Institution: Keele University

Unit of Assessment: A5 (Biological Sciences)

Title of case study: Enhanced environmentally benign thrips monitoring and control

1. Summary of the impact

The impact of this work is that commercial growers of protected fruit, flower and vegetable crops around the world now have a tool to help them to detect the presence of Western Flower Thrips (WFT) in their crops, earlier and at lower numbers than they are currently able to. Growers can also enhance their existing control measures. WFT are insects that cause serious economic loss to growers because of feeding damage and virus transmission. By taking earlier and more effective action against WFT they can reduce plant damage, insecticide use and consequent financial loss.

2. Underpinning research

Gordon Hamilton and **William Kirk** (Life Sciences, Keele University) have spent the last 13 years conducting research on the chemical ecology of thrips, which are agricultural and horticultural insect pests that cause significant crop losses through direct feeding and transmission of plant viruses in protected, semi protected and open-field crops globally. In Europe the combined loss from virus transmission and direct feeding damage is estimated to be €675 million. The worldwide annual economic loss just from the viruses they spread is over €700 million per year and the worldwide direct damage is likely to be 10 to 100 times higher. Between 1997 and 2007 the group's research focussed on understanding the role of pheromones in mediating male and female attraction in Western Flower Thrips (WFT), which is a serious global threat to horticulture. Behavioural work demonstrated for the first time that male WFTs produce a volatile chemical that is attractive to both females and males. This contrasts with the situation in many insects, particularly Lepidopteran pests, in which the females produce chemicals that are attractive to only males. The research group at Keele demonstrated the presence of the pheromone using behavioural experiments in the laboratory. The pheromone was then characterised by chemical analysis and finally the structure was confirmed by synthesising the compound and comparing the response to the synthetic compound in the field and laboratory with the response to the authentic compound from the insect. The group then trialled an appropriate release technology that was compatible with current industry monitoring approaches. A UK patent filing gave an initial priority date of 21st December 2001 and patents have been granted in eight EU countries as well as the USA, Canada, Morocco and Israel. The group at Keele is engaging with other industrial partners to develop new approaches to utilise the existing technology in new ways and develop new technology to address the problem of damage caused by other species of thrips on a wide range of protected and open-field crops.

3. References to the research

Kirk WDJ and Hamilton JGC (2004). Evidence for a male-produced sex pheromone in the Western Flower Thrips *Frankliniella occidentalis*. *J Chem Ecol* 30: 167-174.

Hamilton JGC, Hall DR and Kirk WDJ (2005). Identification of a male-produced aggregation pheromone in the western flower thrips *Frankliniella occidentalis J Chem Ecol* 31: 1369-1379.

Dublon IAN, Hamilton JGC and Kirk WDJ (2007). Development of a laboratory bioassay to test flight responses to semiochemicals in the western flower thrips, *Frankliniella occidentalis. J Insect Sci* 7: 10-11.

Kirk WDJ (2007). The chemical language of thrips. *J Insect Sci* 7: 17.

Dublon IAN, Hamilton JGC and Kirk WDJ (2008). Quantification of the release rate of the aggregation pheromone of the Western Flower Thrips, *Frankliniella occidentalis* (Pergande), using solid–phase microextraction (SPME). *Acta Phytopathol Entomol Hung* 43: 249–256.

Kirk WDJ (2009). El uso de feromonas para el control de trips. *Phytoma* 213: 24.

Sampson C, Hamilton JGC and Kirk WDJ (2012). The effect of trap colour and aggregation pheromone on trap catch of *Frankliniella occidentalis* and associated predators in protected pepper in Spain. pp. 313-318. in IOBC-WPRS Integrated control in protected crops – Mediterranean Climate, October 9th – 12th, 2012, Italy.

Sampson, C and Kirk WDJ Can mass trapping reduce thrips damage and is it economically viable? Management of the western flower thrips in strawberry. *PLoS One* (*in press*).

Key Grants

Peer-reviewed at application stage by either academic or commercial (*) reviewers.

2012 EU FP7 IRSES. Europe Australasian Thrips Semiochemical (EATS) Network. €58,800.
2011 DEFRA/FERA. The integrated control of *Thrips palmi*. £20,000.
2010 DEFRA HortLINK. Biological, semiochemical and selective chemical management methods for insecticide resistant western flower thrips on strawberry. £874,720.
2010 EU FP7 Marie Curie. Pheromone Identification for Environmentally Responsible Control of Thrips. €196,000.
2007 Innovation Keele. Insect Control – *Thrips palmi*. Commercial Peer Review. £11,000.
2006 DEFRA. A modular approach to the integrated control of *Thrips palmi* Karny. £15,000.
2003 Syngenta Bioline Ltd. *Chemical ecology of the western flower thrips (3). £2,500.
2002 Syngenta Bioline Ltd. *Testing analogues of compound Y for increased activity. £6,000.
2002 Syngenta Bioline Ltd. *Field Feasibility Study. £20,090.
2002 Insect control products. Spinner, a consortium of West Midlands Universities, £7,200.
2002 Insect control products. Spinner, a consortium of West Midlands Universities, £5,400.

4. Details of the impact

Commercial Impact:

This work at Keele University attracted the attention of a UK-based global crop protection company (Syngenta Bioline Ltd. part of Syngenta AG) who were interested in the potential of the technology to enhance environmentally benign Insect Pest Management (IPM) approaches to crop protection that minimise pesticide use and have minimal effect on beneficial insects. In particular they were interested in using the pheromone to enhance conventional monitoring of WFT in crops to allow earlier intervention so that growers could apply pesticides only when thrips are present. In addition to economic benefits this approach is of particular importance because of the increasing resistance to conventional pesticides in this group of crop pests. Environmentally damaging pesticides have been removed from sale in the EU and there is increasing consumer demand for produce that is deemed insecticide-free at the point of consumption. Syngenta Bioline Ltd. funded several projects to characterise the active compound and conduct field trials in protected sweet pepper crops in Spain to confirm its identity and evaluate approaches for its effective use.

Keele University signed a technology licence for the commercial exploitation of the pheromone in 2004 and this was followed by an amendment in 2008. Syngenta Bioline Ltd. have included the technology as part of their product portfolio to UK and International growers as two products; Thripline$_{ams}$® (product codes 8061-01 and 8061-02). The commercial products allow Syngenta Bioline Ltd. to offer an enhanced monitoring service to growers giving earlier warning of potential
thrips damage and thus the possibility of earlier, more effective and less costly intervention.

Syngenta have sublicensed distribution and sales of their products mainly in overseas markets including in the protected horticultural crop industry in Spain, France and Morocco. Here, the products target particularly aubergine, cucumber, melon, pepper, blueberry, raspberry, strawberry, tomato, cut flowers and ornamental pot plants. Sub-licensees include Fargro Ltd (UK), Biobest Belgium N.V. (marketed as ThriPher - mainland Europe), Anthesis Ltd (Greece, Turkey), Waldo and Associates Inc (USA) and Brinkman International BV (UK, mainland Europe). Syngenta Bioline Ltd. invested in research to characterise the WFT pheromone (2001) and evaluate its commercial potential (2002). They remain an active partner in the development of new approaches for the use of the WFT pheromone and in the identification and commercialisation of pheromones of other economically important thrips species. The research group (**Hamilton** and **Kirk**) have carried out academic consultancies as part of DEFRA/FERA (2011, 2006) funded projects for the Central Science Laboratory (CSL, York). As the pheromone is sold as part of a pest control or monitoring package and because of commercial sensitivity, detailed analysis of the commercial impact of the pheromone is not available. However taking into account variability in the type of crop, severity of thrips infestation and the equipment used in application of the pheromone, Syngenta Bioline Ltd. tell us that use of the pheromone can reduce growers costs by more than 30% through reduction in pesticide usage, reduced labour costs, more accurate timing of insecticide application and increased cropping. Also, in recent trials the pheromone has been shown to reduce crop damage by 30%. From a monitoring perspective, use of the pheromone provides an additional easy to use monitoring tool for growers. It helps them distinguish between damaging pests and accidental, largely benign but similar insects such as cereal thrips. By doing so it reduces further the tendency to spray with insecticides.

Impact on Practitioners and Services:

The work at Keele has influenced the work of other crop protection researchers and practitioners. The initial Keele work has generated new avenues of research and international links for example research groups in the USA, Australia, China, Tunisia and Romania have either confirmed our original results or are working on new aspects. Independent research published by the Department of Agriculture and Food Western Australia (DAFWA) has shown that Thripline$_{ams}^{®}$ gave significant improvement in monitoring of WFT (3x greater catches of thrips) in top fruit orchards in Western Australia when compared with alternative monitoring systems including a competitor product (Lurem-TR). They have recommended the use of traps baited with Thripline$_{ams}^{®}$ for improved selectivity of WFT and reduced capture of beneficial insects.

The Keele Research group is part of an EU International Research Staff Exchange Scheme (IRSES) that allows us to disseminate our existing and developing technology to a global audience of partners who are heavily involved in the provision of advice to end users on control and monitoring of thrips pests as well as the development of new crop control measures. Engagement with these organisations is leading to the development of new related products and services. The IRSES project has partners in; Plant and Food Research (PFR) (a New Zealand government-owned institute agency), the Department of Agriculture and Food Western Australia (DAFWA), the University of Natural Resources and Life Sciences (BOKU), Austria (an education and research centre for renewable resources), the Institut de Recerca I Tecnologia Agroalimentàres (IRTA), Spain (IRTA is a public company of the Government of Catalonia, linked to the Department of Agriculture, Food and Rural Action (DAR) and Plant Research International (PRI), Netherlands (a private not-for-profit research institute, which is part of Wageningen University and Research Centre).

The research group at Keele has worked with industry (e.g. Syngenta Bioline Ltd., Russell IPM Ltd., and others) growers groups (e.g. Horticulture Development Company, ADAS UK Ltd) and end users (e.g. Bayer CropScience Ltd., Belchim Crop Protection Ltd., BerryWorld Ltd., Certis Europe B.V., Tesco Ltd.) individually and collectively through the DEFRA Hort-LINK program to develop enhanced methods and technology for using the WFT pheromone for enhanced monitoring and to develop control measures.

5. Sources to corroborate the impact

Syngenta Bioline Ltd. (Commercial Impact).

Russell-IPM Ltd. (Commercial Impact)

Berry Gardens Growers Ltd. (Commercial Impact)

Marie Curie Incoming International Fellowship. EU Marie Curie Website (Project 252258)