Horticultural
Development
Company

Grower summary

PC 302

Organic tomato: Phase 1 of contingency plans for the control of *Tuta absoluta* and *Nesidiocoris tenuis*

Final Report 2010

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Only officially approved pesticides may be used in the UK. Approvals are normally granted only in relation to individual products and for specified uses. It is an offence to use non-approved products or to use approved products in a manner that does not comply with the statutory conditions of use, except where the crop or situation is the subject of an off-label extension of use.

Before using all pesticides check the approval status and conditions of use.

Read the label before use: use pesticides safely.

Further information

If you would like a copy of the full report, please email the HDC office (hdc@hdc.org.uk), quoting your HDC number, alternatively contact the HDC at the address below.

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Headline

- High volume sprays of spinosad provide a short-term solution to *Tuta absoluta* infestations.
- Entomopathogenic nematodes offer a biological alternative to spinosad.

BACKGROUND AND EXPECTED DELIVERABLES

Tuta absoluta and *Nesidiocoris tenuis* are becoming increasingly important pests in southern Europe. They are extremely damaging and are currently controlled in those countries by intensive applications of chemical pesticides. However, such products are not compatible with biological control agents and would threaten the continued use of IPM if adopted in UK tomato crops. Organic crops are particularly vulnerable to these pests because growers would not be allowed to use synthetic pesticides and retain organic status, even under PHSI instruction. It was therefore vital that contingency plans were prepared for the control of both pests.

When the concept note for this project was presented to the TGA Technical Committee and HDC PC Panel in June 2009, *Tuta* had already been detected in several UK tomato pack houses. By the time the project began in August 2009, it had been found in a conventional tomato crop in Essex and PHSI had implemented an intensive control programme. The project was split into three phases, with Phase 1 focusing on the development of a short-term solution that could be implemented immediately against *Tuta*. WSG were in a unique position in that they had crops in southern Europe that were already infested with this pest and in which efficacy trials could be done on a large-scale. In addition, a desk study was prepared for Phase 2 by identifying potentially useful IPM compatible products to be tested against *Nesidiocoris*. This was completed in December 2009 and will be incorporated into the Phase 2 report.

Preliminary desk studies and small-scale trials at WSG's nursery in Spain in 2009 indicated that high volume sprays of spinosad could control *Tuta* larvae within the leaf and could provide the short-term solution. This insecticide is derived from naturally-occurring soil fungi and is therefore allowed in organic growing systems. Larger scale trials were subsequently done in 12 hectares of crops at the WSG nursery in Portugal following the general approach that had been successfully developed in HDC project PC 240. This approach immediately

identified any important interactions with current agronomic practice and eliminated the need for an additional exploitation phase to transfer the technology to the commercial situation.
In addition to the work on spinosad, the team recorded and collated information relevant to the use of pheromone traps and biological control. This knowledge will pave the way towards longer-term more sustainable control measures that may be further investigated in Phase 3.

SUMMARY OF THE PROJECT AND MAIN CONCLUSIONS

Use of Tuta absoluta pheromones:

Female *Tuta* produce a sex attractant pheromone which has been synthesised and utilised as a very effective lure in sticky traps, often detecting males before there is any other evidence of the pest in the crop. Water traps fitted with lures are also effective but it is more difficult to sort the catch. The lures have a limited life and we may expect them to continue releasing pheromone for 4-6 weeks in the UK. The initial release is relatively large and this is reflected in the size of the catch. Thereafter, the release declines progressively and the size of the catch may follow the same pattern. Each time the lure is replaced there will be a surge in both the quantity of pheromone released from the trap and the size of the catch even if the size of the insect population remains constant. As a consequence, the data collected from the traps can be misleading when used to monitor population trends and effects of insecticidal treatments. Our solution was to have multiple traps, replace them in sequence and then average the counts.

Although the pheromones are highly selective, it can not be assumed that all the moths caught are *Tuta*. At least three other species of moths have been found in traps; *i.e. Blastobasis lignea* and two species of *Brytropha* spp. While none of these species are pests, it is difficult to separate them from *Tuta* and their presence could result in misleading monitoring results.

Considerable research has been carried out in southern Europe on methods of monitoring the pest with pheromone baited traps. However, the results have been varied and more work is required to establish treatment thresholds. In particular, researchers must be consistent when reporting pheromone dose rates so that comparisons can be drawn between separate studies.

The sensitivity of the male moth to the pheromone means that there is potential to control the pest using mating disruption techniques. However, a definitive paper on this subject has stated that “there is a need to obtain the synthetic sexual pheromone at much lower cost in order to obtain a commercial product that meets the agro-economic needs of the end-user”.

Monitoring Tuta absoluta populations in WSG crops:

Tuta were consistently caught on traps around the outside of the Portuguese site from planting to termination of the crops. The numbers caught appeared to be influenced by infestations in local potato crops and by weather conditions. The results demonstrated that the crops were under constant invasion pressure and all control measures were given a very severe test.

All eight organic blocks were fitted with screened roof ventilators and double entrance doors to reduce pest invasion while the four conventional crops had unscreened ventilators and doors. The benefits of screening the glasshouses were very clear. Significant numbers of moths were caught within the unscreened glasshouses from week 46 (2009) and treatments were applied from week 48. In contrast, very few moths were caught in the screened glasshouses until week 8 (2010) and no treatments were applied before week 10.

Notes on biology and behavior of Tuta absoluta:

At the start of this project, our knowledge of *Tuta* was based on data from warmer climates and there was little information of direct relevance to the UK. By collating data, we estimated that the life cycle would take between 3 and 6 weeks. However, there were many gaps in our knowledge and a spin-off project (HDC Project PE 002) was encouraged to generate relevant life cycle data.

It was noted that there were few mines in the top 0.8 m of the plant canopy, which represented about 2-3 weeks of new growth. It is possible that eggs were laid on those leaves but, due to the time to hatch, the mines were not seen until the leaves were lower down the plant. The nursery adopted an aggressive deleafing policy resulting in only 5-6 weeks of leaf growth remaining on the plant. This removed many mines in which *Tuta* larvae had not yet completed their development and there was little doubt that this slowed the pest’s population growth. However, this practice could also have an adverse effect on the biological control of whiteflies.

Evaluation of high volume sprays of spinosad against Tuta absoluta:

It was difficult to interpret the results of early plant scale experiments because many larvae evacuated the leaves following treatment and it was impossible to determine whether they had survived or died. The worst possible scenario was that the treatment had driven larvae from the leaves and they had moved into fruit, thus increasing the risk of damaged produce reaching the retail customer. Techniques were developed to overcome this experimental difficulty.

Using two approaches, spinosad (as Spintor 480SC at 25 ml per 100 litres water) was applied to the point of run-off to leaves containing *Tuta* larvae. The effect was compared to untreated controls over eight days. By day four, most of the larvae had moved out of the untreated mines and by day eight most had pupated. In the spinosad treatments, some mortality was noted the day after the leaves were sprayed but the majority of larvae succumbed to the chemical between two and four days post application. Approximately half died within the leaves while the rest had moved out into containers which were used to retain them. All were dead by day six.

In addition to that formal study, we took every opportunity to gain more information about the use of spinosad on a commercial crop scale and the impact that the treatment would have on *Tuta* at the population level. In week 10 (2010), a crop was treated with Spintor 480SC at 25 ml product per 100 litres water using the robotic sprayer. The spray was applied to the point of run-off using approximately 2,500 litres of diluted spray per ha. No active mines were found in the crop for two weeks following treatment. Thereafter, the population gradually increased but no further treatments with spinosad were deemed to be necessary in that block until week 19.

Spinosad applied through the irrigation system:

The above results showed that high volume sprays of spinosad would provide the short-term solution to *Tuta* infestations that had been sought by this project. However, there was concern that the treatment may be incompatible with the primary biological control agents, *Macrolophus* and *Nesidiocoris*. One possible solution was to apply spinosad through the irrigation system.

The results of four such treatments were monitored in rockwool-grown crops. In each case, the irrigation was turned off at mid-day to allow the plants to partially dry out the growing medium and the treatment was applied at dusk. The product (Spintor 480SC) was diluted in a spray tank (500 ml per 400 litres water) and pumped through valves in the irrigation manifolds. Following treatment, the pipes were flushed with normal irrigation water. The irrigation system was then turned off until 11.00 am the following day to avoid flushing the product out of the growing medium. In all cases, there was a rapid decline during the first two weeks post-treatment, which was followed by a period of at least three weeks when there were very few active mines.

These results indicate that this is a potentially useful method of applying spinosad in hydroponic crops. However, the system has yet to be tested in soil grown crops. Furthermore, we know little about the uptake of the chemical and its subsequent transport to the aerial parts of the plant. It is recommended that further work be done to monitor the speed with which uptake occurs, the parts of the plant the chemical reaches and the possible risk of residues being found in fruit.

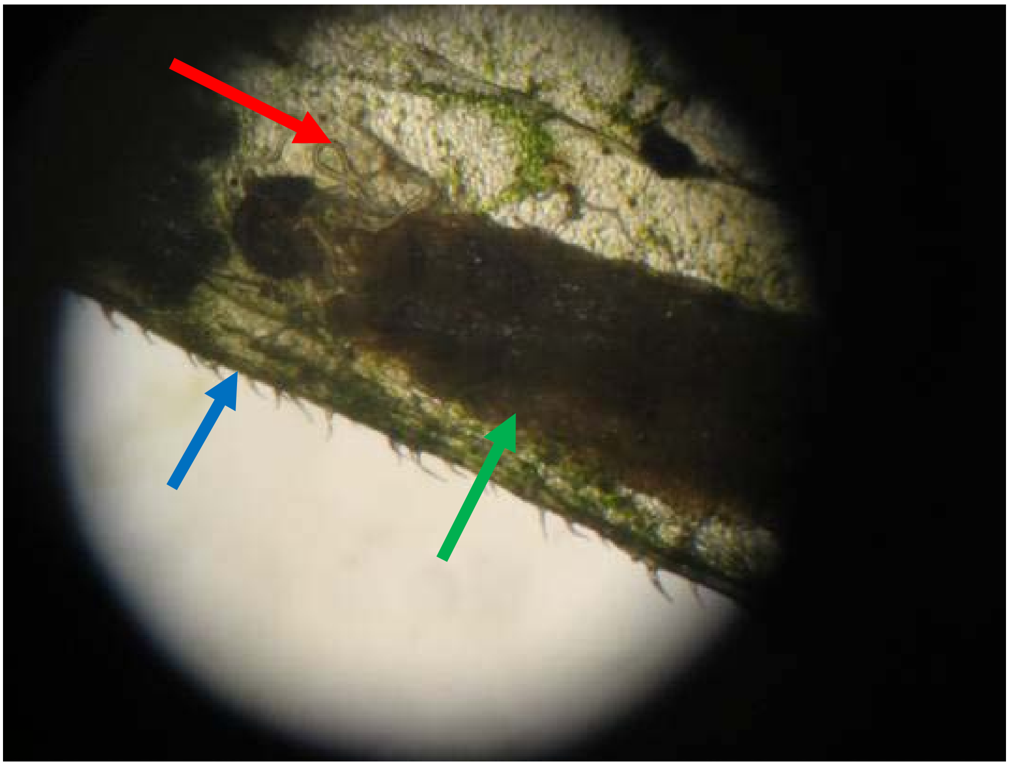
Evaluation of entomopathogenic nematodes against Tuta absoluta:

This study evaluated two species of entomopathogenic nematodes, *Steinernema feltiae* and *S. carpocapsae*, against *Tuta* larvae in tomato leaves*.* The efficacy of the nematodes was compared to an untreated control and to spinosad.

Leaves containing medium sized *Tuta* larvae were sprayed to the point of run-off taking care to cover upper and lower surfaces. Treatments were applied during the last 90 minutes of daylight to slow the rate of drying and allow the nematodes more time to find entry holes to mines. The dry leaflets were then placed in plastic boxes with tissue paper refuges and examined at daily intervals until dead or pupated. On each date, a sample of dead larvae was dissected to determine whether nematodes were present inside the cadaver.

There was very little mortality in the untreated controls, while those treated with spinosad died within six days of application. The first dead *Tuta* larvae were seen in the *Steinernema* treatments two days after application of the spray and all were dead by day 6. Dead larvae dissected on day 4 contained nematodes at a range of development stages with the most advanced being adult females. By day 8, there was evidence of offspring within female nematodes and these had been released into the cadaver by day 10. A photographic record of the effect of the treatments is shown in the series of images given below. Further studies are required to determine the efficacy and cost effectiveness of the nematodes when used in a commercial cropping situation.

Photograph taken through leaf two days after application of *S. feltiae* showing:



Blue arrow – leaf edge

Green arrow – *Tuta absoluta* larva

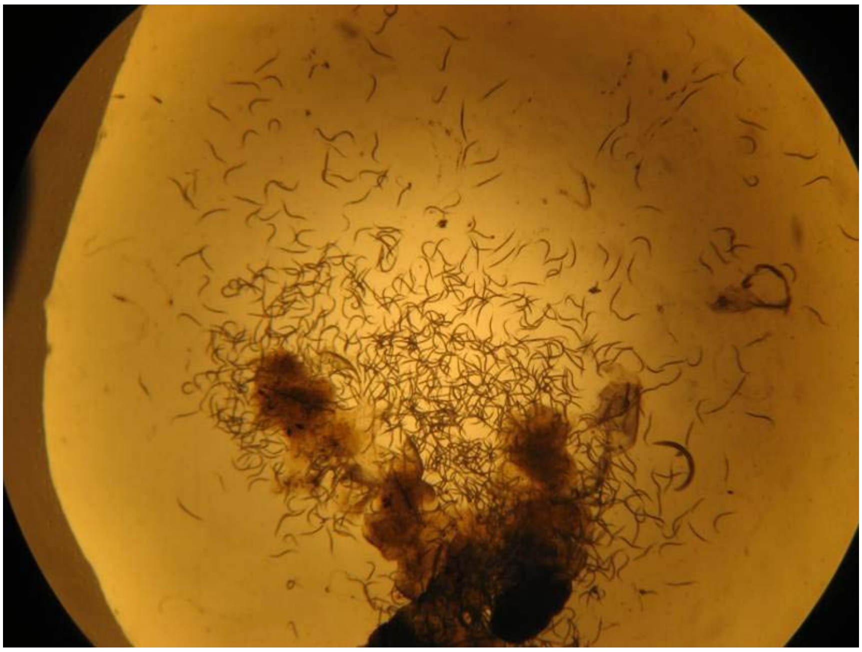
Red arrow – nematode having located larva within mine

Dead *Tuta absoluta* larvae two days after application of nematodes in mine (above) and removed from mines (below)

Nematodes emerging from dissected dead *Tuta absoluta* larva four days after application to leaves on plants. The most advanced were now mature females (red arrow)

Eight days after application of *S. feltiae* to leaflets on plants showing offspring within an adult female nematode

Nematodes spilling out of a dissected dead *Tuta absoluta* larva ten days after treatment



Other biocontrols

While the main objective of this project was to develop a short-term solution that could be implemented immediately against *Tuta*, the authors also took the opportunity to record and collate information relevant to biological control of the pest.

Nesidiocoris is emerging as the most effective biological control agent in the Iberian peninsular. It is a voracious predator feeding on *Tuta* eggs and larvae as well as many other species of pests. *Nesidiocoris* also feed on tomato plants and the authors have first hand experience of the serious damage that can occur to growing points and trusses after invertebrate pests have been controlled. The latter is being addressed in Phase 2 of this project.

Macrolophus pygmaeus is closely related to *Nesidiocoris* and is the more common species in natural vegetation in northern Spain and France. They feed on immature stages of *Tuta* and can provide some control of the pest in the absence of harmful insecticide residues. The related species, *Macrolophus caliginosus*, has become established on many of our tomato nurseries, and currently offers the best option for biological control in the UK.

An egg parasitoid, *Trichogramma achaeae*, is effective against *Tuta* and has out-performed other *Trichogramma* species in Europe and South America. Large numbers of these parasitoids are reported to have controlled the pest in a series of Spanish trials. However, most practitioners would require more substantive data before risking commercial crops.

Several surveys in Mediterranean countries have sought alternative natural enemies with potential against *Tuta.* In addition to the species mentioned above, two parasitoids (*Necremnus artynes* and *Hemiptarsenus zilahisebisi*) have been detected on *Tuta* larvae but it remains to be seen whether they have value as biological control agents. Perhaps most surprisingly, the predatory mite, *Amblyseius swirskii*, has been seen feeding on first instar *Tuta* larvae.

Bacillus thuringiensis (*Bt*) will kill *Tuta* larvae under experimental conditions but its success is dependant upon contact / ingestion by the pest. In theory, the larvae should only collect a lethal dose when outside the mine, so the most vulnerable stage should be the free living first instar. In practice, later instars may be vulnerable if they move between leaves. Nonetheless, the product would have to be applied at regular intervals to have an impact on the pest population and this has led to considerable debate about its cost effectiveness. Although no formal trials were done with *Bt* in this project, the product was used in several blocks and we constantly looked for beneficial effects. The only occasion that cadavers were found with typical symptoms of death by *Bt* were following application of the product in a tank mix with Neem. It is possible that the Neem drove the larvae out of the leaf where they came into contact with the *Bt*. This approach is worthy of further investigation.

ACTION POINTS FOR GROWERS

- High volume sprays of spinosad provide a short-term solution to *Tuta absoluta* infestations in organic tomato crops. Trials in Portugal used Spintor 480SC sprayed to run-off at 25 ml per litre. Two products containing spinosad are available in the UK; Conserve (120 g/litre) and Tracer (480 g/litre). Conserve has approval for tomato (MAPP 12058).
- The following control measures have potential and should be investigated in more detail:
    - Application of spinosad through the irrigation system.
    - Application of spinosad as a tank mix with natural pyrethrins.
    - Efficacy and cost-effectiveness of *Steinernema feltiae* and *S. carpocapsae* on a commercial crop scale.
    - Efficacy and cost-effectiveness of the egg parasitoid, *Trichogramma achaeae*.

- Use of *Bacillus thuringiensis* in tank mixes with other products which encourage the *Tuta* larvae to emerge from mines.

FINANCIAL BENEFITS

If larvae of *Tuta* are detected inside tomato fruit by retailers, then the produce will be rejected and it is highly likely that further supplies from that source will be put on hold until the grower can provide assurance that the infestation has been completely controlled. It will be very difficult for the grower to find another outlet for that produce at short notice and this could result in very large quantities of produce being dumped. The financial loss could be over £300k per hectare depending on the time of year that the infestation is first detected.

Effective control measures will minimise such losses in organic tomato crops. Furthermore, new IPM compatible control measures will have knock-on benefits to conventional tomato production, particularly to those growers attempting ‘pesticide free’, and will therefore be advantageous to the whole UK tomato industry.