Grower Summary

CP 092

The role of naturally occurring entomopathogenic fungi in regulating aphid populations on vegetable Brassica crops

Annual 2014

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.

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Further information

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GROWER SUMMARY

Headline

Brassica aphid populations are charaterised by a sharp population decline around July in the UK. At present this population ‘crash’ cannot be accurately predicted. Initial fieldwork results suggest the aphid population crash occurs regardless of plant age and that a guild of natural enemies are involved.

Background

Aphids as crop pests

Aphids (Hemiptera, Aphididae) are one of the most serious pests of vegetable brassica crops (Blackman & Eastop, 1984; Dedryver *et al.* 2010). Among the aphid species colonizing Brassica, *Brevicoryne brassicae* and *Myzus persicae* are the most economically important (Blackman & Eastop, 1984). Plant damage is caused directly via aphid feeding action on foliage and in the case of *B.brassicae* severe leaf fouling due to its tendency to form dense colonies, or indirectly through the transmission of plant pathogenic viruses including, turnip and cauliflower mosaic virus and cabbage black ring spot virus (Blackman & Eastop, 1984; Flint, 1985). Annual brassica yield losses due to aphid infestations range from 30% to 80% in developed and developing countries respectively (Razaq *et al.* 2011; Dedryver *et al.* 2010; Isik & Gorur, 2009). At present, aphid management in brassica crops is heavily reliant on the use of synthetic chemical insecticides and aphicides account for 39% of all insecticide applications (Garthwaite *et al.* 2007). Current chemical control methods of aphids include neonicotinoids, pyrethroids, pirimicarb, chlorpyrifos and pymetrozine (IRAG, 2012). However, growers are under pressure to reduce their reliance on insecticides: (a) consumer concerns (and by extension retailer concerns) over pesticide residues in food; (b) effective insecticides declining in number as a result of product withdrawals linked to new, more stringent health and safety criteria as part of European pesticides legislation (Directive EC1107/09); and (c) excessive use of insecticides resulting in control failure through the evolution of heritable resistance (IRAG, 2012). Whilst there is currently no evidence to suggest *B. brassicae* is resistant to insecticides *M.persicae* has three known resistance mechanisms, esterase, MACE and kdr rendering certain organophosphates, carbamates, and pyrethroids ineffective (IRAG, 2012). As a result, there is an urgent requirement to develop alternative forms of aphid management.

Aphid population dynamics

Aphids are r-strategist insects that reproduce parthenogenetically meaning they are capable of producing significant amounts of biomass in a short period of time (Blackman & Eastop, 1984; Karley *et al*. 2004). However, the exponential growth seen during spring and early summer does not continue. During mid-summer (usually July) many aphid species exhibit a sharp population decline to apparent local extinction (Karley *et al.* 2003). This mid-season 'crash' occurs in the absence of insecticide in both agricultural and natural landscapes and populations generally remain low or undetectable for at least 6-8 weeks post crash (Karley *et al*. 2003; Karley *et al*. 2004). At present the timing of this crash cannot be accurately predicted.

Many factors have been suggested for the mid-season crash, ranging from ecological factors such as plant age, natural enemies and adverse weather conditions to population process including decreased birth rates (decreased performance), increased death rates (increased natural enemies action) and increased alate production (emigration) (Karley *et al*. 2004). Of the natural enemies, entomopathogenic fungi have been strongly implicated in the crash of populations but little is known of their biology (Karley *et al*. 2003; Karley *et al*. 2004). A better understanding of the role of natural enemies in aphid population dynamics might enable the mid-season crash to be forecast, which would give growers the option of withholding pesticide sprays. Particularly effective natural enemy species may also be worth considering as augmentation biocontrol agents.

As a result the aims and objectives of this project are:

<u>Aim:</u>

The proposed work will test the hypothesis that fungal epizootics are one of the principle factors causing the mid-season crash in populations of aphids on horticultural brassicas.

<u>Objectives:</u>

i. Monitor populations of healthy and fungus-infected cabbage aphids on sequentially planted brassicas and study the link between the mid-summer population crash and epizootics of insect pathogenic fungi.

ii. Identify insect pathogenic fungi associated with the cabbage aphid *Brevicoryne brassicae* on field brassicas.

iii. Use laboratory bioassays to measure the susceptibility of the cabbage aphid to fungi collected from the field and compare to commercial mycopesticides.

iv. Model the effect of temperature and moisture on the pathogenicity of fungi to the cabbage aphid to forecast the outbreak of fungal epizootics.

Summary

Work began on Ascomycetes as fungi in this order are 'easier' to work with, which allowed time to get acquainted with the techniques required for working with *Pandora neoaphidis*. Moreover, the data collected will provide a useful comparison with *P.neoaphidis.*

Objective 1 - Monitor populations of healthy and fungus-infected cabbage aphids on sequentially planted brassicas and study the link between the mid-summer population crash and epizootics of insect pathogenic fungi.

Fieldwork for 2013 took place from May-October 2013 and consisted of two separate experiments as follows:

- Experiment 1: Monitor the development of populations of *B. brassicae* on plants of two different ages transplanted into the field at the same time.
- Experiment 2: Monitor the development of populations of *B. brassciae* within plots that have been planted sequentially, on 4 separate occasions from May to August.

Aphid populations on field brassicas increased until mid to late July when they crashed regardless of plant age. Associated with the timing of the crash was a fungal epizootic and a guild of other natural enemies suggesting a potential link. The composition of the guild of natural enemies changed throughout the course of the field season with parasitoid mummies being the most common. As the season progressed primary parasitoids became less frequent implying a potential fourth trophic level interaction that will be investigated further during the field season of year 2.

Objective 2 - Identify insect pathogenic fungi associated with the cabbage aphid Brevicoryne brassicae on field brassicas.

Field experiments set up at Wellesbourne during the 2013 growing season in order to monitor aphid populations on brassicas and study the link between the mid-season crash and epizootics of insect pathogenic fungi (objective 1) did indeed see the establishment of a field epizootic which acted to reduced aphid infestations. Attempts were made to isolate the fungi but were unsuccessful, however, morphological data suggests that the epizootic was caused by *Pandora neoaphidis* (Commonwealth Mycological Institute, 1979).

Objective 3 - Use laboratory bioassays to measure the susceptibility of the cabbage aphid to fungi collected from the field and compare to commercial mycopesticides.

A series of bioassays were conducted in controlled environment rooms set at 20^{o}C and a 16:8 L:D photoperiod. Bioassays were repeated three times in a block design allowing flexibility in scheduling as fieldwork took over in May 2013. Replicates were completed in November 2013.

Initial analysis of results suggest the cabbage aphid, *Brevicoryne brassicae*, is more susceptible than the peach potato aphid, *Myzus persicae*, to the products Naturalis L (*Beauveria bassiana* (ATCC strain)) (Troy Biosciences Inc., 113 South 27th Ave. Phoenix, AZ 850433, USA), Mycotal (*Lecanicillium muscarium*) (Koppert B.V., Unit 8, 53 Hollands Road, Haverhill, Suffolk, CB9 8PJ, UK) and Vertalec (*Lecanicillium longisporum)* (Koppert B.V., Unit 8, 53 Hollands Road, Haverhill, Suffolk, CB9 8PJ, UK).

In bioassays at a dose of $1x10^{8}ml^{-1}$ *L.longisporum* was the most effective control against *M.persicae* (LT^{50} 4.67 days); conversely, it was the least effective against *B.brassicae* (LT^{50} 4.67 days). The most effective control of *B.brassicae* was *L.muscarium*, LT^{50} 3.33, however, this EPF proved to be least effective against *M.persicae* (LT^{50} 5.33 days).

Objective 4 - Model the effect of temperature and moisture on the pathogenicity of fungi to the cabbage aphid to forecast the outbreak of fungal epizootics.

There are three processes vital to the infection and subsequent spread of infection within a host population; growth, germination and sporulation, each have been or will be considered in this project. Since fungi are ectothermic organisms their biology is largely driven by external temperature. Mycelial growth and germination assays were conducted during February-May 2013 & October-December 2013 respectively. Experimental treatment consisted of 6 different temperatures as to investigate and eventually model the influence temperature exerts on these processes.

Five of the six Ascomycetes included in mycelial growth experiments (*B. bassiana* ATCC & GHA, *M. brunneum, I. fumosoros* & *L. longisporum*) seemed to respond to temperature in a similar way with the optimum for growth approximately 25^{o}C. One interesting point to make is the difference for *L.muscarium* it seems to have a lower optimum for growth around 20^{o}C.

Financial Benefits

It is difficult to comment on the financial benefits given that this work is in its infancy. However any new method that would allow growers to reduce their reliance on synthetic chemical would clearly be financially beneficial.

Action Points

Experiments are still underway to elude the role entomopathogenic fungi play in the crash of aphid populations, as such there are no action points to growers at present.