Grower Summary

FV 436

Pea Downy Mildew diversity in the UK

Final 2017

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GROWER SUMMARY

Headline

In 2016, 42 downy mildew (DM) isolates were collected across the UK and their races determined. These 42 isolates belonged to thirteen different races, nine of which had been defined by work performed in the 1980's (Taylor, 1986). Races 10 and 11 were most frequent in 2016 and races varied at different locations. Twenty pea varieties were planted at six locations across the UK to investigate whether severity of disease symptoms varied with geographical location. Some pea varieties showed differences in DM infection in different locations. However, one year's data is not enough to define any relationship between race occurrence and disease severity.

Background

Pea DM, caused by *Peronospora viciae* f. sp. *pisi*, is a major disease of both vining and combining peas in the UK. Primary infection caused by soil borne oospores can kill plants, while secondary infections caused by airborne spores can reduce yield by up to 55% in the UK. Quality standards for vining peas are high and blemish due to disease infection is not accepted by processors. Downy mildew invades pods, reducing the quality and visual appearance of the produce. Primary infection, caused by soil-borne oospores, can be supressed by the use of the seed treatment Wakil XL (metalaxyl-M, fludioxonil and cymoxanil) but this has been restricted to peas drilled from the 1st of April and will not be available for pea drilled in February or March. Disease tolerance is present in some varieties, and DM race differentiation leads to variable levels of disease occurrence at different growing locations.

Primary infection of young seedlings can be reduced by growing peas in a rotation of one year in five. Vining peas are intensively grown in the east of the UK where processing factories are located. In order to maintain 150 minutes from field to frozen for high quality peas the pea growing area is restricted. This intensity of pea cropping has led to the build-up of soil-borne inoculum. Wakil XL is used when there is a high risk of DM, either from early sowing into poor soil conditions when weather is suitable for disease development, or where disease pressure is high. Crop rotation and seed treatment reduce the incidence of primary infection by soil-borne oospores but secondary infection from airborne spores cannot be controlled in this way. Descriptive and recommended lists are produced annually to indicate relative tolerance of current pea varieties to DM (PGRO Vining Pea Growers Guide and PGRO Pulse Agronomy Guide) and growers use the lists to influence their choice of variety and seed treatment. No single option to reduce the risk of the disease gives complete control of DM.

The UK DM population is made up of a number of genetically distinct races, shown by a study carried out in the 1980s, in which 11 UK races were identified (Taylor, 1986). No studies have been undertaken since then to establish dynamics and geographic spread of these races. In this project (FV 436), the current distribution of DM populations across the UK is being investigated. Differences in DM populations affect the susceptibility of individual pea varieties to the disease. This is due to differing interactions between the host variety and the pathogen race. In order to be able to recommend pea varieties with lower susceptibility to DM for specific regions of the UK, differences in pea varietal resistance to the different DM populations is also being studied.

Summary

In 2016, 42 DM isolates were obtained and their race determined (Table 1). These isolates were collected from eight different locations across the UK and from 21 different pea varieties. The 42 isolates comprised of thirteen different races, nine of which had been characterised by Taylor's study (for details refer to Table 4 the Science Section). Overall, comparison of project results and those obtained by Taylor appears to indicate that the occurrence of DM races has remained relatively similar over the last 30 years. For 2017 the aim is to collect isolates from the same locations as 2016 to determine whether the indication of race stability holds up.

All 42 isolates were also inoculated onto potential breeding lines JI 15 and JI 85 which are carriers of resistance genes as identified during the Pulse Crop Genetic Improvement Network (PCGIN) study. In total, six of the 42 isolates overcame the resistance of JI 15; one isolate each of race 1, 9 and an unknown race (unk 2) from Stockbridge, one isolate of race 3 from Perth, and two isolates of race 10 from Chatteris and Kirton. The resistance from JI 85 was also overcome by six isolates, all different except the race 1 isolate from Stockbridge (I 130), which also infected JI 15. The other five isolates were one race 1 and one race 5 from Perth, one isolate each of races 10 and 11 from Chatteris and one isolate of an unknown race (unk 1) from Chatteris.

Table 1. Forty two 2016 Downy Mildew isolates. Isolate number, collection location, collection date, pea host variety, race, performance on germplasm lines JI 15 and JI 85 and availability in PGRO's long term storage.

Isolate	Location	Grid reference	Collected	Pea variety	Race	JI 15	JI 85	Storage
I 85	Donington	PE11 4TR (PC)	collected in 2015	?	10	r	r	no
I 94	Romney Marsh	TN28 8TS (PC)	collected in 2015	Kelvedon Wonder	10	r	r	yes
I 100	West Ashby	LN9 5PT (PC)	collected in 2015	Span	5	r	r	yes
I 107	Chatteris	TL422887	20/05/2016	?	3	r	r	yes
I 112	Chatteris	TL422887	31/05/2016	JI 758	11	r	r	no
I 113	Chatteris	TL422887	31/05/2016	Prophet	Unk 1	r	r	no
I 115	Chatteris	TL422887	31/05/2016	JI 1272	10	s	r	no
I 117	Stubton	SK884910	31/05/2016	Sakura	11	r	r	no
I 118	Stubton	SK884910	31/05/2016	Tomahawk	10	r	r	no
I 119	Stubton	SK884910	31/05/2016	Mascara	11	r	r	no
I 120	Stubton	SK884910	31/05/2016	Crackerjack	10	r	r	yes
I 123	Stubton	SK884910	31/05/2016	Maro	11	r	r	no
I 127	Stockbridge	SU335358	03/06/2016	Greenwood	9	s	r	yes
I 128	Stockbridge	SU335358	03/06/2016	Sakura	6	r	r	yes
I 129	Stockbridge	SU335358	03/06/2016	Crackerjack	Unk 2	s	r	yes
I 130	Stockbridge	SU335358	03/06/2016	Kingfisher	1	s	s	yes
I 139	Stockbridge	SU335358	03/06/2016	Prophet	10	r	r	no
I 140	Stockbridge	SU335358	03/06/2016	Mascara	3	r	r	yes
I 146	Howden	SE737265	30/06/2016	Tomahawk	8	r	r	yes
I 147	Howden	SE737265	30/06/2016	JI 1272	8	r	r	yes
I 148	Howden	SE737265	30/06/2016	Maro	3	r	r	yes
I 149	Howden	SE737265	30/06/2016	Gregor	8	r	r	yes
I 150	Howden	SE737265	30/06/2016	Sakura	3	r	r	yes
I 151	Howden	SE737265	30/06/2016	Oasis	8	r	r	yes
I 152	Howden	SE737265	30/06/2016	Avola	4	r	r	yes
I 153	Howden	SE737265	30/06/2016	JI 560	8	r	r	yes
I 156	Howden	SE737265	30/06/2016	JI 411	3	r	r	yes
I 159	Perth	NO061209	30/06/2016	JI 560	5	r	s	yes
I 162	Perth	NO061209	30/06/2016	Avola	1	r	s	no
I 163	Perth	NO061209	30/06/2016	Waverex	5	r	r	yes
I 164	Perth	NO061209	30/06/2016	JI 1272	3	s	r	no
I 170	Sledmere	SE929680	07/07/2016	Amalfi	10	r	r	yes
I 171	Sledmere	SE929680	07/07/2016	Amalfi	3	r	r	yes
I 172	Sledmere	SE929680	07/07/2016	Amalfi	11	r	r	yes
I 174	Chatteris	TL422887	08/07/2016	JI 85	10	r	s	yes
I 176	Chatteris	TL422887	08/07/2016	JI 85	Unk 1	r	s	yes
I 178	Chatteris	TL422887	08/07/2016	JI 85	10	r	r	yes
I 179	Chatteris	TL422887	08/07/2016	JI 85	11	r	s	yes
I 184	Kirton	TF316371	12/07/2016	Waverex	3	r	r	yes
I 185	Kirton	TF316371	12/07/2016	Waverex	10	s	r	yes
I 188	Stratford upon Avon	SP167522	20/07/2016	Legacy	10	r	r	yes
I 189	Mixture				3	r	r	yes

PC = post code; r = resistant; s = susceptible

The geographical distribution of the different races is shown in Figure 1. DM isolates were collected from a total of eleven sites, ten in England and one in Scotland. Races 3, 10 and 11 occurred in several locations in the UK whereas races 6 and 9 were only found in Stockbridge, Hampshire and race 8 was only found in Howden, Yorkshire. Results of geographical distribution are based on one year of data only and more data are needed to draw conclusions distribution patterns. In 2017, more isolates will be collected from both new locations and locations already studied in 2016.

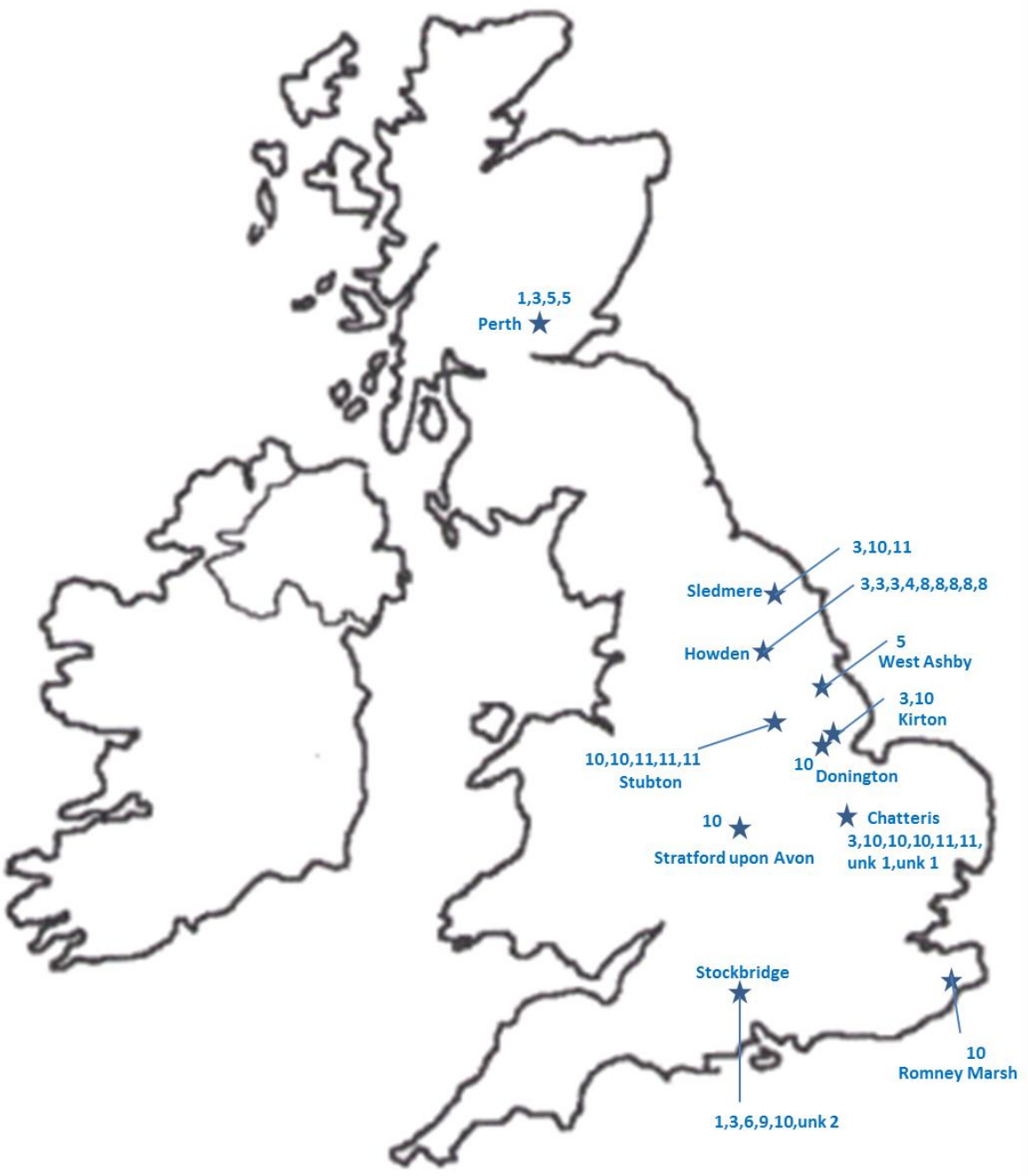

Figure 1. Distribution and race of 42 DM isolates in 2016.

Field trials to evaluate infection levels of different pea varieties in six different locations across the UK were established in 2016 (Table 2). A total of 20 combining pea varieties, vining pea varieties and research pea lines were planted at each location, with three replicates (Table 3). The research lines were four differential pea lines (JI 411, JI 560, JI 758, JI 1272) and two germplasm lines (JI 15, JI 85) which are carriers of resistance genes. Fifty seeds were sown, per variety and replicate. Leaf infections were scored as percentage of plants with percentage leaf infection; pod infection was measured as percentage of pods infected over all 50 plants per variety.

Table 2. Locations of the six DM field trials in 2016

Field site	Grid ref	County
Chatteris	TL422887	Cambridgeshire
Howden	SE737265	Yorkshire
Nocton	TF036638	Lincolnshire
Perth	NO061209	Perthshire
St Germans	TF611128	Norfolk
Stubton	SK884910	Lincolnshire

Table 3. Pea varieties grown at the six field sites in 2016

Variety	Type
Aikido	Marrowfat (combining)
Aloha	Vining pea
Avola	Vining pea
Crackerjack	Large Blue (combining)
Gregor	White Pea (combining)
JI 1272	DM race differential
JI 15	Germplasm (resistance gene carrier)
JI 411	DM race differential
JI 560	DM race differential
JI 758	DM race differential
JI 85	Germplasm (resistance gene carrier)
Mantara	Maple Pea (combining)
Maro	Combining Pea
Mascara	White Pea (combining)
Maurice	Vining pea
Oasis	Vining pea
Prophet	Large Blue (combining)
Sakura	Marrowfat (combining)
Tomahawk	Vining pea
Waverex	Petis pois

Table 4 shows an overview of results obtained in 2016. In three of the locations, St Germans, Perth and Nocton, only low levels of DM infection occurred. The other three locations, Chatteris, Howden and Stubton, showed higher levels of DM infection.

Table 4. Mean percentage leaf infection and pod infection of 20 pea varieties grown at six different locations.

	Chatteris	Howden	Nocton	Perth	St Germans	Stubton
Variety	**% leaf infection**					
Aikido	1.17	2.22	0.13	0.00	0.00	0.00
Aloha	0.00	0.03	0.04	0.00	0.00	0.00
Avola	4.17	15.33	1.75	0.33	0.02	3.50
Crackerjack	1.58	1.57	0.08	0.00	0.00	2.18
Gregor	4.89	1.59	0.38	0.00	0.00	1.25
JI 1272	8.03	4.38	0.14	0.01	0.00	3.62
JI 15	0.96	0.37	0.00	0.00	0.00	0.23
JI 411	1.03	0.71	0.21	0.00	0.00	0.00
JI 560	1.88	5.75	1.68	0.00	0.00	5.00
JI 758	1.31	3.72	0.25	0.00	0.00	1.85
JI 85	0.01	0.38	0.00	0.00	0.00	0.00
Mantara	1.75	0.18	0.00	0.00	0.00	0.00
Maro	5.83	9.58	0.17	0.01	0.00	3.52
Mascara	6.25	0.20	0.08	0.00	0.00	0.02
Maurice	0.00	0.17	0.00	0.00	0.00	0.00
Oasis	4.25	4.10	0.00	0.00	0.33	1.65
Prophet	4.60	0.35	0.00	0.00	0.00	0.04
Sakura	3.62	6.90	0.00	0.00	0.00	0.43
Tomahawk	4.10	5.73	0.31	0.00	0.00	0.96
Waverex	4.12	1.75	0.00	0.00	0.00	0.17
Variety	**% pod infection**					
Aikido	1.00	0.00	NA	NA	7.33	0.00
Aloha	1.00	1.67	NA	NA	7.33	0.00
Avola	71.67	15.00	NA	NA	91.67	1.67
Crackerjack	6.00	0.00	NA	NA	2.33	1.33
Gregor	13.00	0.00	NA	NA	3.00	0.00
JI 1272	5.33	0.00	NA	NA	8.00	4.00
JI 15	8.33	0.67	NA	NA	0.00	0.00
JI 411	11.33	0.33	NA	NA	11.67	5.00
JI 560	4.33	0.00	NA	NA	2.33	3.33
JI 758	4.33	0.00	NA	NA	0.00	1.67
JI 85	4.00	1.67	NA	NA	0.00	1.33
Mantara	2.67	0.00	NA	NA	0.33	0.00
Maro	7.33	0.00	NA	NA	4.00	2.33
Mascara	0.33	0.00	NA	NA	0.00	0.00
Maurice	1.33	0.00	NA	NA	1.67	0.00
Oasis	45.00	1.67	NA	NA	22.33	15.00
Prophet	8.67	0.00	NA	NA	1.33	1.67
Sakura	5.33	0.00	NA	NA	7.33	3.33
Tomahawk	46.00	10.00	NA	NA	31.67	0.67
Waverex	53.33	0.00	NA	NA	8.33	6.67

Infection severity was assessed for each individual location and split into three categories - bottom, middle and upper third. Range of percentage infection for each category (both leaves and pod) depends on the location. Green = bottom third; Yellow = middle third; red = upper third. No colour = free from infection. NA = not assessed

During 2016, variety performance, location and DM population showed some potential relationships but more data will be needed to verify any trends. For example, varieties Maro and JI 1272 showed high infection levels at Chatteris and Stubton sites, where races 10 and 11 were dominant. Mascara, on the other hand, was severely infected in Chatteris but not in Stubton, and JI 560 in Stubton but not in Chatteris. This might indicate that other races than race 10 and 11 played a role in overall infection at these field sites. Four varieties, Aikido, Aloha, Mantara and Maurice only had very low levels of infection in all locations and might prove to be varieties of choice in fields with a history of DM. The overall goal would be to identify pea varieties that can show resistance to the majority of DM races making them less susceptible to changes in DM populations. Noticeable were the levels of pod infection in some varieties, which were relatively high even though leaf infection had been low. This is of importance, in particular, for the two potential breeding lines JI 15 and JI 85 both of which had relatively high pod infection levels in Chatteris and Howden although leaf infection had been low. Pod quality is of greatest importance in the vining pea industry because only unblemished pods contain high quality peas. If JI 15 and JI 85 are generally prone to pod infection under field conditions, their usefulness in resistance breeding might be reduced.

Financial Benefits

None at the moment. One year of data is insufficient for advice on which pea varieties would perform best in specific locations in the UK. More data are needed about downy mildew populations across the UK.

Action Points

Until more results from this project become available, please refer to the PGRO Vining Pea Grower Guide and the PGRO Pulse Agronomy Guide for information about resistance of different pea varieties to downy mildew.