Final Project Summary

Control of Turnip yellows virus: Assessing impact on oilseed rape quality traits and dissecting circulative transmission by aphids

Project number	RD-2008-3516	**Student Project Report**	SR26
Start date	1/10/09	**End date**	30/09/13
HGCA funding	£16,000	**Total cost**	£90,809

What was the challenge/demand for the work?

TuYV is a major disease of oilseed rape which can decrease rapeseed yield by up to 26%. Additionally, it may affect a variety of other factors relating to quality of the crop, such as the composition of fatty acids or glucosinolates present in rapeseed oil, but this has not been tested. Like the majority of plant viruses, TuYV is transmitted by insect vectors. Aphids transmit TuYV and the green peach aphid (*Myzus persicae*) is the predominant vector. Pesticide treatments are the principal means of controlling aphids, and therefore the viruses they transmit. However, these treatments are becoming less effective with resistance against these chemicals developing in key pest species. Furthermore, EU regulations are leading to an increasing number of chemical treatments becoming restricted or withdrawn from use, such as neonicotinoid-based pesticides, the predominant component of oilseed rape seed treatments. Without these aphid control measures, the incidence of TuYV is likely to increase in future. This makes this work topical and of great importance to UK oilseed rape growers and breeders. Additionally, it is not fully understood how aphids transmit viruses and tools to investigate aphid gene function are under-developed. There is a need to develop more robust tools for studying insect gene function and these may be ultimately applied to dissect the transmission process by aphids. Increased understanding of virus transmission by aphids will improve TuYV control measures and potentially lead to novel means of controlling aphids and viruses in agriculture.

How did the project address this?

One of the aims of this work was to evaluate the resistance status of UK commercial varieties and to assess the impact of TuYV on seed quality traits. To achieve this, a collaboration was established with Dr. Mark Stevens (Broom's Barn research centre, Suffolk, UK). Field trials were done using winter oilseed rape varieties from the HGCA Recommended List. The impact of TuYV on yield and the accumulation of virus for each variety were assessed. Seed from these varieties were also assessed for a variety of seed characteristics including seed weight, total oil content, fatty acid profile and glucosinolate content after TuYV infection.

Another aim of this research was to develop methods for studying virus transmission by aphids. To accomplish this, the plant-mediated RNA interference (PMRi) tool was developed for the green peach aphid. PMRi has the potential to determine the function of genes potentially involved in virus transmission by aphids and therefore improve fundamental understanding of these processes. This procedure is achieved in aphids by feeding the insects on transgenic plants.

What outputs has the project delivered?

This project confirms that TuYV can reduce overall oilseed rape yield and also demonstrates that TuYV may have subtle but observable changes on rapeseed quality traits. There was a general trend towards decreased oil content in TuYV-infected varieties, and certain varieties had altered fatty acid and/or glucosinolate content in seed. No complete resistance to TuYV was discovered in the commercial varieties examined, however, some varieties are more susceptible to virus-induced changes to yield and seed characteristics. Virus impact is not dependent on virus accumulation in the plant indicating that each variety should be assessed separately (Coleman *et al.*, 2014, in preparation).

The PMRi tool has been successfully developed for aphids (Pitino and Coleman *et al.*, 2011, PLoS ONE e25709). This technique was achieved in two model plant systems and demonstrates successful down-regulation of two aphid target genes expressed in different aphid tissues. This is the first example of PMRi in aphids and may have a variety of applications, including investigation of aphid genes potentially involved in TuYV transmission.

I have been involved in several knowledge transfer activities with a variety of audiences. I have presented my work at the HGCA student symposia as well as Oilseed RapE Genetic Improvement Network (OREGIN) meetings, Royal Entomology Society meetings and UK Brassica Research Community meetings (UK-BRC). I have also presented my work internationally at the International Congress for Molecular Plant Microbe Interactions in Kyoto, Japan. I have also engaged in teaching primary and secondary pupils about plant pathology, entomology and crop protection.

Who will benefit from this project and why?

Greater understanding of TuYV impact on yield and seed quality will be of use to farmers and breeders to cope with the imminent restrictions on key pesticides. The resistance status of the UK oilseed rape crop has been evaluated. This information can be used directly to grow varieties which are more tolerant to TuYV.

The PMRi technique will be of great use to functional genomics studies in aphids and other similar insects. This can be used to improve understanding of how aphids transmit viruses, how they subvert host plant defences, or develop resistance to pesticides amongst other potential applications. Should attitudes towards GM become more moderate in the future then this work will directly lead into PMRi-based insect control approaches. PMRi-based strategies are gaining traction under companies such as Monsanto in the US, but may take significantly longer in Europe.

If the challenge has not been specifically met, state why and how this could be overcome

How have you benefited from this studentship?

I have benefited immensely from this studentship. I have learnt a variety of skills, a high degree of specialist knowledge, and have developed the ability to communicate my research to a variety of

audiences. I now have strong experience in crop pathology, entomology, molecular biology, and agricultural science. This studentship has provided links between industry and academia, offering a wider application of the research. My future career plans are to work in the agricultural sector in crop protection and improvement. I aim to gain further plant pathology experience with a postdoctoral position abroad before moving back to the UK.

Lead partner	John Innes Centre, Norfolk, UK
Scientific partners	Broom's Barn Research Centre, Suffolk, UK
Industry partners	Home Grown Cereals Authority (HGCA), Velcourt
Government sponsor	Biotechnology and biological sciences research council (BBSRC)