Grower Summary

FV 436

Pea Downy Mildew diversity in the UK

Final 2017

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Read the label before use: use pesticides safely.

Further information

If you would like a copy of the full report, please email the AHDB Horticulture office (hort.info.@ahdb.org.uk), quoting your AHDB Horticulture number, alternatively contact AHDB Horticulture at the address below.

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Project title:	**Pea Downy Mildew diversity in the UK**
Project number:	FV 436
Project leader:	Processors and Growers Research Organisation
Report:	Final report, March 2018
Previous report:	Annual report 2017
Key staff:	Dr L Herold, C Smith, M Seymour & R Howard, PGRO Dr C Domoney, C Moreau & M Ambrose, JIC
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Industry Representative:	Stephen Francis, Fen Peas Ltd, The Old Farm House, Church End, Old Leake, Boston, PE22 9HR
Date project commenced:	1st April 2014
Date project completed (or expected completion date):	31st March 2018

GROWER SUMMARY

Headline

At least 15 different pea downy mildew races exist in the UK currently. Five of these have been described for the first time in this project, whereas ten races had already been found during the 1980's (Taylor, 1986). Races 1, 3 and 10 seem to be slightly dominant across the UK over the last 30 years. The races collected in this project are stored in a culture collection at PGRO, currently holding 114 downy mildew isolates. Two pea germplasm accessions, JI 15 and JI 85, identified as carriers of resistance genes, have been used to generate crosses to dissect and understand the genetic basis of disease resistance and assist breeding. All downy mildew isolates were inoculated onto seedlings of JI 15 and JI 85 to test the durability of the resistance. The resistance of JI 15 was overcome both by individual races under growth room conditions and by natural populations in the field. Resistance of JI 85 was consistent in the majority of tests carried out.

A selection of vining and combining pea varieties were planted at several locations across the UK to identify regional differences of infection levels. Vining pea varieties show strong differences in infection levels depending on growing location whereas combining peas show more equal levels of infection.

Background

Pea downy mildew was first reported as a serious problem in pea crops in the UK in the 1960's, and yield losses between 45 and 80% are reported (Stegmark, 1994; Chang *et al.,* 2013). Downy mildew compromises the growth of the plants, and later spreads into the pods where it directly affects the quality of the developing seeds. Primary infection, which frequently results in plant death, is caused by soil borne oospores. Infected seedlings show grey mycelial growth on the underside of the leaves. Neighbouring and distant plants are infected by air borne spores. This is the secondary infection causing disease on flowering plants and pods. Infected plants have reduced photosynthetic area which can result in substantial yield reduction and poor produce quality.

Some control of primary downy mildew can be achieved through use of cultural practices and fungicidal seed treatments. The seed treatment Wakil XL (metalaxyl-M, fludioxonil and cymoxanil) is used to control primary infection of seedlings planted in areas where there is a history of disease. However, this does not control secondary or pod infection. A new directive, affecting growers in 2018, has restricted the use of Wakil XL to pea seeds planted between the 1st of April and the 29th of September. Peas sown early in February and March are therefore at greatest risk to the disease. There are currently no foliar-applied products to control downy mildew. Choice of variety can also reduce the risk of disease. Disease resistance exists in many combining pea varieties and ratings can be

found in the PGRO Pulse Recommended List tables (http://www.pgro.org/recommended-lists-2017/). However, there is less varietal disease resistance available in vining peas and ratings can be found in the PGRO Vining Pea Descriptive List tables (http://www.pgro.org/downloads/PGRO-GUIDE-2018-VINING-PEA.pdf).

To understand downy mildew race diversity in the UK, downy mildew isolates were collected in 2016 and 2017 and their races determined. Field trials were carried out to investigate if pea varieties showed differences in severity of downy mildew infection at different locations and if these differences can be related to the occurrence of downy mildew races.

Summary

During the 2016 and 2017 growing season, downy mildew isolates were collected from across the UK. The race of these isolates was determined (Table A). Races 1, 3, 10 and 11 were the most prominent overall. Five so far unknown, potentially new races have been identified. PGRO holds 114 of these races in a culture collection. The geographical distribution of the races is shown in Figure A. Most isolates are distributed widely across the UK but dominance of races varies by location.

Table A: Number of isolates of each downy mildew race and isolate collection location in 2016 and 2017. Races 1 to 11 had already been described in work carried out in the 1980's. Races Unk 1 to Unk 5 are so far unknown and potentially new races identified in this project.

Race	Number of isolates collected in 2016	Location	UK County	Number of isolates collected in 2017	Location	UK County	Total number of isolates
1	2	Stockbridge, Perth	Hampshire, Perth and Kinross	13	Alyth, Holbeach, Huggate, North Wootton(5), Sledmere, Stubton(3), Thorney	Perth and Kinross, Lincolnshire, Yorkshire, Norfolk, Cambridgeshire	15
2	0			2	Kilham, North Wootton	Yorkshire, Norfolk	2
3	8	Chatteris, Stockbridge, Howden (3), Perth, Sledmere, Kirton	Cambridgeshire, Hampshire, Yorkshire, Perth and Kinross, Lincolnshire	19	Alyth(3), Holbeach(2), Huggate, Kilham(2), North Wootton(2), Sledmere(2), Stubton(4), Thorney(2), Walcot	Perth and Kinross, Lincolnshire, Yorkshire, Norfolk, Cambridgeshire	27
4	1	Howden	Yorkshire	4	Chatteris, North Wootton, Stubton, Thorney	Cambridgeshire, Norfolk, Lincolnshire	5
5	2	Perth (2)	Perth and Kinross	4	Chatteris(2), Huggate, Thorney	Cambridgeshire, Yorkshire	6
6	1	Stockbridge	Hampshire	1	Huggate	Yorkshire	2
7	0			0			0
8	5	Howden (5)	Yorkshire	4	Chatteris, Sledmere, Stubton, Walcot	Cambridgeshire, Yorkshire, Lincolnshire	9
9	1	Stockbridge	Hampshire	6	Alyth(3), Ancaster, Kilham, Stubton	Perth and Kinross, Lincolnshire, Yorkshire	7
10	9	Chatteris (3), Stubton (2), Stockbridge, Sledmere, Kirton, Stratford apon Avon	Lincolnshire, Cambridgeshire, Hampshire, Yorkshire, Warwickshire	7	Alyth(3), Ancaster, Chatteris(2), Holbeach	Perth and Kinross, Lincolnshire, Cambridgeshire, Lincolnshire	16
11	6	Chatteris (2), Stubton (3), Sledmere	Cambridgeshire, Lincolnshire, Yorkshire	8	Alyth, Ancaster, Chatteris(2), Kilham, Nocton, Thorney(2)	Perth and Kinross, Lincolnshire, Cambridgeshire, Yorkshire	14

Unk 1	2	Chatteris (2)	Cambridgeshire	4	Holbeach, Huggate, Kilham, Stubton	Lincolnshire, Yorkshire	6
Unk 2	1	Stockbridge	Hampshire	5	Chatteris, Holbeach, Kilham, Stubton, Thorney	Cambridgeshire, Lincolnshire, Yorkshire	6
Unk 3	0			2	Alyth, North Wootton	Perth and Kinross, Norfolk	2
Unk 4	0			3	Kilham, Stubton, Thorney	Yorkshire, Lincolnshire, Cambridgeshire	3
Unk 5	0			1	Huggate	Yorkshire	1

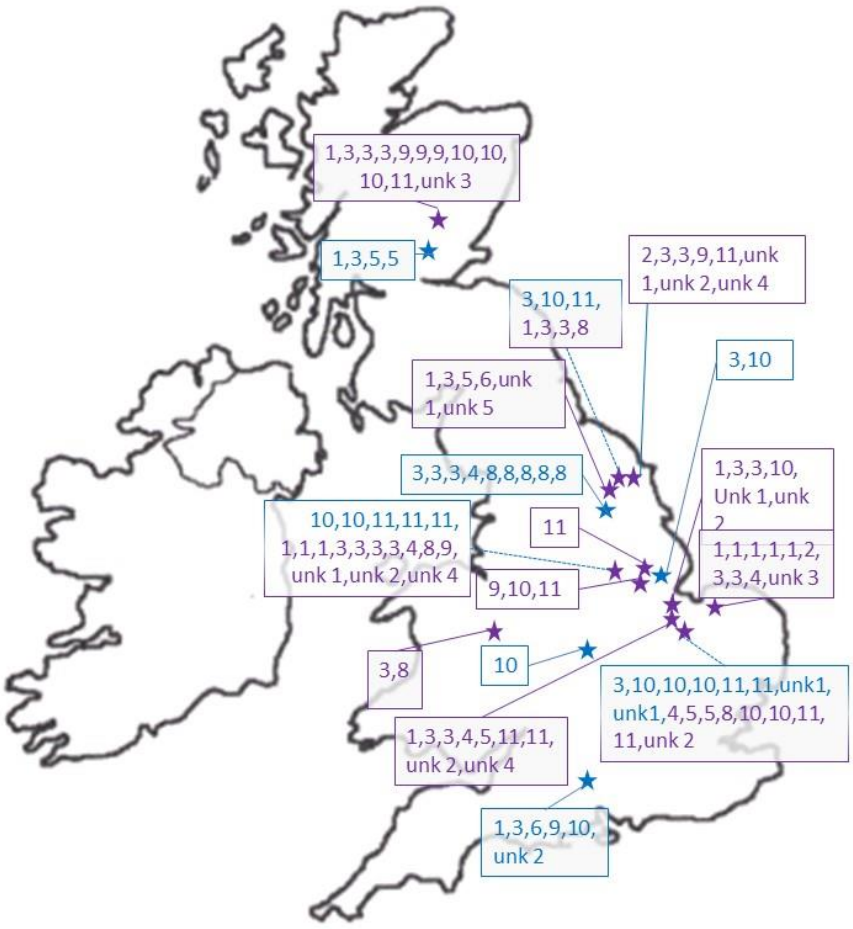

Figure A: Geographical distribution of the downy mildew races identified in 2016 and 2017. Boxes containing text in blue represent races collected in 2016 and boxes containing text in

purple represent races collected in 2017. Races Unk 1 to Unk 5 were previously unknown and potentially new races identified in this project.

Two pea germplasm accessions, JI 15 and JI 85, identified as carriers of resistance genes to pea downy mildew, have been used to create new crosses to support genetic studies of disease resistance and support future breeding. In addition, the isolates collected have been inoculated onto JI 15 and JI 85 seedlings to monitor their performance (Table B). The resistance of JI 15 was overcome both by individual races under growth room conditions and by natural downy mildew populations in the field. Resistance of JI 85 was also overcome but only by a few races and it generally maintained good field resistance.

Table B: Susceptibility of germplasm accessions JI 15 and JI 85 to downy mildew isolates in 2016 and 2017, together with isolate number, collection location, collection date, pea host variety, and race. s = susceptible, r = resistant.

Isolate	UK County	Location	Date Collected	Pea variety source	Race	JI 15	JI 85
I 130	Hampshire	Stockbridge	2016	Kingfisher	1	s	s
I 226	Lincolnshire	Holbeach, Koppert	2017	Wav 106	1	s	r
I 264	Norfolk	North Wootton	2017	?	1	s	r
I 277	Perth and Kinross	Alyth	2017	Maro	1	s	r
I 317	Yorkshire	Sledmere	2017	Maro	1	s	r
I 246	Cambridgeshire	Thorney	2017	?	3	s	r
I 222	Lincolnshire	Holbeach, Koppert	2017	Wav 106	3	s	r
I 231	Lincolnshire	Stubton	2017	?	3	s	r
I 164	Perth and Kinross	Perth	2016	JI 1272	3	s	r
I 303	Cambridgeshire	Chatteris	2017	Ida	5	s	r
I 328	Yorkshire	Huggate	2017	04555315N	5	s	r
I 202	Lincolnshire	Stubton	2017	06S55519A	8	s	r
I 127	Hampshire	Stockbridge	2016	Greenwood	9	s	r
I 115	Cambridgeshire	Chatteris	2016	JI 1272	10	s	r
I 185	Lincolnshire	Kirton	2016	Waverex	10	s	r
I 323	Lincolnshire	Ancaster	2017	Kingfisher	10	s	r
I 209	Lincolnshire	Nocton	2017	LG Element	11	s	r
I 223	Lincolnshire	Holbeach, Koppert	2017	Wav 106	13	s	r
I 241	Lincolnshire	Stubton	2017	?	13	s	r
I 337	Yorkshire	Kilham	2017	Celebration	13	s	r
I 129	Hampshire	Stockbridge	2016	Crackerjack	Unk 2	s	r
I 162	Perth and Kinross	Perth	2016	Avola	1	r	s
I 159	Perth and Kinross	Perth	2016	JI 560	5	r	s
I 174	Cambridgeshire	Chatteris	2016	JI 85	10	r	s
I 179	Cambridgeshire	Chatteris	2016	JI 85	11	r	s
I 176	Cambridgeshire	Chatteris	2016	JI 85	Unk 1	r	s

A selection of vining pea varieties was planted at six locations in 2016 and nine locations in 2017 and their infection levels monitored. Generally, Aloha, Anna, Ida and Maurice showed very low levels of infection regardless of location. In 2017, many vining pea varieties showed

greatest relative infection levels at Chatteris or Stubton but Waverex and 06S54009A showed greatest levels of infection at Holbeach and Alyth, respectively (Figure B). In common with Ida, 08S01030, Anna and 04S51315N, Maurice had average levels of infection below 2% across all sites. Avola had relatively high levels of infection at Stubton, Chatteris and Thorney (each being over 6.5%) but fared better at Alyth (0.42%) and North Wootton (1.19%) with hardly any infection at Holbeach (0.12%). Figure B provides an illustration of varietal performance at each site in 2016 and 2017, each pie chart representing a single variety and split to show % leaf area infection of that variety at each site. Figure B indicates that highest levels of infection were recorded at Chatteris, Thorney and Stubton.

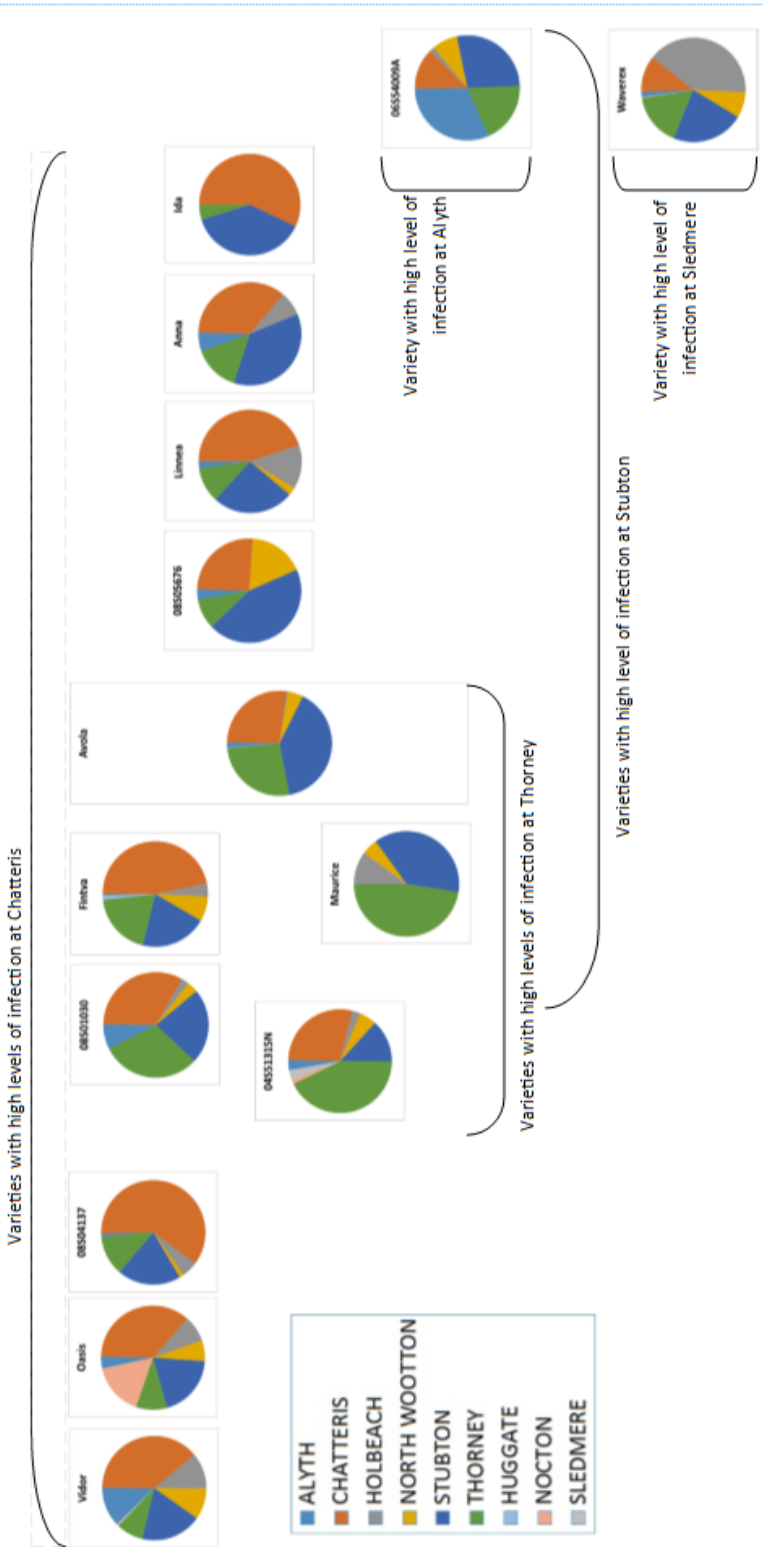

Figure B: Percentage of downy mildew for each variety at each site, illustrating varieties that performed better at each site in 2016 and 2017. Each pie chart represents a single variety and is split to show a comparison of % leaf area infection at each site as a proportion of the total infection at all sites.

Financial Benefits

Better management of downy mildew can reduce seedling losses caused by primary soil-borne infection and reduce secondary disease infection that is spread from primary inoculum sources. The use of varieties with tolerance to downy mildew will lower the risk of disease development and encourage improved yield and quality of produce. Increased yield and reduced factory losses due to improved quality will increase profits, and managing downy mildew using knowledge of varietal tolerance and field history does not increase cost. It is estimated that downy mildew causes yield loss of between 45 and 80% when high levels of infection occur between flowering and pod formation. The area of vining peas in 2017 was 33,500 hectares, producing 142,000 tons of frozen and canned peas (BGA, 2018). 44,000 hectares of combining peas were grown, producing 169,000 tons of harvested peas (EUROSTAT, 2018). The current farmgate value of vining peas is approximately £350 per ton and combining peas are currently around £180 per ton depending on end-use (Farmers Weekly, 2018). Total value of vining peas in 2017 was approximately £50M and the value of combining peas was approximately £30.5M. In years when infection by downy mildew is high, using the lower figure of 45% yield loss if disease occurs between flowering and pod formation, the estimated financial loss to growers could be £22.4M for vining peas and £13.7M for combining peas. The financial benefits to growers provided by the selection of the best performing varieties by region are therefore very high. The further financial benefit to processors by 1% improvement in factory throughput ensuing from the reduction of waste and quality loss, has been estimated to be 0.25 Euros per ton produced.

The JI germplasm lines that are carriers of resistance have been shared with breeding companies. The resistance of JI 15 has been overcome under field conditions and JI 15 will have to be combined with other lines that are carriers of resistance for durable resistance breeding. The downy mildew isolate collection at PGRO is used to screen new breeding lines to select promising candidates for resistance.

Action Points

- Select varieties with higher tolerance to downy mildew for your location to reduce disease impact (Tables 9 and 10).
- Contact PGRO to enquire about the performance of specific varieties in your area.
- Take field history into account and avoid planting peas early in fields with a known history of downy mildew.
- Maintain a rotation where peas are grown one year in five at most to avoid rapid build-up of soil-borne downy mildew.

- Treat seed that is to be planted after 1st April with Wakil XL seed treatment if varieties are susceptible to downy mildew.
- There are no effective foliar fungicides to control downy mildew in peas.

PGRO will repeat field trials across the UK and evaluate varietal performance, providing up-to-date information to growers and monitoring changes in race structure in the future.

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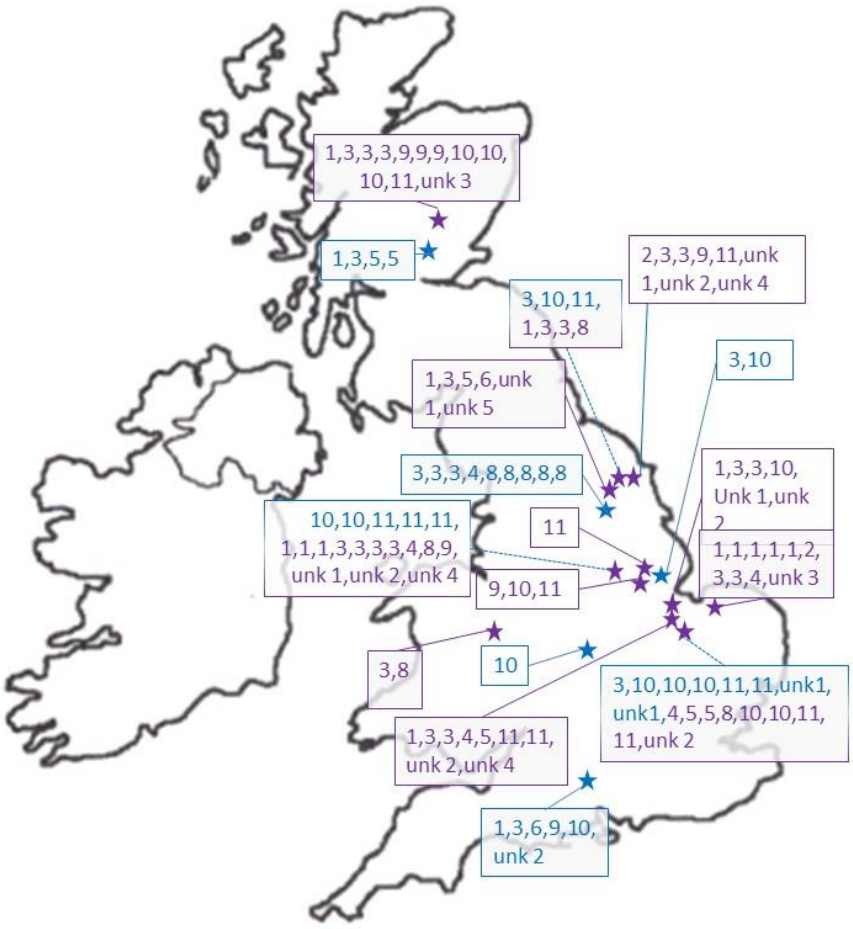

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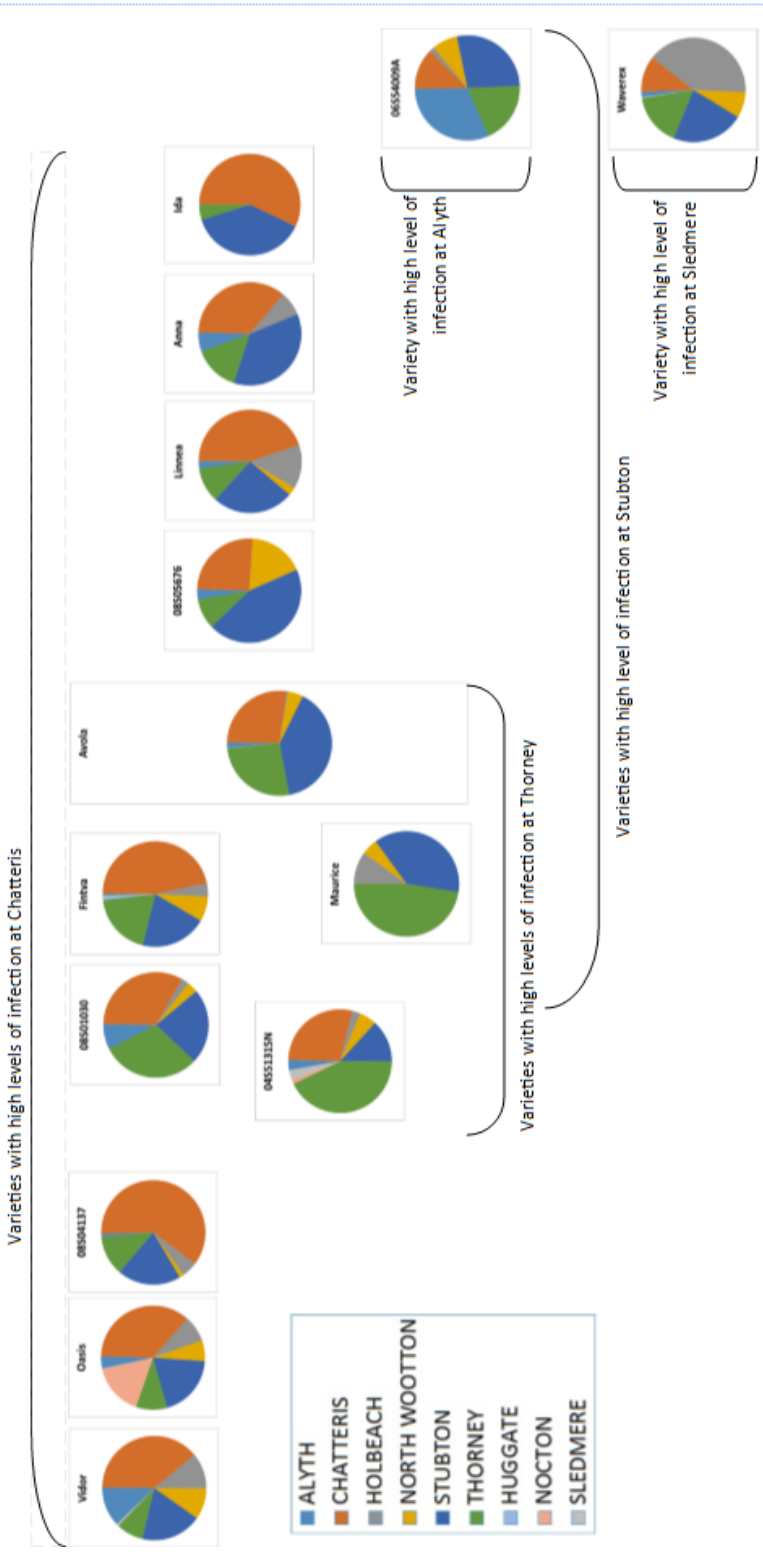

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- Maintain a rotation where peas are grown one year in five at most to avoid rapid build-up of soil-borne downy mildew.

- Treat seed that is to be planted after 1st April with Wakil XL seed treatment if varieties are susceptible to downy mildew.
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