Redheaded Flea Beetle Integrated Pest Management

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ABSTRACT: Redheaded flea beetle (*Systena frontalis*) has become a serious pest insect of woody and herbaceous ornamental plants over the last several years. Our research focused on identifying when key life stages of the redheaded flea beetle were active and correlating these stages with growing degree day (GDD) data and plant phonological indicators (PPIs). Choice and no-choice feeding assays were conducted to determine host plant preferences. Entomopathogenic nematodes (epns) were applied to containers in field experiments at two locations to evaluate efficacy against the soil-dwelling larvae. Overwintering eggs hatch with larvae active between 257– 481 GDD_{50}, and the corresponding PPIs were black locust and Chinese fringetree in full bloom. First adult emergence occurred between 590–785 GDD_{50}, and the PPIs were *Magnolia grandiflora* in flower bud swell to bloom. The second generation of larvae was found between 1818– 1860 GDD_{50} and the following plants were in the indicated phenological stage: 1) *Hosta* in full bloom, 2) Crape Myrtle 'Hopi Pink' bloom to full bloom, 3) Crape Myrtle 'Siren Red' flower bud swell, 4) *Hibisucs* in bloom and 5) *Cerastigma plumbaginoides* in bloom. Field observations and choice tests found *S. frontalis* feeds on many different hosts and exhibited little preference between host plants tested. Field trials with epns did not provide significant control of *S. frontalis* larvae in either experiment. Further work with potting media, soil temperatures and irrigation needs to continue in order to improve EPN efficacy. Weed management in nurseries may also be an important management strategy for this pest.

INTRODUCTION:

Nursery and greenhouse operations contributed nearly $19 billion in value-added impacts to the economy in 2002 (Hall et al. 2006). Stakeholders in Delaware, New Jersey and Maryland are seldom successful with insecticide applications to manage redheaded flea beetles because little is known about the insect.

Redheaded flea beetle, *Systena frontalis*, overwinters as eggs in the soil; in the spring, larvae emerge to feed on nearby plant roots. Unlike other flea beetles, *S. frontalis* is polyphagous across many plant families. Maltais and Ouellette (2000) list many of the adult host plants such as: chrysanthemum, forsythia, hibiscus, lamb's-quarter, pigweed, zinnia, and asters. Feeding damage rarely affects plant health; however, even slight amounts of feeding damage on ornamental plants often renders them unsalable (Skirvin et al. 2002).

Objectives:

- Determine when *S. frontalis* larvae and adults are active in nurseries by using GDD50 and plant phenology.
- Evaluate efficacy of entompathogenic nematodes against *S. frontalis* larvae in laboratory and field experiments
- Determine if adult *S. frontalis* demonstrates any host plant preferences

MATERIALS AND METHODS:

Redheaded flea beetle experiments were conducted either in the laboratory at University of Delaware, College of Agriculture and Natural Resources located in Newark, DE, or, in one of two field locations: 1) Earlville, MD, or 2) Deerfield, NJ. Redheaded flea beetles were also collected from these two sites, in addition to another located in Dover, DE. Flea beetles were collected and experiments were conducted between May and August of 2012.

Figure 1. Hobo weather station

Field:

Growing degree days (GDD_{50})

Air, soil, and pot temperature data were collected throughout the growing season using a HOBO® weather station (Fig. 1). Additional weather data was collected online through the Delaware Environmental Observing System (http://www.deos.udel.edu/) operated by the University of Delaware, and Weather Underground (http://www.wunderground.com/).

Plant Phenological Indicators (PPIs)

- Fields were scouted on a weekly basis
- Potential host plants were removed from pots and the root balls were visually inspected for *S. frontalis* larvae. Adults were observed on the foliage of host plants.
- Upon detecting each life stage for each generation, we recorded the phenological stage of nursery crops and surrounding landscape plants.
- Parameters documented included: bloom, full bloom, early bloom, bud, late bud, early bud, fruit set, early fruit set, late fruit set.

Entomopathogenic Nematode Efficacy Trials (EPNs)

- The EPNs tested included: *Steinernema carpocapsae*, *S. feltiae* and *Heterorhabditis bacteriophora* and are commercially available to growers. Nematodes used in both field trials and the laboratory trial were provided by Becker Underwood.
- EPNs were applied in the evening of overcast days at a rate of 2 billion epns/acre.
- Trial 1 was 4 replicates in 5 gallon pots and Trial 2 was 3 replicates in 1 gallon pots. Host plant was *Salvia*.

Laboratory

Entomopathogenic Nematode Efficacy Trials (EPNs)

- EPNs tested were: *Steinernema carpocapsae*, *S. feltiae*, *S. krauseii* and *Heterorhabditis bacteriophora.*
- In a Petri dish with moistened filter paper was:
  - Five *S. frontalis* larvae
  - Five hundred epns (100/larva)
- Mortality readings were recorded every 24 h for 72 h.
- There were three replicates in both trials.

Figure 2. Bioassay arenas

Host plant preference:

Choice & No-choice tests:
- 8 – 12 adult flea beetles added to bioassay arena (Fig. 2)
- Four leaf discs (1" square or entire leaf) of host plant and moistened filter paper pinned into bioassay arena
- Percent damage evaluated after 48 h by three people
- Host plants pinned in alternating pattern in choice tests
- Six replicates in 2 choice tests; Eight replicates in 4-choice test (entire leaves)

RESULTS :

Growing degree days & PPI:

Figure 3. Larva on root ball found while scouting (A), close-up of larva on root ball (B), close-up of larvae with scale for size (C).

Figure 4. Black locust in full bloom (A) and Chinese fringetree in full bloom (B).

Larval activity (Fig. 3) of the first generation was found between 257 – 481 GDD_{50} and two trees in full bloom were black locust and Chinese fringetree (Fig. 4).

Adult activity was first noticed between 590 – 785 GDD_{50} and corresponding PPI found *Magnolia grandiflora* in flower bud swell to bloom and *Ilex verticillata* in bloom to full bloom (Fig. 5).

Figure 5. *Magnolia grandiflora* in bloom (A), *Ilex verticillata* in bloom (B).

Second generation of flea beetle larvae were first noticed between 1818 – 1860 GDD_{50} and corresponding PPI included: *Hosta* in full bloom, Crape Myrtle 'Hopi Pink' bloom to full bloom, Crape Myrtle 'Siren Red' flower bud swell, *Hibisucs* in bloom and *Cerastigma plumbaginoides* in bloom.

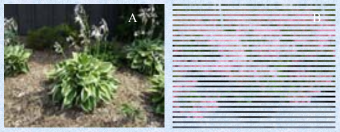

Figure 6. *Hosta* in full bloom (A) and Crape myrtle 'Hopi Pink' in full bloom (B).

Results continued

Second generation of adult emergence was first noticed between 2100 – 2240 GDD_{50} and no woody ornamentals were found at an easily observable phenological stage.

Entomopathogenic Nematode Efficacy Trials (EPNs)

Entomopathogenic nematodes did not significantly decrease the number of live larvae found per pot during the either field trial. *Galleria mellonella* suffered poor mortality when exposed to treated potting mixture suggesting issues regarding EPN viability or infectivity.

Laboratory trials found *Steinernema carpocapsae* has potential as a biological control agent against *S. frontalis* larvae (Fig. 7).

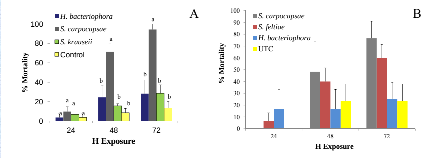

Figure 7. Mortality of *S. frontalis* exposed to different species of EPNs in laboratory bioassay Trial 1 (A) & Trial 2 (B; NS at each interval) (α=0.05; Tukey HSD).

Host Plant Preferences

Some of the results from host plant preference experiments are still be analyzed. We found in the four-way choice trial *S. frontalis* preferred to feed on whole leaves of Joe Pye weed versus other hosts (F=42.9; df=4,27; P<0.0001; Fig. 8). In choice trials between two hosts and leaf discs are provided Joe pye weed does not appear to be as preferred (data not presented).

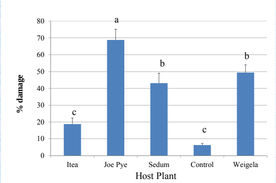

Figure 8. Choice test of host feeding preference by adult *S. frontalis* during a 48 h feeding trial. Letters designate significant differences α=0.05, Tukey HSD.

CONCLUSIONS:

- ❖ Redheaded flea beetle, *S. frontalis*, provides challenges to nursery growers along the East coast.
- ❖ Results from this project should help with proper timing of insecticide applications. There are two and possibly three generations, but the overlap of life stages from early August to mid-October makes it difficult to determine with accuracy.
- ❖ EPNs may still provide control of *S. frontalis* larvae; however more work needs to be done in this area.
- ❖ Host plant preferences may provide options for possible trap-cropping or early detection of adult activity.

Sources:

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- **Maltais, P. M., and M. C. Ouellette. 2000.** A note on Systena frontalis (Coleoptera: Chrysomelidae) adults on lowbush blueberry, Vaccinium angustifolium. Phytoprotection 81:129-131.
- **Skirvin, D. J., M. E. Williams, J. S. Fenlon, and K. D. Sunderland. 2002.** Modelling the effects of plant species on biocontrol effectiveness in ornamental nursery crops. J. Appl. Ecol. 39:469-480.

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