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BCPC Diseases Review 2019

Integrated disease management for soil-borne pathogens

Dr Amanda Bennett, AHDB

Overview

- Research often focused on understanding a single pathosystem
  - Biology, ecology and epidemiology of the pathogen
  - Host genetic tolerance and resistance
  - Environmental conditions
- Practical management on-farm
  - Detection in soil
  - Integrated methods for control
- Rotational soil management
  - Soil health and crop health

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Developing targeted management methods for clubroot through pathotyping and field mapping

Prof. Fiona Burnett, SRUC

Dr Julie Smith, ADAS

(Aug 2015 – Feb 2019)

SRUC · The University Of Sheffield. · P3 Plant Production and Protection · LS Plant Breeding Combining Excellence · soilessentials precision farming solutions · ADAS · CEREALS & OILSEEDS

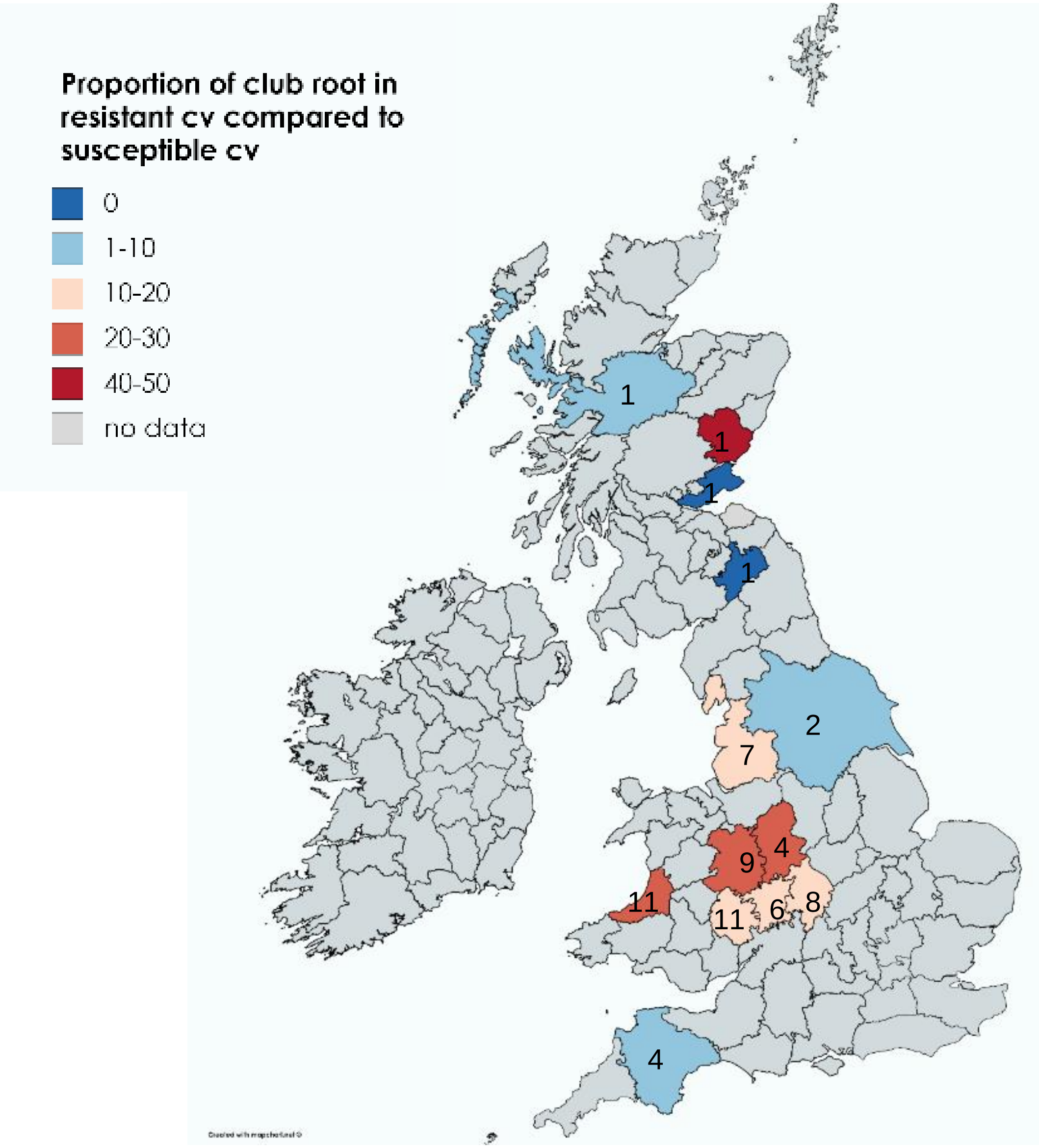
Clubroot caused by *Plasmodiophora brassicae*

- Wide host range: oilseed rape, vegetable brassicas, cover crops, weeds
- Yield reduction = 0.3 t/ha for every 10% clubroot severity
- Inoculum can survive in soil for 15 years, half life of 4.5yrs
- Exacerbated by close rotations
- Often goes undetected at field and national level
- Cultivar resistance based on single dominant gene and is being eroded
- Fungicide and bio-control options not available
- Limited management from agronomic strategies

Prevalence of resistance breaking strains present in the UK

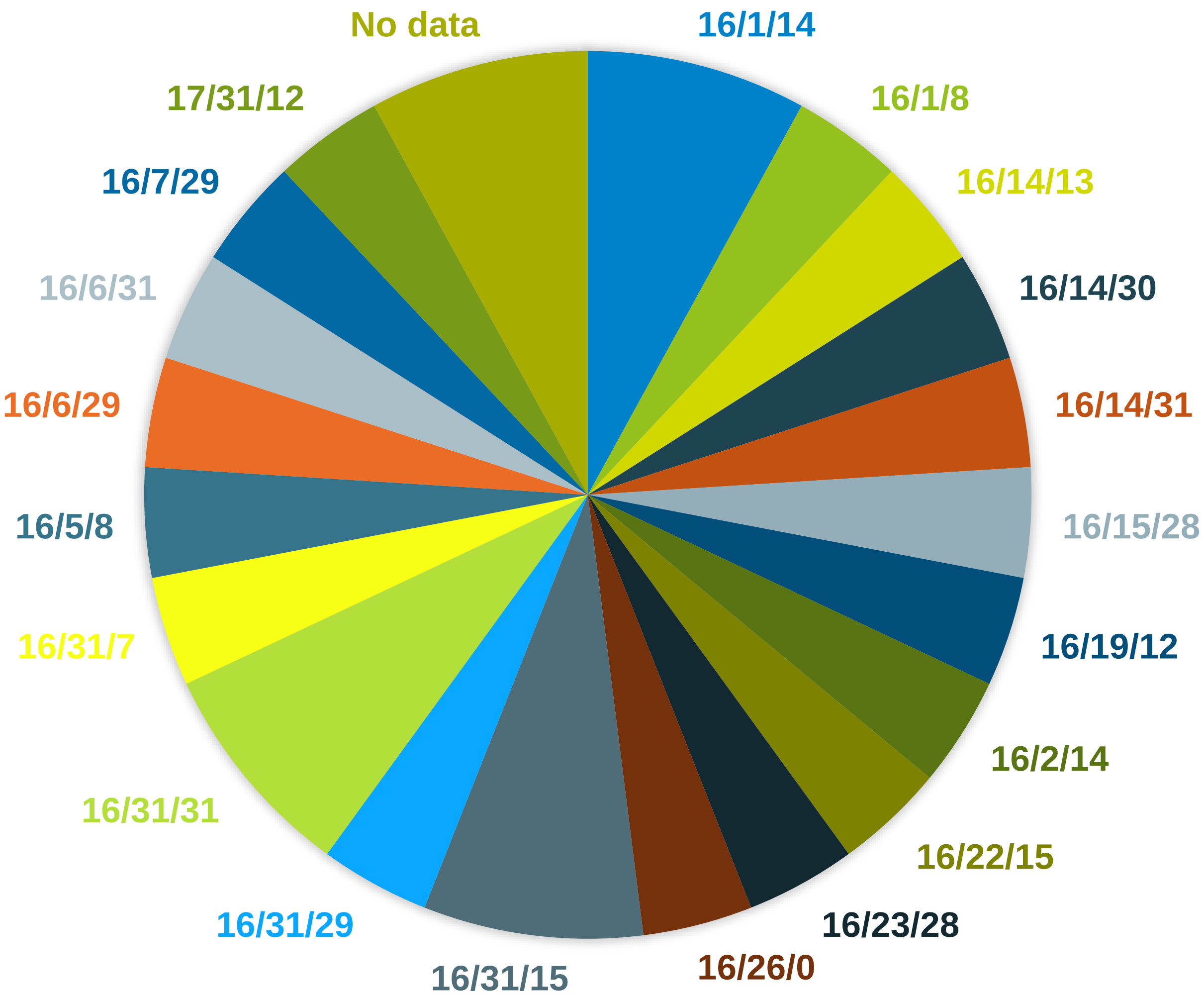
~75 commercial fields sampled

‘Mendel’ resistance breaking strains identified

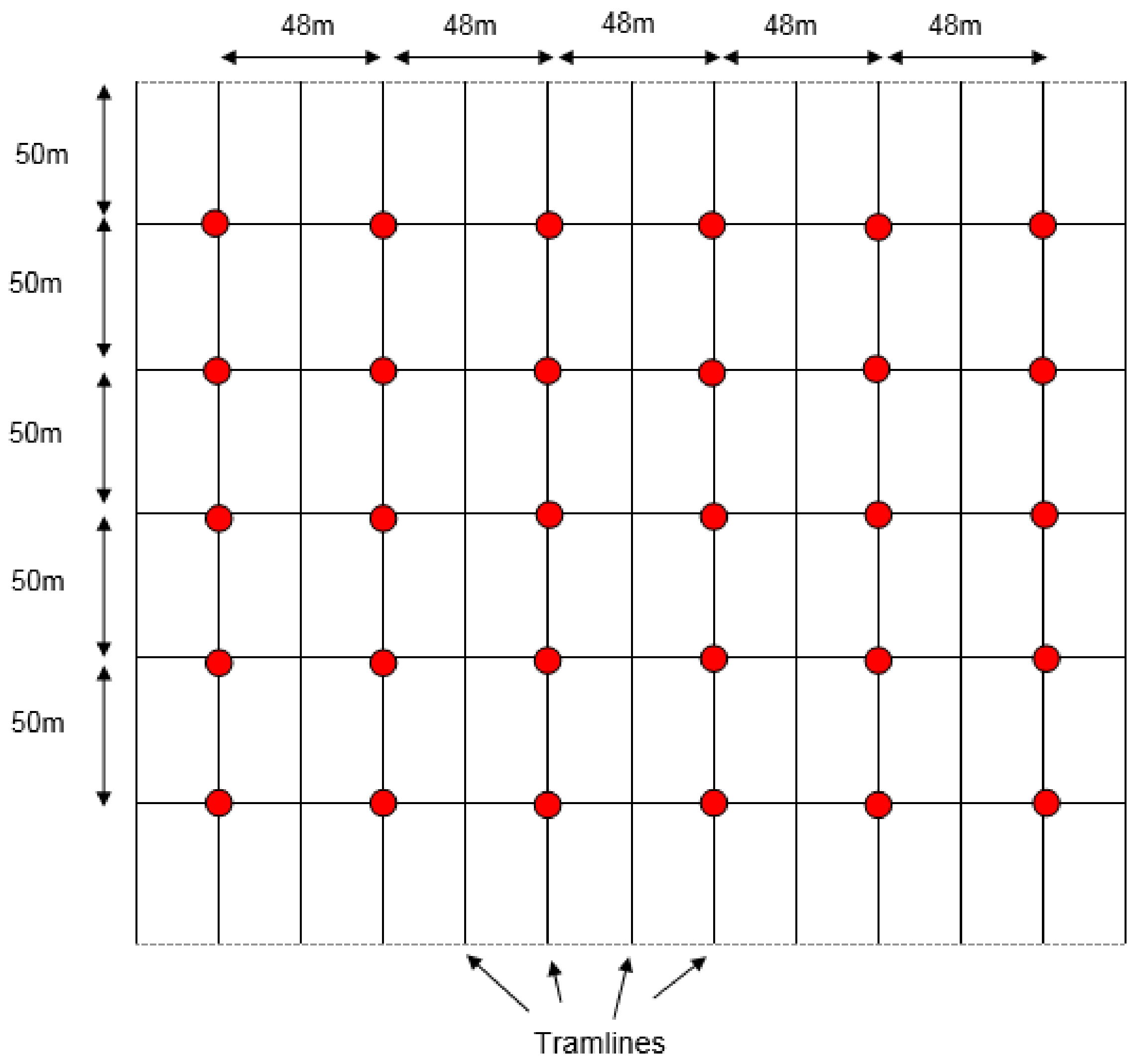


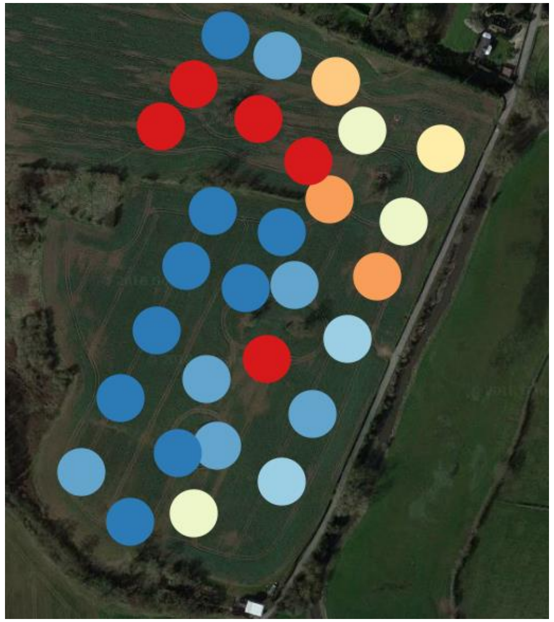
Diversity of pathotypes in the UK

European clubroot differential set



Impact of inoculum density on yield - when would patch treatment be economic?

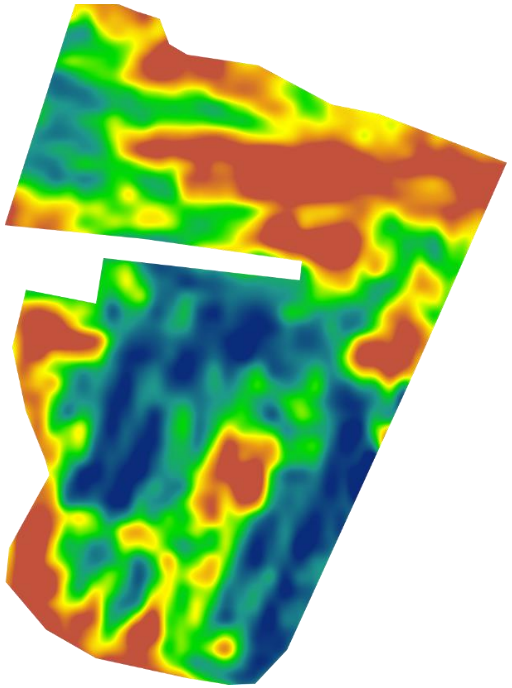




Congrieve, April 2018 – club root severity index (0-100)

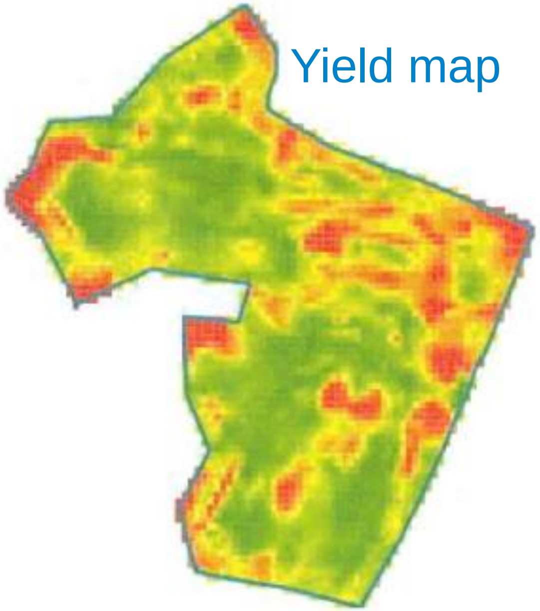
	0.00 - 10.00
	10.00 - 20.00
	20.00 - 30.00
	30.00 - 40.00
	40.00 - 50.00
	50.00 - 60.00
	60.00 - 70.00
	70.00 - 80.00
	80.00 - 90.00
	90.00 - 100.00

Congrieve, Clubroot severity index key (0 – 100)



Congrieve, April 2018, NDVI map

Yield map



Margin over liming cost

Colour	£ per hectare (£/ha)
	-150 – -100
	-100 – -50
	-50 – 0
	0 – 50
	50 – 100
	100 – 150

Integrated management for clubroot (OSR)

- Rotation planning – cover crop mixes often contain susceptible species
- Use field mapping to target control
- Keep accurate crop records of clubroot occurrence, location and intensity
- Frequency and detail of testing is key in susceptible rotations
- Buy certified seed; do not home-save resistant varieties
- Manage volunteers and susceptible weeds
- Long term planning should be based on the long-term profitability and sustainability of a field

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Clubroot management in crops

Pathogen

Plasmodiophora brassicae

Hosts

Clubroot affects all cultivated and wild cruciferous plants. In addition to oilseed rape, all vegetable brassica species are affected. Other susceptible broad-acre arable crops include turnip, swede, Brussels sprouts, cauliflower, calabrese and mustard. Numerous weed species, such as charlock and shepherd's-purse, are also common hosts.

Symptoms

The first symptoms usually occur within six weeks of planting, provided soil temperatures are greater than 15°C. In oilseed rape, symptoms commonly start in late autumn. Roots become swollen and distorted, and develop small, irregular, white-coloured, solid galls. These are present on taproots and/or lateral roots. As the season progresses, galls may enlarge and discolour, before starting to rot.

Above-ground symptoms do not usually develop until later in the season. Typical symptoms include stunting and yellowing. Under dry conditions, plants may wilt, especially when galling is severe. Distinct patches of poor growth are often visible. Plant loss occurs in the most severely affected areas and, occasionally, the whole field may fail.

Life cycle

Clubroot is a soilborne pathogen that produces resting spores. These spores have thick walls and help the pathogen survive for up to 15 years in the soil. Chemicals, released by the roots of host plants, cause nearby resting spores to germinate and release motile spores (zoospores). These move through soil water and infect the host's root hairs, where a secondary spore stage occurs. These spores invade the outer layer of the root (the cortex) and form structures called secondary plasmodia. These structures cause the root cortical cells to enlarge and increase the rate of cell division. Ultimately, this results in the formation of the characteristic clubroot galls. These galls decay during the season and release large numbers of resting spores back into the soil.

Importance

Clubroot is a global problem and has increased in recent years. For example, many new UK cases were reported in 2016, often on farms with no history of the disease. The trend for shorter rotations, along with milder and wetter winters, have probably

Figure 1. Clubroot symptoms in oilseed rape

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www.ahdb.org.uk/clubroot

Rotational soil management

Healthy soils, healthy roots

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Soil Biology and Soil Health Partnership

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fA INNOVATION *for* AGRICULTURE
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Soil Biology and Soil Health Partnership

- Five years to deliver linked knowledge exchange and research on soil biology and soil health
- Building on work already carried out

Aims to:

- Improve on-farm understanding of soil health by sharing current academic and industry knowledge in usable formats
- Develop and validate indicators of soil biology and soil health in research trials and on-farm

All soils are different

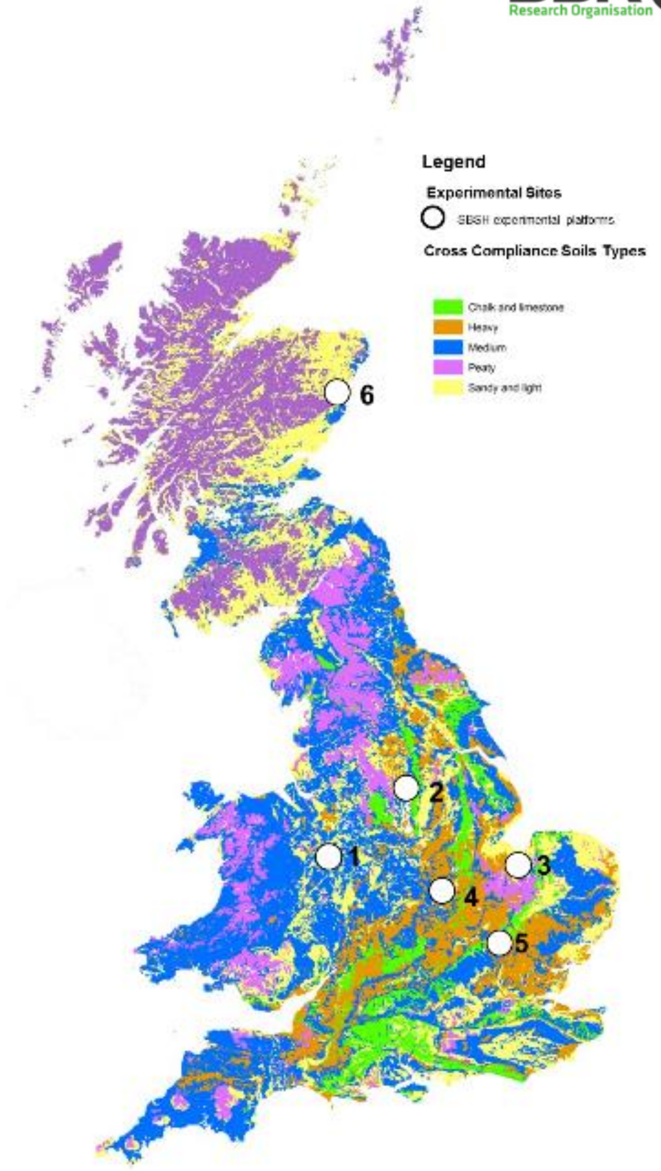





Soil health assessment sites: Arable and ley/arable rotations

1. Harper Adams
2. Gleadthorpe
3. Terrington
4. Loddington - Tillage
5. Boxworth - Drainage
6. Craibstone
   a. Crop rotation x fertiliser; 90+yrs
   b. Crop rotation x pH; 60+yrs.

10-20 years of repeated organic material additions (sites 1–3)



Developing and validating indicators of soil biology and soil health

- Visual assessment of soil structure (VESS)
- Penetrometer resistance
- Bulk density

- pH
- Routine nutrient analyses (P, K, Mg)
- Soil organic matter / loss on ignition
- Total N
- Potentially mineralisable nitrogen

- Earthworms
- Mesofauna
- Nematodes
- Microbial biomass carbon
- Respiration: Solvita® test

- DNA measures of pathogens and soil health

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Attribute*	Field A; Farm 1	Field B; Farm 2	Field C; Farm 3
SOM (%)	3.4	2	2.2
pH	6.7	6.9	7.0
Ext. P (mg/l)	40.6	59.6	37.2
Ext. K (mg/l)	158	106	148
Ext. Mg (mg/l)	82	89	144
VESS score	2	2	2
Earthworms (Number/pit)	13	8	1

Investigate Monitor No action needed

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Assessing soil health using DNA

- Can we replace many of the biological assays with analysis of a single DNA sample?
- Sample size and cost evaluated in a comparative experiment
- Interpretation by analysing the same samples as the 'traditional' assays

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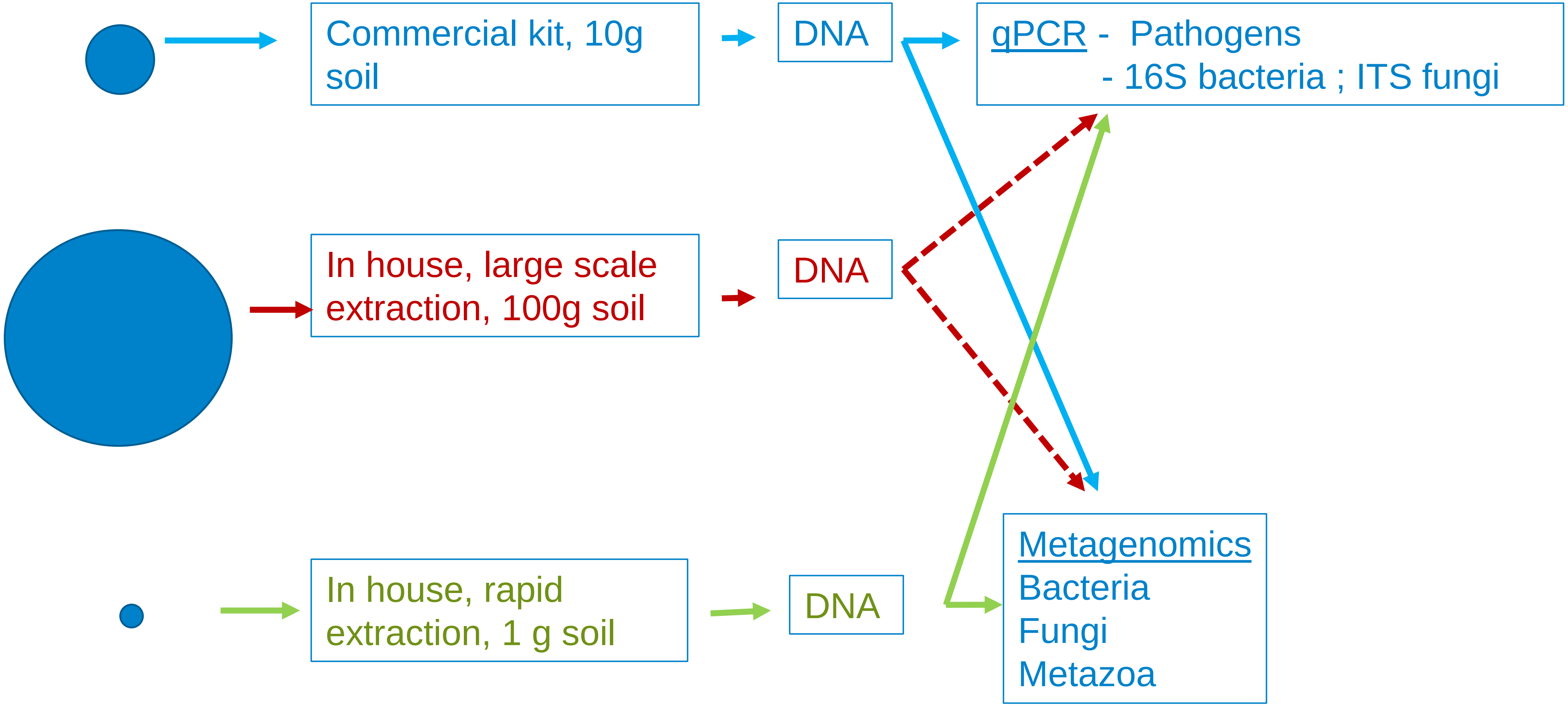

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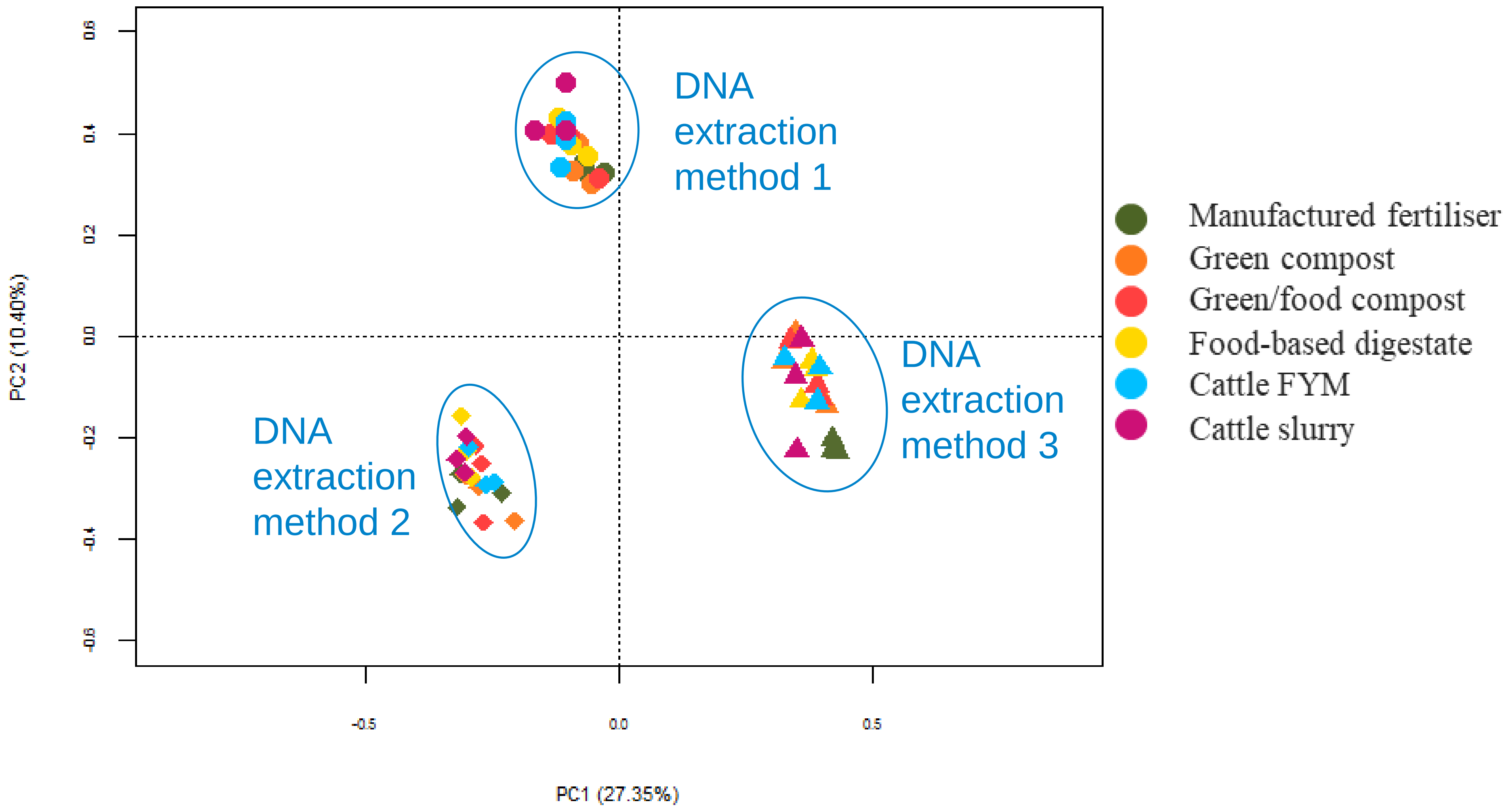

Figure courtesy of The University of Lincoln

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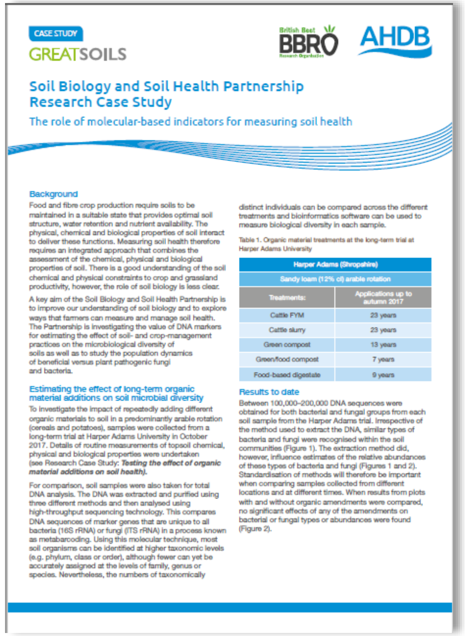
Research case studies

- The role of molecular indicators for measuring soil health
- Testing the soil health scorecard (on-farm monitoring 2018-2019)
- Testing the effect of organic material additions on soil health
- Testing the effect of pH on soil health


CASE STUDY

GREATSOILS

Soil Biology and Soil Health Partnership Research Case Study

The role of molecular-based indicators for measuring soil health


FACTSHEET

GREATSOILS

Soil Biology and Soil Health Partnership Research Case Study

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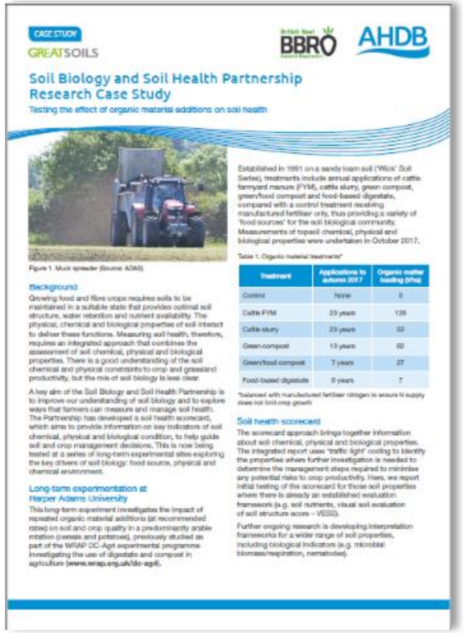
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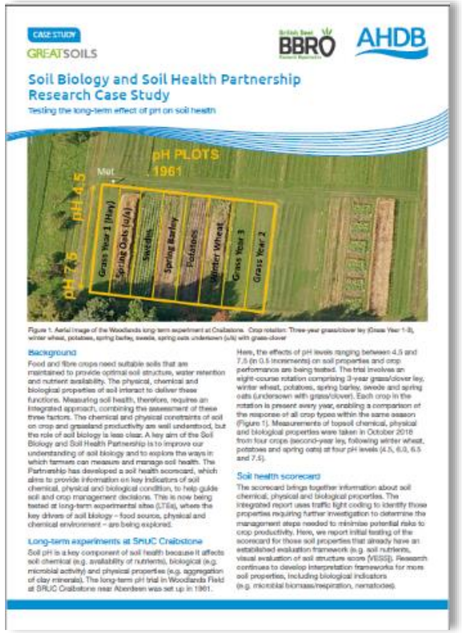
CASE STUDY

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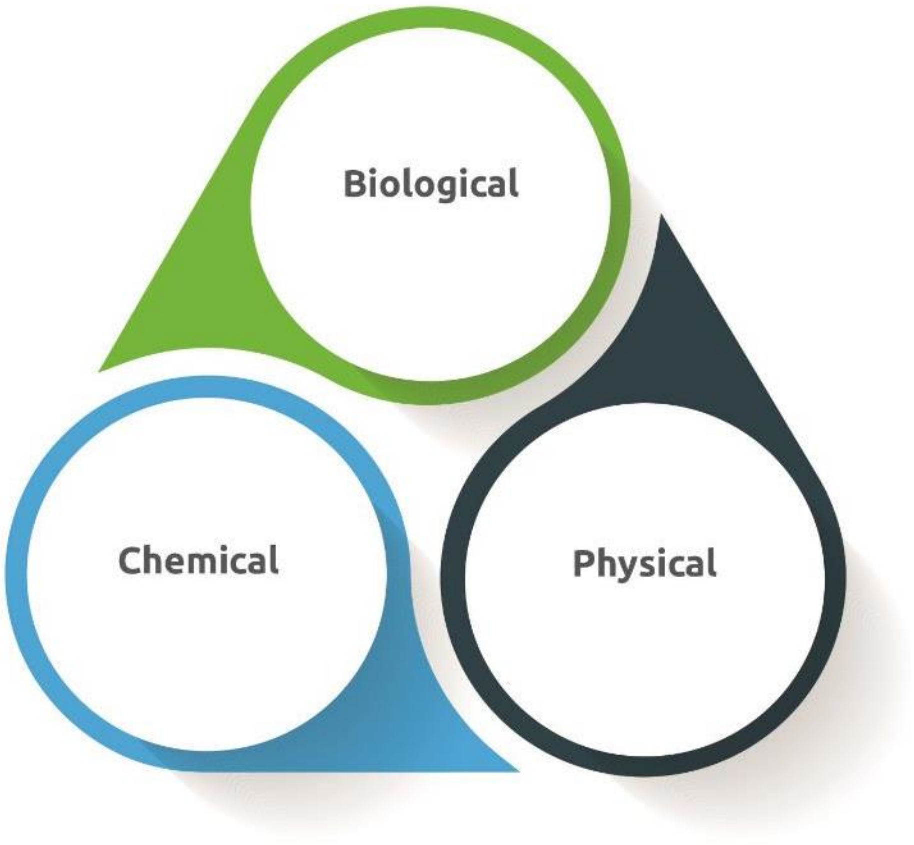
Soil Biology and Soil Health Partnership Research Case Study

Testing the long-term effect of pH on soil health

www.ahdb.org.uk/greatsoils

Integrated management for soil health and soil-borne pathogens



- Field mapping – ‘know your soils’
  - Investigate poor areas
  - Dig a hole
  - Soil testing and diagnostics
  - Pull up a plant to look at roots
- Cultural practices
  - Extend and diversify rotations
  - Cultivations
  - Organic amendments
- Varietal resistance/tolerance
  - Seed rate

Future

- Soil management to suppress disease
- Precision mapping of soil-borne pathogens (monitoring)
  - Soil sampling
  - Diagnostics
  - Targeted management approaches
- Thresholds for disease development and impact on yield or quality
  - Environmental conditions
- Varietal tolerance or resistance
  - Breeding: examining below-ground traits
- Seed treatments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rapidly changing world’