Grower Summary

Tomato: Further optimisation of *Macrolophus* release and feeding strategies.

PE 020a

Final report 2015

Project title:	Tomato: Further optimisation of *Macrolophus* release and feeding strategies.
Project number:	PE020a
Project leader:	Mr Paul Howlett, Wight Salads, Arreton, Isle of Wight, PO30 3AR
Report:	Final report [August, 2015]
Previous report:	Not applicable
Key staff:	Dr R Jacobson, RJC Ltd Mr B Moralee, Wight Salads Mr O Capel, Wight Salads Dr J Fenlon, Warwick University
Location of project:	Wight Salads, Arreton, Isle of Wight RJC Ltd, Bramham, West Yorks Libraries at Fera and Lancaster, Leeds and York Universities Warwick University
Industry Representative:	Dr P Morley, (TGA Technical Officer) TGA, Pollards Nursery, Lake Lane, Barnham, W. Sussex, PO22 0AD
Date project commenced:	1 January 2015
Date project completed (or expected completion date):	31 December 2015

DISCLAIMER

AHDB, operating through its HDC division seeks to ensure that the information contained within this document is accurate at the time of printing. No warranty is given in respect thereof and, to the maximum extent permitted by law the Agriculture and Horticulture Development Board accepts no liability for loss, damage or injury howsoever caused (including that caused by negligence) or suffered directly or indirectly in relation to information and opinions contained in or omitted from this document.

[The results and conclusions in this report are based on an investigation conducted over a one-year period. The conditions under which the experiments were carried out and the results have been reported in detail and with accuracy. However, because of the biological nature of the work it must be borne in mind that different circumstances and conditions could produce different results. Therefore, care must be taken with interpretation of the results, especially if they are used as the basis for commercial product recommendations.]

AUTHENTICATION

We declare that this work was done under our supervision according to the procedures described herein and that the report represents a true and accurate record of the results obtained.

Dr R Jacobson

Director

RJC Ltd

Signature ..... Date .....

Report authorised by:

Mr P Howlett

Head of Agronomy

Wight Salads

Signature ..... Date .....

GROWER SUMMARY

Headline

Establishment of *Macrolophus* in tomato crops can be enhanced by providing *Artemia* cysts as supplementary food. The effect can be further enhanced by maintaining the cysts in a hydrated state. A new feeding system was effective when used on a small scale but will require further development for commercial crops.

Background

In 2013, AHDB Horticulture (formerly HDC) funded project PC 302d developed a *Macrolophus*-based IPM strategy for the control of the leaf and fruit mining caterpillar, *Tuta absoluta.* The full details of the IPM programme can be found in AHDB Horticulture Factsheet 02/14. Where the predator established well, the programme was highly successful but delays elsewhere resulted in additional interventions with chemical pesticides. *Macrolophus* population growth appeared to be improved when the predator was provided with supplementary food in the form of eggs of *Artemia* (brine shrimp) and / or *Ephestia* (a stored product moth).

AHDB Horticulture project PE 020 allowed the team to conduct a more in depth study of these supplementary food materials during 2014. *Artemia* eggs are usually in an encysted form which is able to resist extreme adverse conditions for long periods of time. They are used by the fish farming industry either in the collected form or in a ‘decapsulated’ state with the outer coating removed by an industrial process. Upon delivery, the *Artemia* eggs are in a dehydrated state. Given that *Macrolophus* have ‘piercing and sucking’, rather than ‘chewing’, mouthparts we were concerned that the predators would have difficulty feeding on the desiccated eggs. It soon became obvious that both the encysted and decapsulated eggs would readily absorb moisture and could be rehydrated simply by placing them on a damp pad for about an hour. They would remain in that state for as long as sufficient moisture was available. To investigate whether the eggs would rehydrate naturally on leaves within a commercial tomato crop canopy, they were placed on leaves at various positions in the crop canopy and examined in situ after 24 hours and 7 days. At best, they were only partially hydrated. It was clear that there was normally insufficient moisture on the upper leaf surface to fully hydrate the eggs. *Ephestia* eggs are not dehydrated upon delivery

and are a suitable food material for *Macrolophus* in their delivered state. They are highly nutritious and are the preferred food material for raising *Macrolophus* in laboratory culture or in commercial breeding units. However, they are relatively expensive which restricts the quantity that can be distributed within a tomato crop. Suppliers sometimes dilute *Ephestia* eggs with the less expensive *Artemia* eggs in a 10-20% mix to aid distribution and thus reduce the overall cost of the product.

The overall objective of this project was to improve the reliability and efficacy of *Macrolophus pygmaeus* as a biological control agent on UK tomato crops. The specific technical objectives were to:

- evaluate a range of supplementary foods.
- develop a feeding system that will keep the food material in a hydrated state.
- evaluate a range of *Macrolophus* release and feeding strategies in a crop-scale trial.

Summary

This project was done in four stages. It began with laboratory-based experiments to determine whether it was beneficial to apply the supplementary food in the fully hydrated state. Three types of food (*i.e.* encysted *Artemia* eggs, decapsulated *Artemia* eggs, and a mixture of decapsulated *Artemia* and *Ephestia* eggs) were simultaneously tested in both desiccated and rehydrated states. Each treatment was replicated six times. The data showed a clear benefit from using rehydrated *Artemia* eggs and greater longevity of *Macrolophus* adults when fed on rehydrated encysted eggs rather than on rehydrated decapsulated eggs. The latter was improved by adding 10-20% *Ephestia* eggs but only to the same degree as rehydrated encysted eggs alone and the addition inevitably increased the cost of the material. As a consequence of these results, the subsequent studies focussed on rehydrated encysted eggs.

The second stage involved designing and developing a system to deliver hydrated food to the predators within a commercial crop. The final design comprised a lightweight biodegradable plant propagation module (60x60x60mm) with an internal base consisting of two 40x40mm layers of pre-soaked highly absorbant Green Blade gel liner. Approximately 1.2g of *Artemia* cysts were sprinkled over the upper surface of the gel liner in each module. The preliminary tests in commercial crops showed that the gel liners retained sufficient moisture to keep the cysts hydrated for at least 2-3 weeks. After 3 weeks a further 40x40mm layer of the pre-soaked gel liner was placed in the ‘basket’ and another 1.2g of

Artemia cysts were sprinkled over the surface. This design was taken forward to the main crop trial.

In the third stage, the most effective type / condition of supplementary food was tested in a commercial crop-scale trial to measure the impact on early-season establishment of *Macrolophus*. The tomato plants, cultivar Mecano, arrived from the propagator in week 50 2014. The treatments comprised two release rates of *Macrolophus* and two methods of providing supplementary food; *i.e.* four treatments in total. Each treatment was replicated on both the east and west side of the glasshouse unit. *Artemia* cysts were applied at a rate equivalent to 250g per hectare. There were 36 feeding points per plot (*i.e.* one point per 47m^2) giving approximately 1.2g of *Artemia* cysts per feeding point. Depending on the particular treatment, the feed was either loosely distributed on leaves or placed in hydrated baskets in the immediate area of *Macrolophus* release during week 51 2014. Feeding was repeated at three week intervals between week 51 2014 and week 8 2015. The predators were released as nymphs at commonly adopted rates (*i.e.* 0.5/m^2 or 1/m^2) in week 51 2014. On the first assessment date, which was three weeks after release of *Macrolophus*, there were significantly more *Macrolophus* where the predators had received rehydrated food in baskets than loose food on leaves. The assessments continued in the vicinity of the feeding stations for a further six weeks. At first, the population trends remained the same as the released nymphs developed into adults and then began to produce offspring. By the end of this period there was a very large increase in the number of first generation *Macrolophus* nymphs in all the treatments. Where hydrated food had been provided within baskets, an approximate 7 fold increase was recorded. However, the largest increases (30 fold) were seen in the treatments which had been fed with loose feed. This reversal in *Macrolophus* numbers between feeding methods towards the end of this period can be explained by examining the effect of several periods of heavy driving rain which penetrated the glasshouse roof panels. As a consequence of the leakage, the tomato leaves were often wet and loose food on the upper surfaces became hydrated. Given that both types of feeding system were now providing the predators with hydrated food, the loose system performed better because the food was spread over a much larger surface area and was therefore more accessible to the predatory nymphs. While this confounded the comparison of the basket feeder system with the loosely applied cysts, it did reinforce the evidence that significant benefits are to be gained from rehydrating the supplementary food.

The final stage of the project was a natural progression from stage 3. The assessment procedures in the crop-scale trial changed to provide a more general indication of *Macrolophus* population growth throughout the crop. Where the predators had received

rehydrated food in baskets, numbers increased steadily over this sampling period with the rate of increase being roughly proportional to the initial release rate. Where *Macrolophus* received loose food on leaves, the numbers increased quite dramatically at week 15, with a very large proportion being in the nymphal stages, and then fell back again at week 19. The latter can be explained by migration away from the rows which had originally housed the release / feeding points as those nymphs developed into more mobile adults.

There was an anomaly in the data which was further investigated in the statistical analysis. The mean number of *Macrolophus* per sample point at week 15 for the loose application treatment at the higher release rate was 11.9, but this fell back to 9.3 when counts from rows under the metal roof gutters were removed. Similarly, for the loose application treatment at the lower release rate the respective numbers were 4.8 and 3.5. There was no apparent change for the other two treatments. This anomaly can be explained. Between weeks 11 and 15, the temporary thermal screen was removed from the glasshouse roof space thus exposing the roof which was relatively cold at night. Condensation formed on the metal roof gutters and moisture dripped onto the leaves below. This kept the remaining supplementary food in the hydrated state and once again provided evidence that this is advantageous to the predators.

Financial Benefits

Macrolophus pygmaeus is potentially one of the most useful biological control agents available to UK tomato growers but, at £70-80 per 1,000, it also one of the most expensive. Hence, it must be used to best effect. A saving in release of only 0.25 *Macrolophus* per m^2 across 66% of the UK tomato industry would equate to a saving of over £24k thus giving immediate payback on this project. *Tuta absoluta* is currently the most important pest of tomato crops in the UK. For example, at one nursery in 2012, 30% of fruit were damaged by the pest and graded out during June and July. This represented losses of approximately £50k per hectare to that grower for that period alone. Where successful, the *Macrolophus*-based control strategy has prevented such damage. Hence, avoiding the situation described in this single example would provide an immediate x2 payback on the cost of this project. *Macrolophus* also controls other pests such as *Liriomyza bryoniae.* These leafminers are currently the most expensive pests to control with biological control agents in UK tomato crops. Improved use of *Macrolophus* could provide savings of £400-£800 per hectare for growers who suffer this problem and so provide the industry with a payback on the cost of this project within a single year.

Action Points

- The combined results of the laboratory and fields studies confirm that it is beneficial to provide *Macrolophus* with supplementary food in the form of rehydrated *Artemia* cysts rather than the desiccated *Artemia* cysts as supplied.
- The prototype feeder basket developed in this project maintained *Artemia* cysts in the rehydrated state for 2-3 weeks and provided a suitable source of supplementary food for *Macrolophus* during that time.
- The use of the feeder baskets in commercial crops significantly increased the survival of the *Macrolophus* nymphs that were released adjacent to the feeder units at the start of those crops. However, the benefits were lost as those *Macrolophus* matured into adults and dispersed elsewhere in the crop.
- There were too few feeding baskets per hectare to influence the subsequent *Macrolophus* population growth and it would not be economically viable to greatly increase the number of feeder baskets within commercial crops.
- The feeder baskets as used in this project enhance *Macrolophus* population growth in small confined areas, such as rearing units, but a much greater number would be required to provide the same effect in a commercial crop. The solution will be to find an alternative means of keeping *Artemia* cysts moist on leaves without creating secondary problems from excessive moisture on leaves; eg making the plants susceptible to plant diseases such as Botrytis.