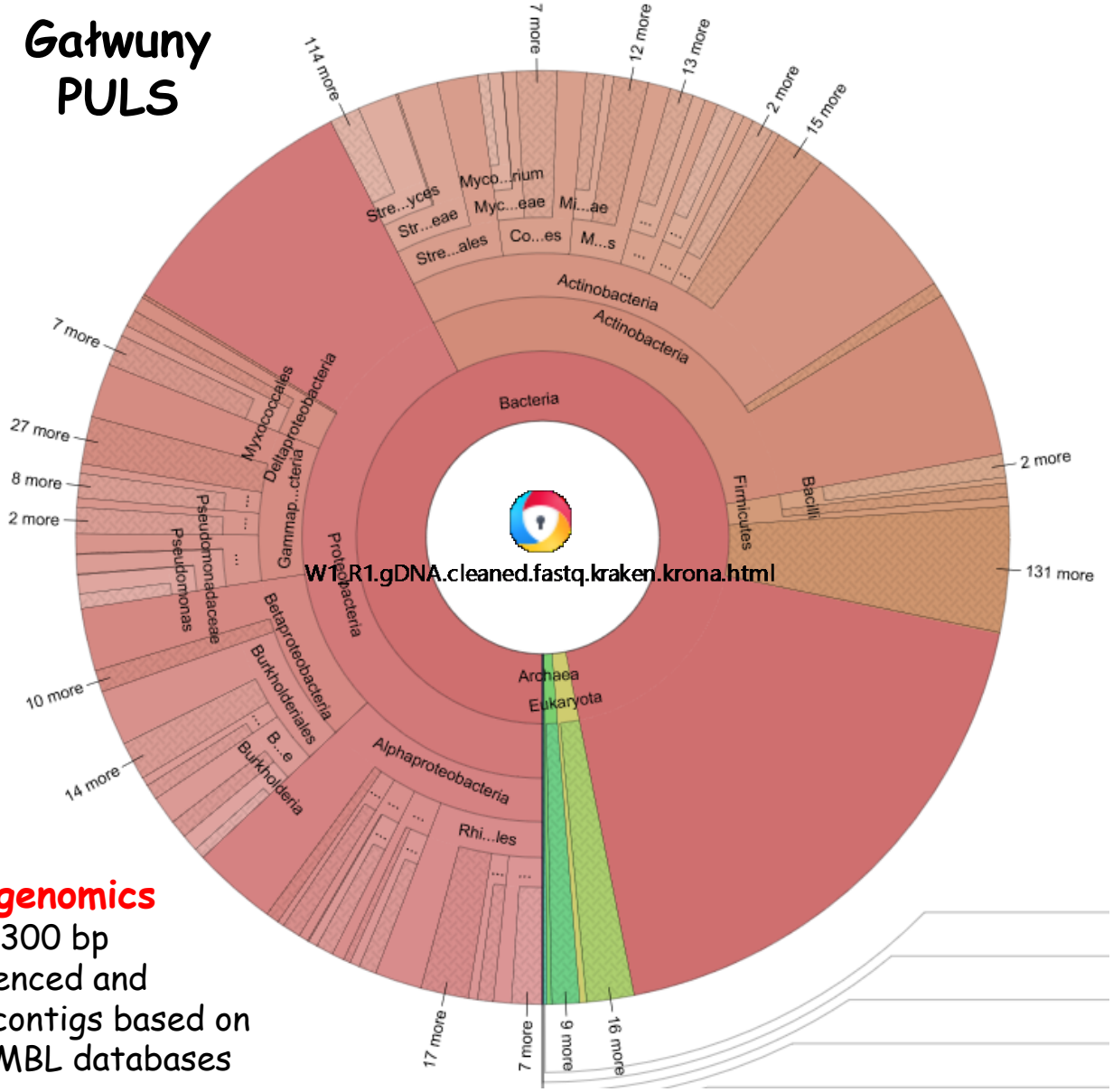
Dream line !!!

HOLL lines
High Oleic and Low Linolenic
(IHAR, Poznan)

+ PB resistance

Microbiome present is soil under OSR heavily infected with *Plasmodiophora brassicae*

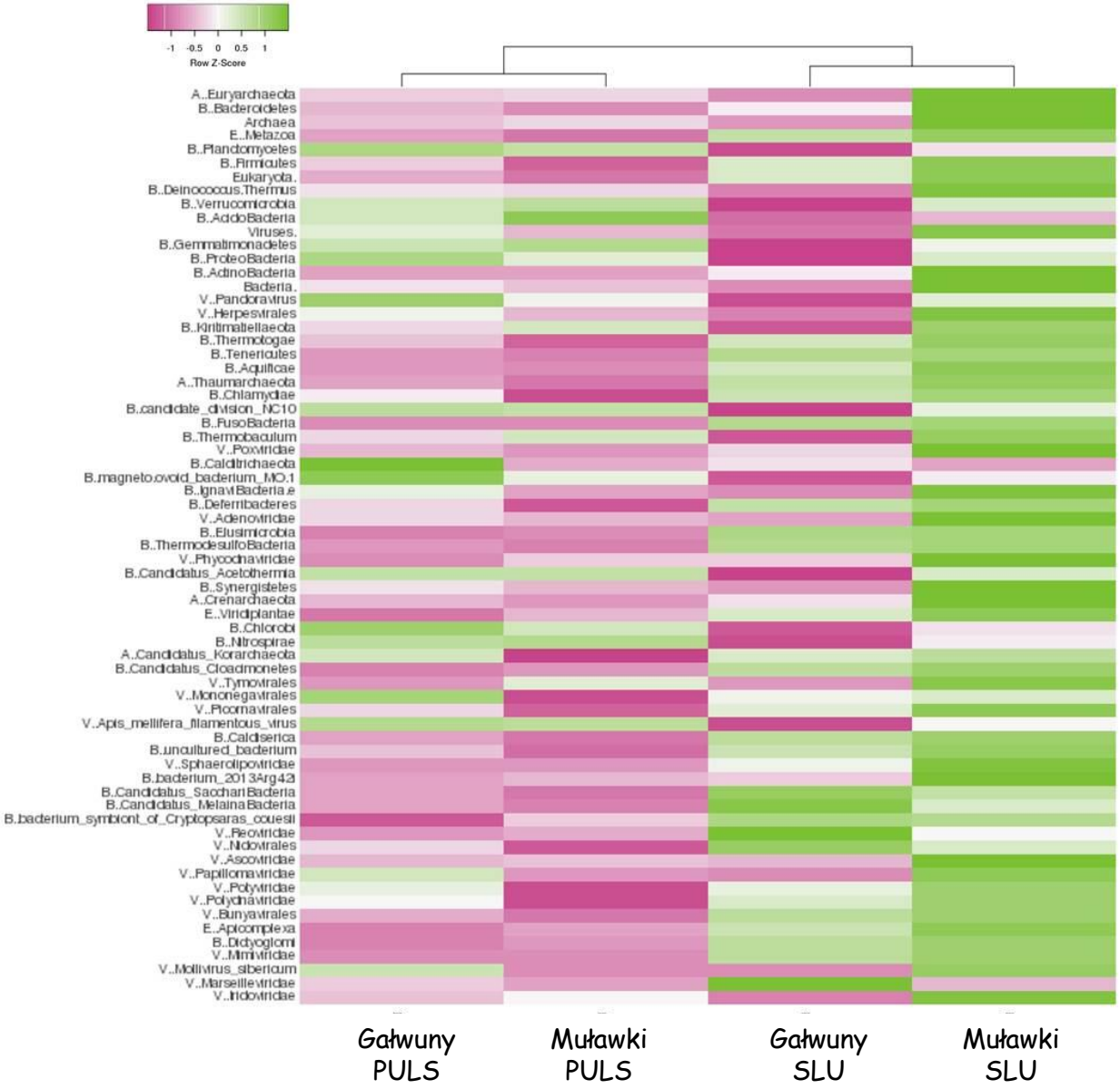
Gałwuny PULS



Shotgun metagenomics

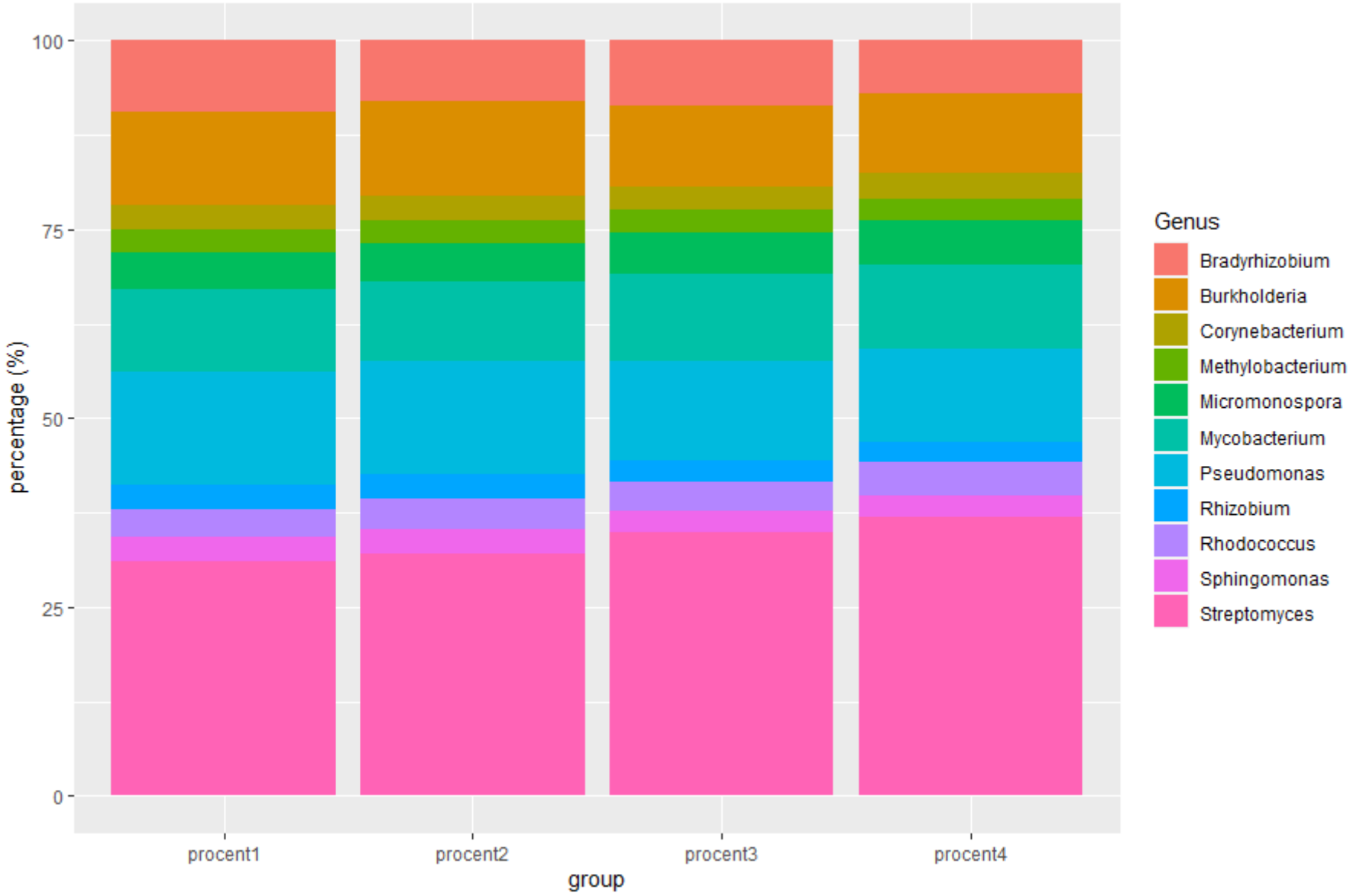
DNA cut to 100-300 bp fragments, sequenced and scaffolded into contigs based on NCBI and ENSEMBL databases

Microbiome present is soil under OSR differing with infestation by *Plasmodiophora brassicae*

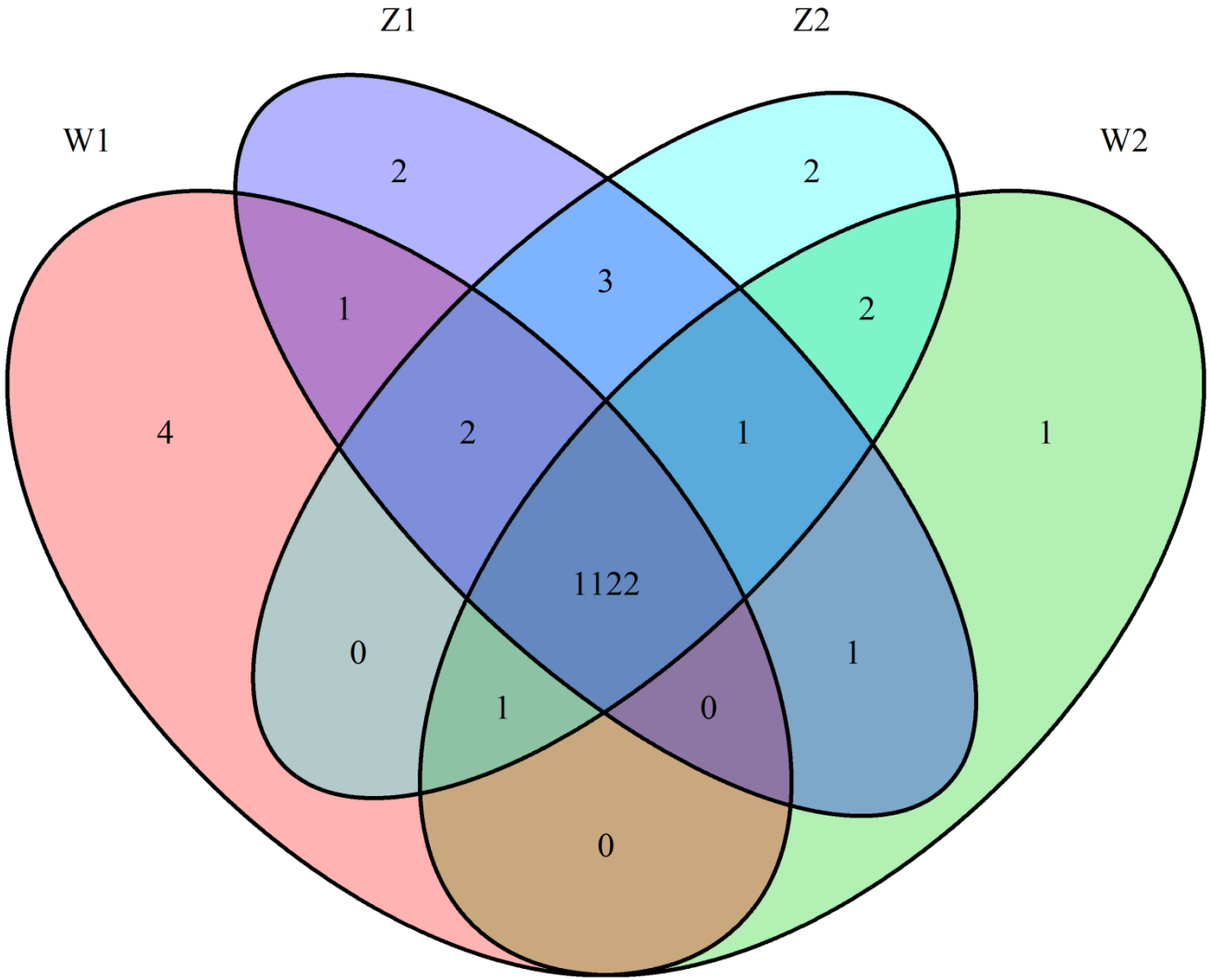


B = Bacteria
A = Archaea
V = Viruses
E= Eukaryota

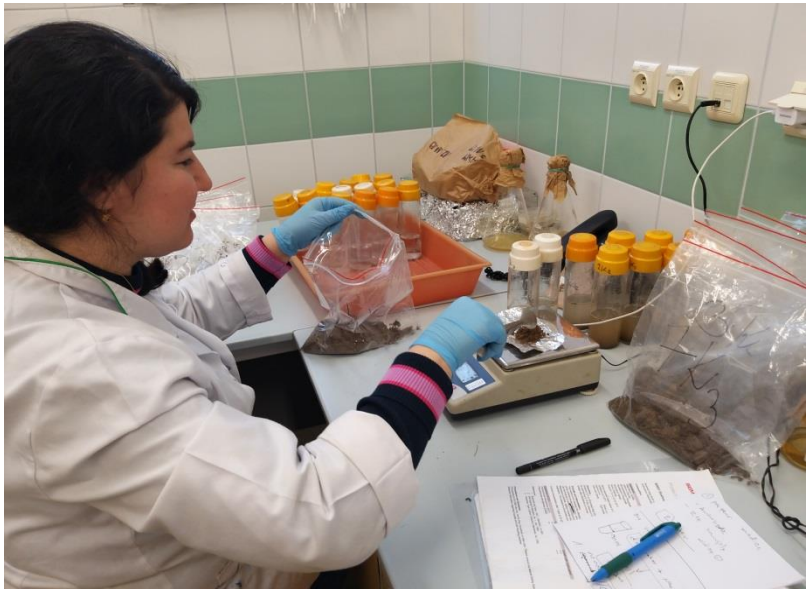
Microbiome present is soil under OSR differing with infestation by *Plasmodiophora brassicae*

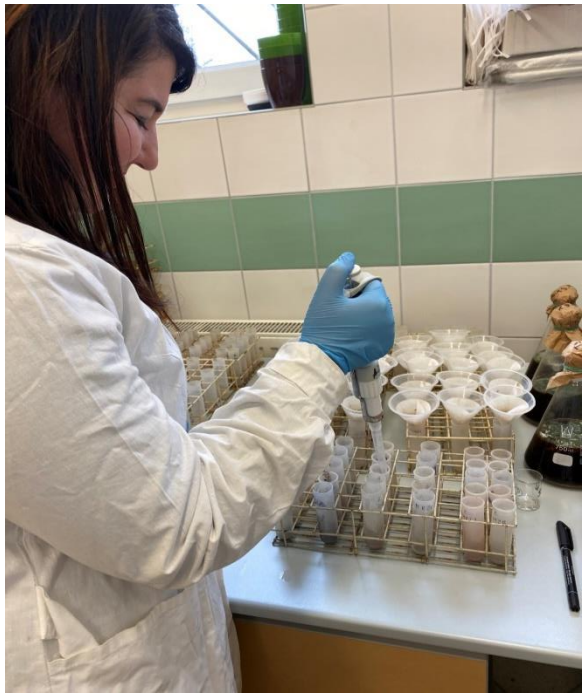


Microbiome present is soil under OSR differing with infestation by *Plasmodiophora brassicae*



Studies of enzymes present in soil samples





Studies of enzymes present in soil samples

DHA - dehydrogenase; indicator of the total content of organic matter = metabolic activity, in particular activity of specific bacteria and actinomycetes. Soil with high content of bacteria and actinomycetes must contain high amounts of DHA due to high amount of organic matter.

PAL- alkaline phosphatase; indicator of the content of organic phosphorus compounds (produced mainly by soil microorganisms when they lack mineral phosphorus in the soil).

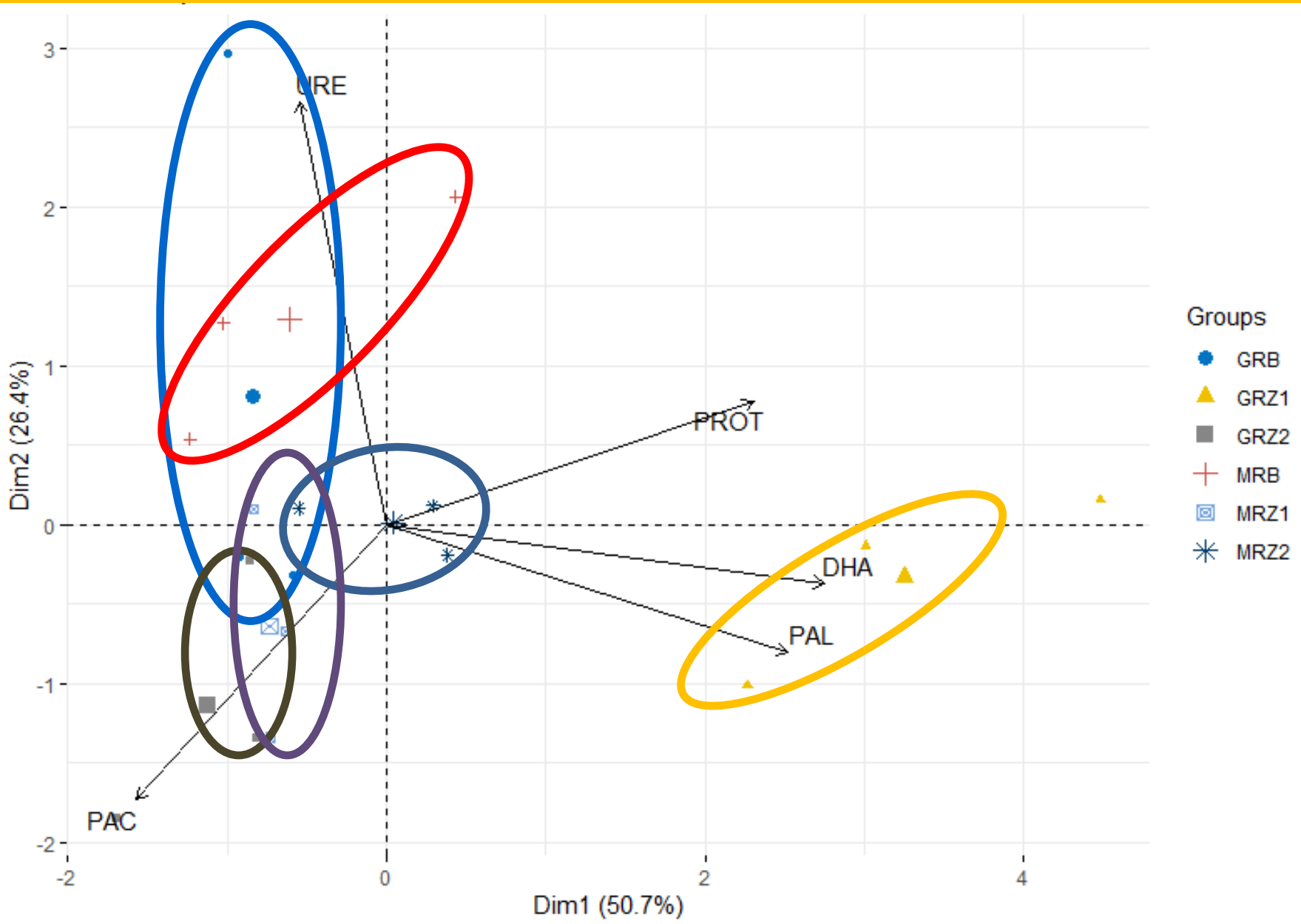
PAC-acid phosphatase, indicates the content of organic phosphorus compounds (produced mainly by plants, but also soil microorganisms when they lack mineral phosphorus in the soil).

URE-urease is an enzyme responsible for the decomposition of urea, with the release of ammonia, ammonia combined with water in the soil environment creates a source of nitrogen available to plants in the form of ammonium ion. Therefore urease is an indicator of the availability of nitrogen for plants.

PROT-protease is the enzyme responsible for the mineralization of proteins to amino acids. In the case of large amounts of nitrogenous organic matter in soil, e.g. from plant residues, its activity increases.

For all of the above enzymes, unfortunately, there are no standards that determine what level of their activity should occur in a given class of the soil. These enzymes are general indicators.

Enzymes present is soil samples under OSR differing with infestation by *Plasmodiophora brassicae*



Take-home messages

1) High incidence of clubroot on WOSR in Poland.

2) High severity of clubroot on WOSR in Poland.

3) Numerous pathotypes: 5 by Somé, 9 by ECD

4) High incidence of P1+ overestimation due to sampling

5) Pathotype-specific resistance: infrequent in *Brassicas*
possibilities of resistance pyramiding

6) General resistance frequent in *Raphanus*
necessity for distant crossings and embryo rescue

7) Differences in soil microbiome: difficulties to fish out

8) Differences in soil enzymes: crude tool

Best wishes of health and happiness