AHDB HORTICULTURE

# Grower Summary

## HNS PO 199

Biology and control of agapanthus gall midge

Final 2017

## Disclaimer



The results and conclusions in this report may be based on an investigation conducted over one year. Therefore, care must be taken with the interpretation of the results.

## Use of pesticides

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 AHDB Horticulture office (hort.info.@ahdb.org.uk), quoting your AHDB Horticulture number, alternatively contact AHDB Horticulture at the address below.

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| **Project title:** | Biology and control of agapanthus gall midge |
| **Project number:** | HNS PO 199 |
| **Project leader:** | Hayley Jones, RHS |
| **Report:** | Final report June 2017 |
| **Previous report:** | N/A |
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| **Location of project:** | RHS Garden Wisley, Surrey |
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| **Date project commenced:** | [Date Month Year] |
| **Date project completed (or expected completion date):** | 30 June 2017 |

## GROWER SUMMARY

### Headline

The agapanthus gall midge has a long and persistent active season and can infest many tissues of *Agapanthus* flower heads. Currently only detection and destruction of infested material can be recommended to growers. Further research into biological and chemical controls is needed.

### Background

The agapanthus gall midge (*Enigmadiplosis agapanthi*) is a recently described pest affecting *Agapanthus*. It was discovered in the UK in 2014 at which time it was new to science. The larvae of this gall midge develop inside the individual flower buds or inside the closed flower head sheaths of *Agapanthus*. The midge can cause the bud to be deformed and discoloured and usually fail to open. The severity of this can range from a few buds failing, to collapse of the entire flower head. This poses a threat to the containerised plant and the cut flower industry. The pest was new to science and as such, very little was known about its biology and life cycle, and it was unknown which control measures could be effective against it.

This project aimed to determine the pest's life cycle and biology, in order to help target control and to ascertain the midge's current distribution both in the UK and abroad. The project also aimed to test the effectiveness of some currently available pesticide and biological control products under laboratory conditions.

### Summary

***Objective 1. Determine and describe the life cycle of agapanthus gall midge.***

The midge was studied through observations in RHS Garden Wisley and by rearing in rearing tubes and rearing cages during 2015 and 2016.

The gall midge has a very long active period, between mid-June and early October. Active larvae in *Agapanthus* flower heads in the garden were confirmed between 30$^{th}$ June and 10$^{th}$ October 2015 and between 24th June and 6$^{th}$ October 2016. Larvae have also been found on 13$^{th}$ June 2017, in agapanthus plants flowering earlier than usual (possibly due to a warm spring). Fortnightly measures of infestation severity were taken from an 'award of garden merit' trial of agapanthus cultivars in 2015. This showed a long and consistent period of activity, indicating multiple overlapping generations.

Rearing showed that the larvae feed and develop inside the flowers and when fully grown emerge and drop into the soil or growing media. They bury themselves to pupate and take between ten days to two weeks from larvae dropping to adult emergence during the summer. It is likely that they bury themselves deeper to overwinter and pupate in the spring, but this has not yet been confirmed. Larvae left in rearing tubes over winter started to emerge in April, but these tubes were kept in sheltered conditions. In RHS garden Wisley active larvae were found as soon as any *Agapanthus* plants had well developed buds, which indicates that the midge starts to emerge before its host plant flowers.

***Observations of rearing cages failed to observe mating and oviposition (egg-laying) behaviour***

*Agapanthus* flower heads can be infested at different stages of growth and the associated symptoms severity is therefore quite variable. If only a few buds are infested on a flower head the infestation may go undetected. If infestation is very severe, or occurs before the flower head sheath opens then it may completely fail to flower. Flower dissection in 2016 also showed that larvae can survive inside senesced flowers, further prolonging their active period and making infestation hard to detect. A single flower head can host hundreds or even thousands of larvae; the average number of larvae found across 51 flower heads dissected was 719, with a maximum number of 3465.

***Objective 2. Confirm the distribution and host range.***

***Distribution***

The midge is most likely native to South Africa, as this is the native range of *Agapanthus* and there are reports of symptoms on wild and commercially grown plants there. There is currently no confirmation that this is the same species but samples of midge from SA have been obtained, so DNA sequencing will allow us to confirm whether they are the same species.

The only reports of the midge outside of the UK are on the islands of Guernsey and Jersey, where there are established populations. The International Plant Sentinel Network has circulated surveys to botanic gardens worldwide but currently only negative reports have been returned.

In order to confirm the UK distribution the RHS made a call to the public, through social media, gardening press, the RHS website and *The Garden* magazine. The distribution was ascertained by collating observations from the public and growers, supported by sample or photographic evidence.

These records, combined with those from a survey of commercial premises carried out by APHA in 2015 can be seen in Figure 1.

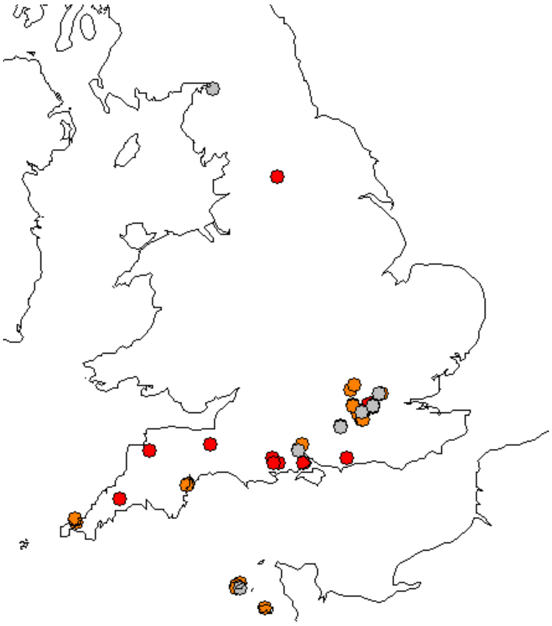

**Figure 1**. Agapanthus gall midge distribution 2014-2016; 2015 records in orange, 2016 records in red and unconfirmed in grey.

The map shows that the midge has a widespread distribution, mostly restricted to the South of England but with isolated cases in the north and established populations on Guernsey and Jersey. The West Yorkshire record was confirmed by a sample with larvae present, the owner of the *Agapanthus* had purchased a plant in Guernsey in spring 2014.

It is likely that the midge has been present in the UK for some years before 2014, evidenced by photographs of symptoms in a private collection in 2012 and reports of possible symptoms from 2011.

*Host range*

Observations in 2015 of 149 cultivars of *Agapanthus* in the RHS 'award of garden merit' trial indicated that there may be some differences in midge infestation between different cultivars of *Agapanthus.* The pie chart in Figure 2 shows the proportions of cultivars with no, mild or severe symptoms.

In another experiment by Matthew Everatt (Defra), developed in collaboration with the RHS, six widely grown cultivars of *Agapanthus* were tested for susceptibility to the midge. This experiment found that Northern Star had much higher levels of infestation than the others tested, measured by number of larvae found inside a flower head. This was measured on plants that were uninfested at the start of the season and had regular infestation pressure applied for twenty days prior to measurement.

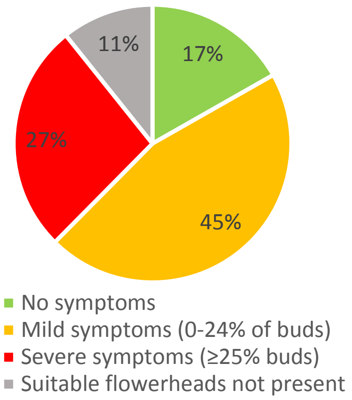


**Figure 2**. Proportions of cultivars showing different levels of agapanthus gall midge symptoms. 149 cultivars were observed.

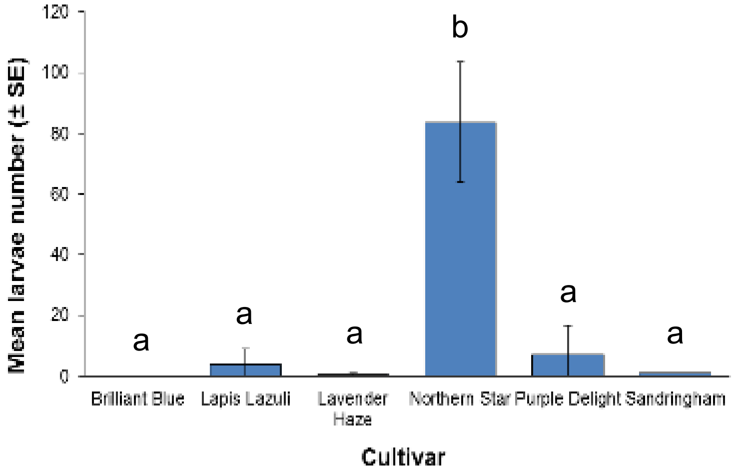


**Figure 3**. Mean number of agapanthus gall midge larvae associated with flower heads of six *Agapanthus* cultivars, following 20 days exposure to the agapanthus gall midge. Means with the same letter are not significantly different from each other.

*Objective 3. Quantify the effectiveness of potential chemical and biological controls.*

The following pesticides and biological controls were tested for their efficacy in controlling the midge:

1. *Steinernema kraussei* (Nemasys® L)
2. *S. feltiae* (e.g. Nemasys®) – both treatments 1 and 2 are entomopathogenic nematode species which can be used on any crop.
3. *Metarhizium brunneum (anisopliae)* (Met52 granular and Met52 OD) – A fungal entomopathogen. The OD product is approved for use as a spray on ornamentals in the UK but not yet commercially available or approved for use as a drench but an EAMU could potentially be sought if shown to be effective.
4. Spinosad (Conserve/Tracer) – an insecticide that has approval for use as a foliar spray on protected ornamentals (Conserve) and an EAMU for use on outdoor ornamentals (Tracer).
5. Thiacloprid (Calypso) – systemic insecticide that has an EAMU for use as a drench on protected ornamentals for control of vine weevil and sciarid fly.
6. Deltamethrin (Decis Protech) – a contact-acting pyrethroid insecticide that has approval for use as a foliar spray on both protected and outdoor ornamentals.
7. Cypermethrin (Cythrin Max EC) – a contact-acting pyrethroid insecticide that has approval for use as a foliar spray on both protected and outdoor ornamentals.
8. Water as a control.

The first experiment tested foliar sprays against flower-dwelling larvae. Cut stems with infested agapanthus flowers were gathered from RHS garden Wisley and inserted into plastic bottles of water through a parafilm seal. The eight treatments were then applied using an Oxford Precision sprayer. Each bottle was then placed in a large saucer of soapy water, to catch any larvae dropping from the flower heads (fully fed larvae drop to the ground to pupate) After 14 days the number of larvae in the saucers was counted, and the flowers dissected and numbers of dead and alive larvae within were counted.

None of the treatments tested had a significant effect on the percentage of live larvae in the petals or the number of larvae that dropped into the saucers. Gall-inhabiting organisms are often difficult to treat with foliar sprays as contact-acting products may not penetrate far enough into the plant tissue to reach the target pests.

The second experiment tested the effectiveness of treatments to growing media against the larvae that drop to the ground to pupate. Small pots of growing media were treated with drenches of the same treatments used in the first experiment on the flowers. Ten mature midge larvae were then added to the surface of the growing media in the pots, to mimic the larvae dropping to the ground. The underside of each of the snap-on lids to the pots were covered with a yellow sticky trap. The number of adult midges emerging was monitored on both the sticky traps and the surface of the growing media. The only treatment that significantly reduced the mean number of emerged adults (zero midges emerged) compared with those in the water controls (mean of 0.9 midges emerged per pot) was the drench of Calypso. However as only a mean of 10% of the larvae added to the water control pots successfully emerged as adults, indicating a mean of 90% natural mortality during the late larval or pupal stages further experimentation is necessary to improve survival of the midges in control pots in order to give a more robust result testing drench treatments for control in the growing media. It is possible that the growing media was too wet for successful adult midge emergence.

Finally a set of 160 agapanthus plants were established at a field site at Wisley, and exposed to pest pressure. These plants will enable us to carry out a field tests of controls in subsequent years, with the potential to test up to eight different treatments.

*Future work*

None of the foliar sprays tested had a significant impact on the midge, and this is likely to be because the products cannot penetrate into the flower buds successfully. Future experiments could repeat the foliar sprays with the addition of wetters to aid penetration of the products and could potentially include additional novel insecticides with translaminar or systemic action.

Future work could include an experiment to determine the optimum growing media moisture level needed for successful midge emergence and then repeat the drench treatments to further test control of the ground-dwelling stages of the pest.

## Financial Benefits

Recommendations available based on the results of this project are limited; as control methods are not yet available, prevention of outbreaks by reliable sourcing and inspection of incoming plant and regular and detailed monitoring of nursery plants is necessary. Prompt destruction of infested plants should limit potential crop loss, which is estimated at up to 70% in an infested nursery. The value of this 70% crop loss would be approximately £840,000 (based on estimates of £3 production cost per pot in a representative sized nursery).

## Action Points

- Source agapanthus plants from uninfested nurseries
- As plants may not yet be showing symptoms when brought onto the nursery, monitor closely for symptoms as soon as they start to flower
- Remove and destroy infested flower heads
- Destroy badly infested plants
- The results of this project indicated that a drench of Calypso (used according to EAMU 2014/2153 for control of vine weevil and sciarid larvae in protected ornamentals) may give some control of the larvae or pupae in the growing media after the larvae have dropped to the ground to pupate. However this result needs validating in a repeated experiment before this can be recommended to growers for control of agapanthus gall midge.
- Avoid highly susceptible cultivars such as Northern Star