Final Project Summary

Project title	Evaluation of resistance levels to verticillium wilt in UK oilseed rape varieties, and relevance to productivity		
Project number	2140002105	**Final Project Report**	PR605
Start date	01/06/15	**End date**	30/11/18
AHDB Cereals & Oilseeds funding	£117,400	**Total cost**	£117,400

What was the challenge/demand for the work?

Verticillium wilt of oilseed rape, now termed verticillium stem stripe, was first identified in the UK in 2007. Since then, incidence has increased. Survey reports show that up to a quarter of crops have been affected nationally. Currently, there are no specific agrochemical control options. The pathogen, *Verticillium longisporum*, produces numerous microsclerotia, which persist in the soil for 10–15 years. Extending rotations may help to reduce risk, but the value of this is limited by the length of time required between rape crops to reduce disease pressure. Therefore, exploiting variety resistance is the most practical way to reduce the impact of the disease. Initial observations, from a range of projects, have indicated that significant differences in symptom severity exist between varieties. However, at present, there is no mechanism for the formal production of resistance rankings in the AHDB Recommended List (RL). Additionally, while differences in resistance to verticillium may exist, the actually benefit of higher resistance is unclear.

This project developed approaches for the routine production of RL resistance ratings. It also looked to understand the impact of verticillium stem stripe on productivity and how varietal resistance could help mitigate losses to the disease.

How did the project address this?

Resistance to verticillium was assessed by two approaches. Firstly, in each of the three project years, recommended and candidate varieties on the RL were planted at either sites associated with high levels of the disease or at sites where the disease was introduced through the application of microsclerotia on a maizemeal and vermiculite carrier.

Six resistance screening tests were established and assessed. Varieties were scored using a standardised scale that described the extent of verticillium symptoms around the circumference of stems and converted to a disease index on a 0–100 scale. Stem disease assessments were carried out in late June and early-to-mid July. At the same time, pod senescence was also assessed to determine whether this was a reliable proxy for the more labour intensive stem assessment. To understand impacts of verticillium on yield, four experiments over two years were established using six

varieties. Based on the first-year results, three highly susceptible and three more resistant varieties were included in a split-plot experimental design. The main plots were inoculated with verticillim microsclerotia to create differential disease pressure on the varieties.

What outputs has the project delivered?

The resistance screening tests confirmed that there were significant and reproducible differences between varieties. Varieties thought to be more resistant (Incentive and Catana) or more susceptible (Quartz and Harper) from previous observations behaved as expected in all tests. The wider sets of varieties from the RL also behaved consistently, from site to site and year to year (see Figures 1 and 2 respectively).

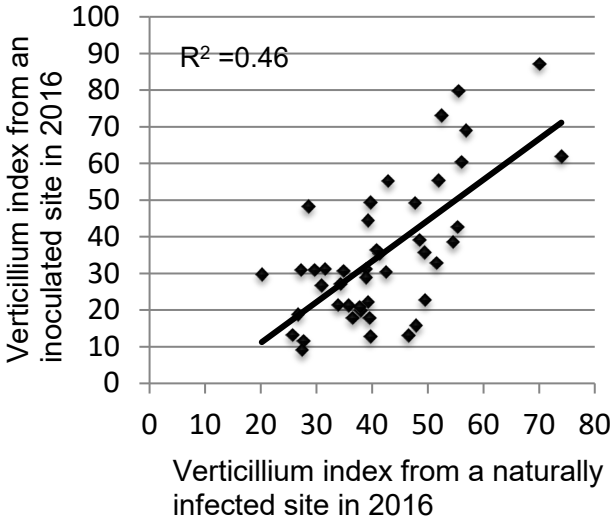

Figure 1. Relationship between verticillium indices on 44 oilseed rape varieties at two sites in July 2016.

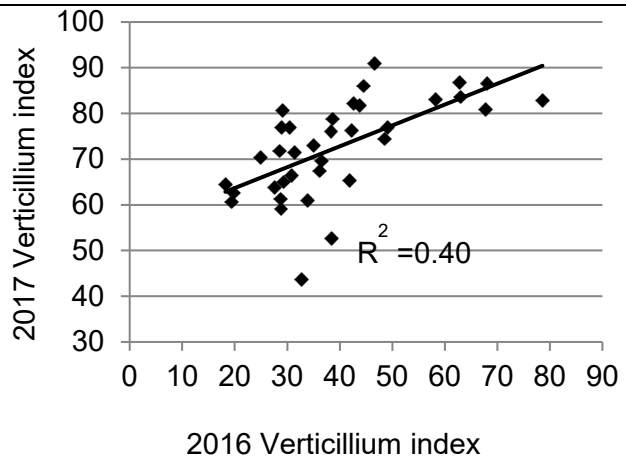

Figure 2. Relationship between verticillium indices between years (2016 and 2017) on 36 oilseed rape varieties.

A standard disease scoring method was devised, suitable for routine use in future testing. A successful inoculation method, which guarantees uniform disease pressure, was developed that would be suitable for use in RL trials. However, fields where uniform infection was already present from previously affected crops were also found to be equally effective. There was a strong positive relationship between mean scores from inoculated and natural infection sites for varieties included in all three years of testing (Figure 3).

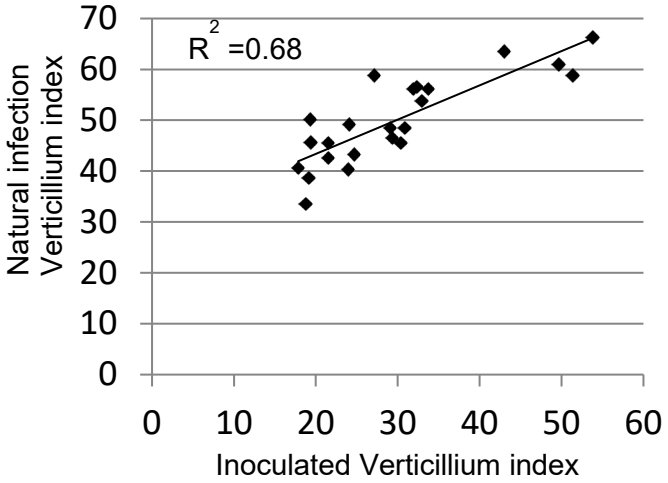

Figure 3. Relationship between mean verticillium indices from three natural and three inoculated tests on 22 oilseed rape varieties.

Final Project Summary

Pod senescence scores showed a near-perfect linear relationship with stem scores in two out of three trials (where assessment was possible) and provides a useful method for future RL protocols.

An over-trial analysis of all the varieties included in the test series showed a maximum mean verticillium index of 60.0 and a minimum of 26.2. Data were converted to draft 1 to 9 ratings, which showed a range from 7.6 (most resistant) to 2.1 (very susceptible). None of the varieties tested was completely resistant. LSD (P<0.05) between ratings was 2.1. Inoculation created differential disease levels in two of the four yield trials. In one trial, there was some disease development in the non-inoculated plots. Here there was a small and non-significant reduction in yield in more susceptible varieties. In the second trial, there was very little disease development in non-inoculated plots, but high levels on the susceptible varieties in inoculated plots. Yield depression here was significant, and two of the susceptible varieties showed the largest yield loss, while more resistant ones did not show any significant yield depression (Table 1). It was notable that DK Extrovert was susceptible, as predicted from initial variety screens, but showed a small and non-significant yield loss, indicating that it may possess true tolerance to verticillium, and that other susceptible varieties may be very sensitive to infection.

Table 1. Verticillium indices and yield loss on six varieties in inoculated (plus) and non-inoculated (minus) blocks, yield trials for harvest 2017 and 2018.

Variety	Disease index 2017 Inoculum level		Yield loss 2017 t/ha	Disease index 2018 Inoculum level		Yield loss 2018 t/ha
	Plus	Minus		Plus	Minus	
SY Harnas	38.8	21.3	-0.12	12.3	1.0	0.14
Incentive	17.5	17.5	0.13	5.3	2.7	0.12
Catana	26.2	17.5	-0.14	2.3	1.7	-0.11
PT 234	67.5	31.3	0.26	47.4	3.5	0.69*
DK Extrovert	62.5	13.8	-0.05	36.9	1.8	0.22
Harper	66.3	12.5	0.43	54.2	2.8	0.45*

*denotes significant yield loss, LSD P<0.05 = 0.421

Final Project Summary

Who will benefit from this project and why?
Information on resistance will help growers select more appropriate varieties for deployment in higher-risk fields. In fields with incipient infection, the use of more resistant varieties would help to reduce the return of microsclerotia to the soil. Yield experiments showed that significant losses due to verticillium stem stripe occur on susceptible varieties in the UK. Plant breeders will also benefit through knowledge of more resistant varieties, which could be used as parents in breeding programmes.

If the challenge has not been specifically met, state why and how this could be overcome
It was not possible to create differential disease severity in all four yield trials, and any further tests would need to take place on land where there was no initial detectable verticillium level. There was an indication that one variety exhibited true tolerance, and further investigation of a wider range of varieties and their sensitivity to verticillium infection is desirable.

Lead partner	Dr J E Thomas, NIAB, Huntingdon Road, Cambridge CB3 0LE
Scientific partners	Dr F Ritchie ADAS, Battlegate Road, Boxworth, Cambridge CB23 4NN, UK
Industry partners	Saaten Union, LS Plant Breeders, DSV, KWS, Elsoms, Bayer Crop Science, Grainseed and BSPB
Breeders who supplied seed for the project	Bayer, DEKALB, Monsanto UK Ltd, DSV, Dupont-Pioneer, Elsoms Seeds, KWS, Limagrain, LS Plant Breeding, RAGT Seeds, Senova, Syngenta, DLF Seeds