Grower Summary

FV 400

Biology and control of ‘spinach’ mites

Final 2014

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Headline

Tyrophagus similis was confirmed as the mite causing damage to outdoor spinach crops. This 'localised' sporadic pest is associated with field patches that have high amounts of partly-degraded organic matter. None of the acaricide products tested completely eliminated the mites.

Background

During late summer-autumn 2010, outbreaks of mites caused damage to outdoor spinach crops in southern England. The outbreaks occurred at several locations. The problem has occurred previously but is sporadic in nature. The objectives of this project were to:

1. Confirm the identity of the mites causing damage to spinach crops.

2. Develop a laboratory culturing technique to provide mites for experiments on control

3. Collate and summarise information on the biology of the mites that would be relevant to predicting and controlling infestations

4. Identify potential control methods and test them on a small scale

Summary

Objective 1 Confirm the identity of the mites causing damage to spinach crops.

Despite the very wet weather in summer 2012, small samples of mites were obtained from field-grown spinach (provided by growers or field-collected by Agrii or Warwick Crop Centre staff) on three occasions and these were sent to Fera for identification. All samples contained *Tyrophagus similis*, confirming the identity of this pest.

Objective 2 Develop a laboratory culturing technique to provide mites for experiments on control

Attempts to produce a laboratory population of *T. similis* were unsuccessful and so attempts were made to establish an infestation in two locations at Wellesbourne, where organic matter was relatively high and spinach was sown. The first location was established in summer 2012 (Dutch lights) and sequential sowings of spinach were made. The plants were not harvested and the organic matter was left to decompose over winter; more spinach

sowings were made in 2013. A second location (12 micro-plots) was sown with spinach in 2013 and the area was 'inoculated' with infested plant material collected in from a crop in Kent in early September 2013.

The areas were sampled from time to time by taking soil samples and putting the soil in polythene bags into which a filter paper 'trap' was placed. Traps were composed of a piece of folded moistened filter paper containing small amounts of dry yeast as used by Japanese researchers. Any mites that were 'captured' were recorded but not identified to species level. Mites were 'captured' from samples of soil taken from the micro-plots in September and October and from the Dutch Lights area in September.

Some potted spinach plants which were infested with mites when sampled in September 2013 were retained over the winter in a polytunnel. One pot was destructively sampled on 6 January 2014 and 2 mites were found on 6 plants.

Objective 3 Collate and summarise information on the biology of the mites that would be relevant to predicting and controlling infestations.

A literature review was undertaken and key points are as follows:

Tyrophagus similis appears to be quite widely distributed world-wide and the main studies on it have been done in Japan and the Yemen. In Japan, mites damage spinach grown in greenhouses in particular. The mites penetrate spinach shoots and feed on young leaves. The shoots are readily accessible because they are close to the soil surface. As the plants grow, the damaged leaves show small holes and/or deformation.

Tyrophagus similis is one of a number of species of small arthropods that have an important role in mineral turnover, vegetation succession and decomposition of organic matter. The pest has been observed to feed mainly on organic fertilizers, plant detritus, small organisms and the dead bodies of soil arthropods. The development of *T. similis* populations on organic wastes and immature composts may be due to their feeding on fungi that occur in these materials. Generally, the growth of fungi is greater on organic wastes and immature composts than on mature ones, because mature composts have already been decomposed by several forms of microorganisms. *Tyrophagus similis* lives in, and on, soil at depths of 0-5 cm and numbers decrease with increasing depth.

The low temperature threshold for development for *T. similis* is 7°C and females can lay several hundred eggs in their lifetime. Egg viability of *T. similis* declined at temperatures

above 30°C, female survival was reduced at temperatures above 35°C, and of *T. similis* maintained at 10, 15, 20 and 25°C, those maintained at 10°C had the greatest fecundity during their lifetime.

In Japanese research on spinach crops grown in greenhouses, the *T. similis* population in the soil remained at low levels during the hot season from May to September, increased rapidly in October and November, remained at a high level during the cool season from December to February, and further increased in April. The mites, which were in the soil, infested the spinach plants mostly in late autumn and early spring. The high temperatures in the greenhouses from spring to early autumn were considered to be one of the main causes of population decrease. It was hypothesised that the mites initially increase in number on, or in, cultivated soil that is rich in organic matter and then invade the spinach plants. It seemed likely that the mites use the spinach plants as a shelter from harsh physical conditions in the surface soil (e.g. high temperature and dryness) in the warm season, because few mites inhabited spinach plants during the cool season even when mite density in the soil was relatively high. If this is the case, then the movement of the mites to the spinach plants might not be primarily to obtain food. It seemed to the Japanese researchers that *T. similis* was more closely associated with the soil than with spinach plants, because it was feeding on and living in various types of organic matter in the soil.

If the mites live mainly in the soil, attempts to control the mites by spraying the plants with pesticide might be expected to have a limited effect. In Japan, attempts have been made to control *Tyrophagus similis* with agrochemicals. Such agrochemicals have been used generally after an increase in damage is observed, but in many cases, their effects have been unsatisfactory. This suggests that the chemicals had little direct contact with the mites in both the soil and spinach plants.

Apart from temperature, dryness of the soil surface and tillage after cultivation might reduce mite numbers temporarily. Solar heating and hot water treatment may be effective for controlling *T. similis* in the soil in greenhouses. To effectively control the mites, it may be necessary to keep the temperature above 35°C for several hours. Cultural approaches to reduce damage to spinach could be by: (1) Reducing the use of organic fertilizers during the mite season, (2) removing plant residues on the soil before cultivation, and (3) reducing the use of immature organic materials, because they increase fungi that are suitable food for *T. similis*. Other mites are certainly likely to be predators of *T. similis,* but an effective biological control system has not been developed.

It is likely that the target for control should be mite populations in the soil rather than the mites in the spinach crop and there may be many mites in the soil at times when there are none on the plants. Thus, surveying mite numbers in the soil may be of value. This can be done using Tullgren funnels to extract mites from soil samples, although this method is labour-intensive. A Japanese group developed a relatively simple 'trap' for monitoring mites in soil. The trap is a piece of folded moistened filter paper containing a small amount of dry yeast. Rather than deploy these traps in the field, the researchers took samples of soil from the field, placed them in polythene bags and then the traps were placed on the surface of the soil in each sample bag. The sample bags were sealed and the traps were checked at intervals and the mites identified and counted. When this approach was compared with the use of Tullgren funnel samples, higher numbers of mites were obtained.

Objective 4 Identify potential control methods and test them on a small scale

Potential control methods highlighted by the literature review include:

- Control with pesticides
  - This depends on a suitable active ingredient being available and approved for spinach.
  - The review indicated that the mites may be a difficult target and that soil treatment might be more effective than treatment of the plants (which may be too late). Soil treatment requires an effective method of application.
- Biological control
  - There might be a suitable control agent available commercially.
  - However, this would be a very expensive, and potentially labour-intensive, way of controlling a sporadic pest.
  - Efficacy has not been demonstrated.
- Physical control
  - Cultivation may reduce mite populations for one or more reasons.
  - Heating the soil (with black polythene?) may be effective.
  - Irrigation may make the soil environment less hostile at certain times and prevent the mites infesting the spinach plants.
- Cultural control
  - Management of organic material in the soil may be key.
- Monitoring
  - Use of the filter paper trap approach may highlight large mite populations.

- A pheromone has been identified in female *T. similis* which acts both as an alarm pheromone and a female sex pheromone. It is possible that, in the right concentration, it could be deployed as a monitoring tool.

Small-scale acaricide trial

A total of 46 pots of infested spinach plants taken from a field in Kent in September 2013 (Figure 1) were used in a small-scale efficacy trial. The treatments were: Masai (20% tebufenpyrad) 1.8l/ha; Dynamec (18g/l abamectin) 0.5l/ha and Spruzit (4.59g/l pyrethrins) 0.5l/ha. All in the equivalent of 300l/ha water. The pots were destructively sampled after treatment. Mite numbers were low, but none of the treatments completely eliminated the mites.

Figure 1 Mite-infested spinach plants collected from Kent in September 2013.

Discussion

Although weather conditions did not favour research on this pest in summer 2012, sufficient numbers were obtained to confirm its identity and the literature review revealed some useful background information. Sufficient mites were collected in September 2013 to undertake a small-scale acaricide trial.

Tyrophagus similis is not an easy pest to work on because of its sporadic nature and because it is likely that it is more closely associated with the soil (organic matter) than the crop. Possible approaches to continue investigating this pest problem are:

- To keep trying to establish a small field infestation. Application of organic matter is probably the key. It may then be possible to get a better handle on the conditions

that lead to damage in spinach. It is likely that there are 'organic matter', 'cultivation' and 'weather' factors involved.

- The 'solution' to this pest problem is likely to be a combination of predicting the 'risk' and managing the crop/cultivation to minimise damage. It is doubtful that an effective pesticide treatment will be identified and, in any case, by the time damage is observed it may be too late. The 'risk' is undoubtedly related to the amount of organic matter (in a certain condition?). Are certain crops in the rotation likely to increase this?
- Traps may be one way of predicting the risk and pheromone traps might be more selective (are they available commercially?) – but how far ahead is it possible to do this? Do populations multiply rapidly under certain conditions where mites are at very low (undetectable) infestations earlier on? Does a grower have the opportunity to 'change fields' if a high risk field was identified early on?
- It may be best to undertake a 'low-key' fairly long-term project that tries to build up a field infestation and uses resources (e.g. infested crops) as they become available. Pheromone traps (if available) might help with surveys of commercial crops and it might be possible over time to build up a picture of the risk factors. In parallel, if a field infestation were established it would be possible to look at cultural and other approaches to control. It also depends how important this problem is and therefore how much a grower might be willing to 'spend' on controlling it?

Financial Benefits

The results of this project contribute to an understanding of this damaging, but sporadic, pest and identify possible methods of predicting and controlling infestations.

Action Points

- Growers should aim to minimise the amount of partly-degraded organic matter in the soil prior to sowing a spinach crop.