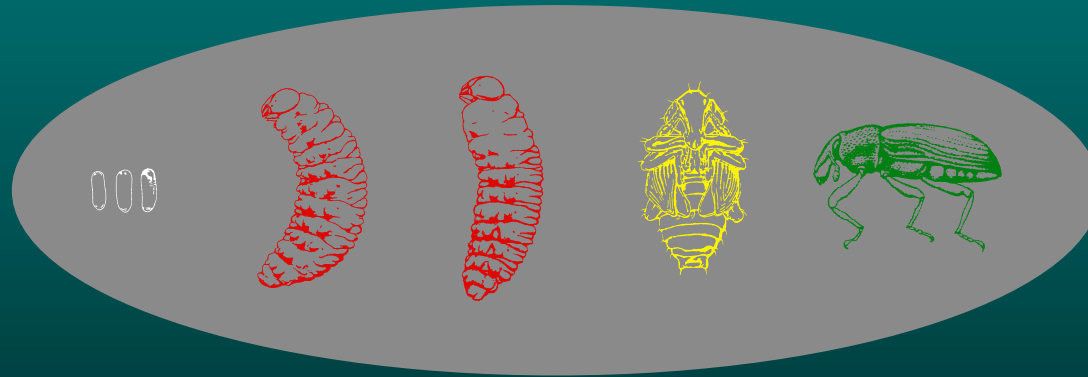


Assessments of Native Strains of Entomopathogenic Nematodes for Plum Curculio Management



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Plum Curculio, *Conotrachelus nenuphar*



Adult female



Feeding damage to newly set fruits



Oviposition scars on fruit at harvest



Egg and oviposition damage

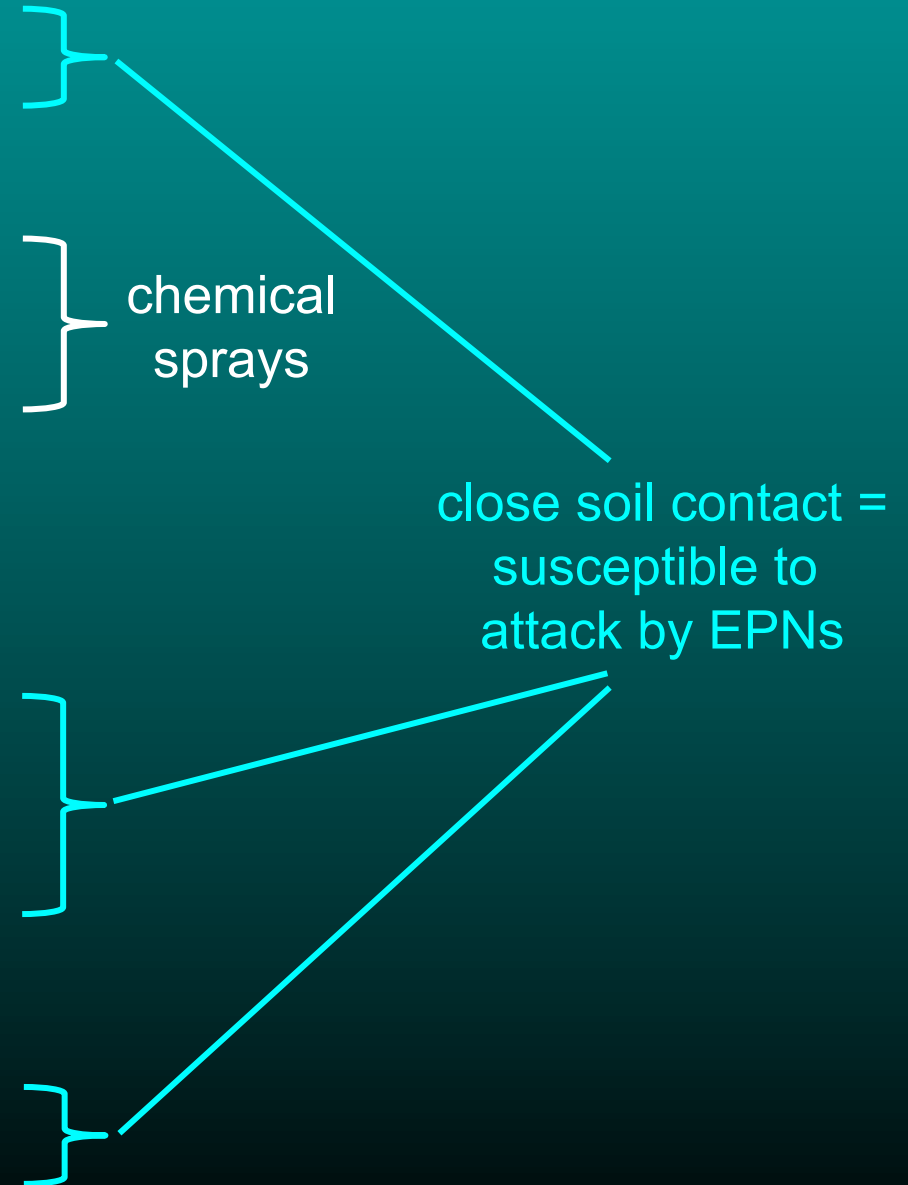
Entomopathogenic Nematodes (EPNs)

- Biological control is achieved by inoculating soil with EPNs
- The nematode stage released from host insects are called infective juveniles (IJs)
- Often reared in wax moth larvae
- Commercial strains have been used in past PC biocontrol efforts
 - usually die off shortly after application
- Shields et al. discovered persistent N-NY strains in alfalfa; highly effective against alfalfa snout beetle:
 - *Steinernema carpocapsae*
 - *Steinernema feltiae*
 - *Heterorhabditis bacteriophora*
- Persist for years AND spread to new areas



Plum Curculio Life Cycle

- Adults overwinter in ground litter
- Become active in spring, migrate into apple trees during bloom
- Feed on buds & flowers; mate & lay eggs in developing fruitlets over 4-6 week period
- Most eggs crushed by pressure of fruit expansion; scars left (economic damage)
- Successfully infested apples abort, drop to ground
- Larvae complete development in fruit, exit and tunnel into ground to pupate (2-3 weeks)
- Adults emerge in July-August, fly into trees
- Some feeding done on nearly mature fruits
- Find hibernation sites in ground litter



Laboratory Bioassays

PC Larval exposure to EPNs

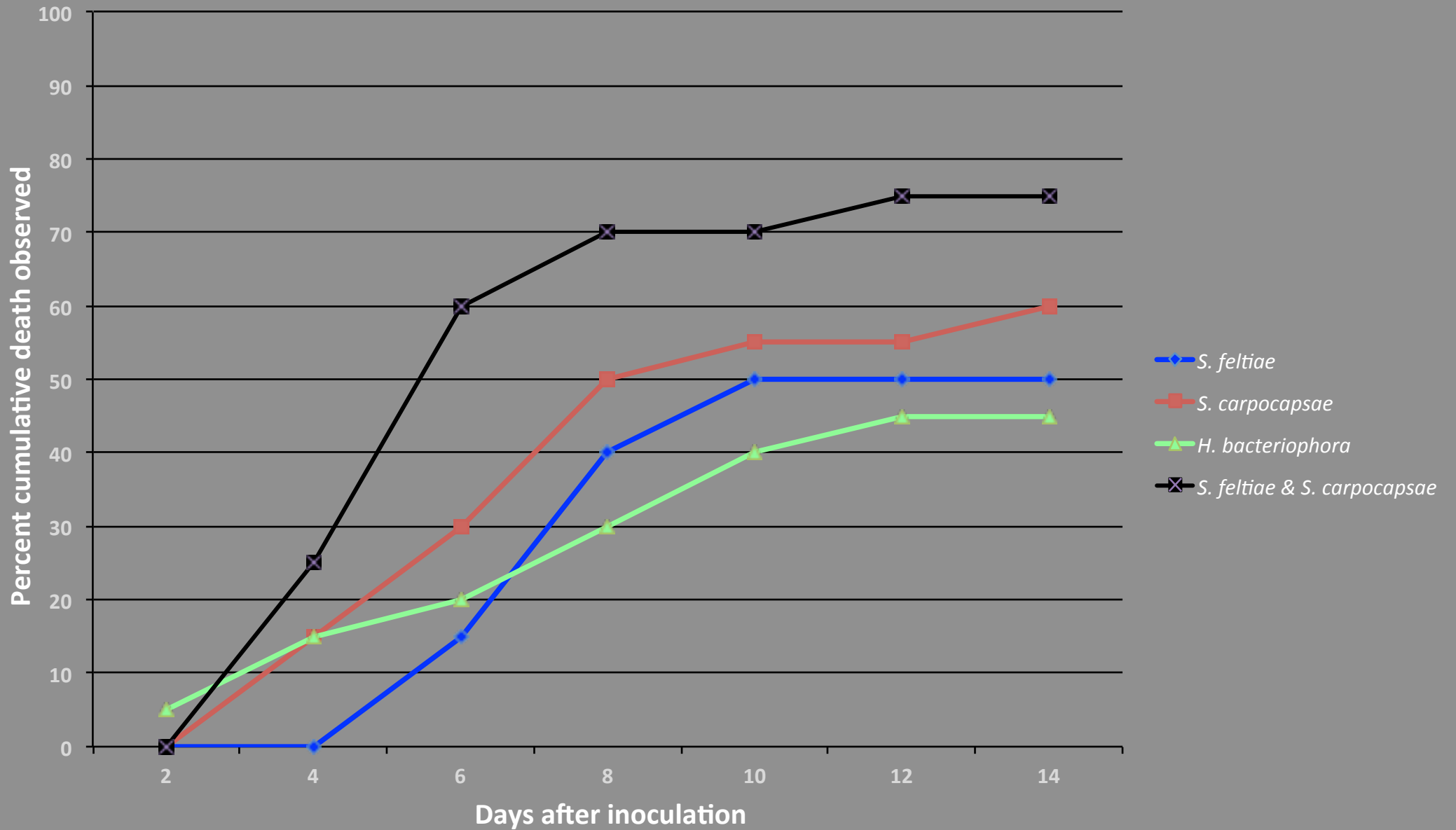
- Petri plates filled with autoclaved soil
- Water solutions with concentrations of 250, 500, 750, 1000, & 1250 IJs per 1 mL made
- 20 total plates inoculated – 4 reps of each concentration
- PC larvae placed into plates of inoculated soil
- Larvae kept in a growth chamber at 82-83°F and checked daily
- Death recorded each day for 30 days after inoculation

PC Adult exposure to EPNs

- Petri plates filled with autoclaved soil
- Water solutions with concentrations of 250, 500, 750, 1000, & 1250 IJs per 1 mL made
- PC adults exposed to the above IJ concentrations for **either 12 or 24 hours**
- Each adult was removed after exposure and placed in its own plastic cup with water-saturated dental wicks and an apple
- Adults kept in a growth chamber at 82-83°F
- Death recorded each day as above

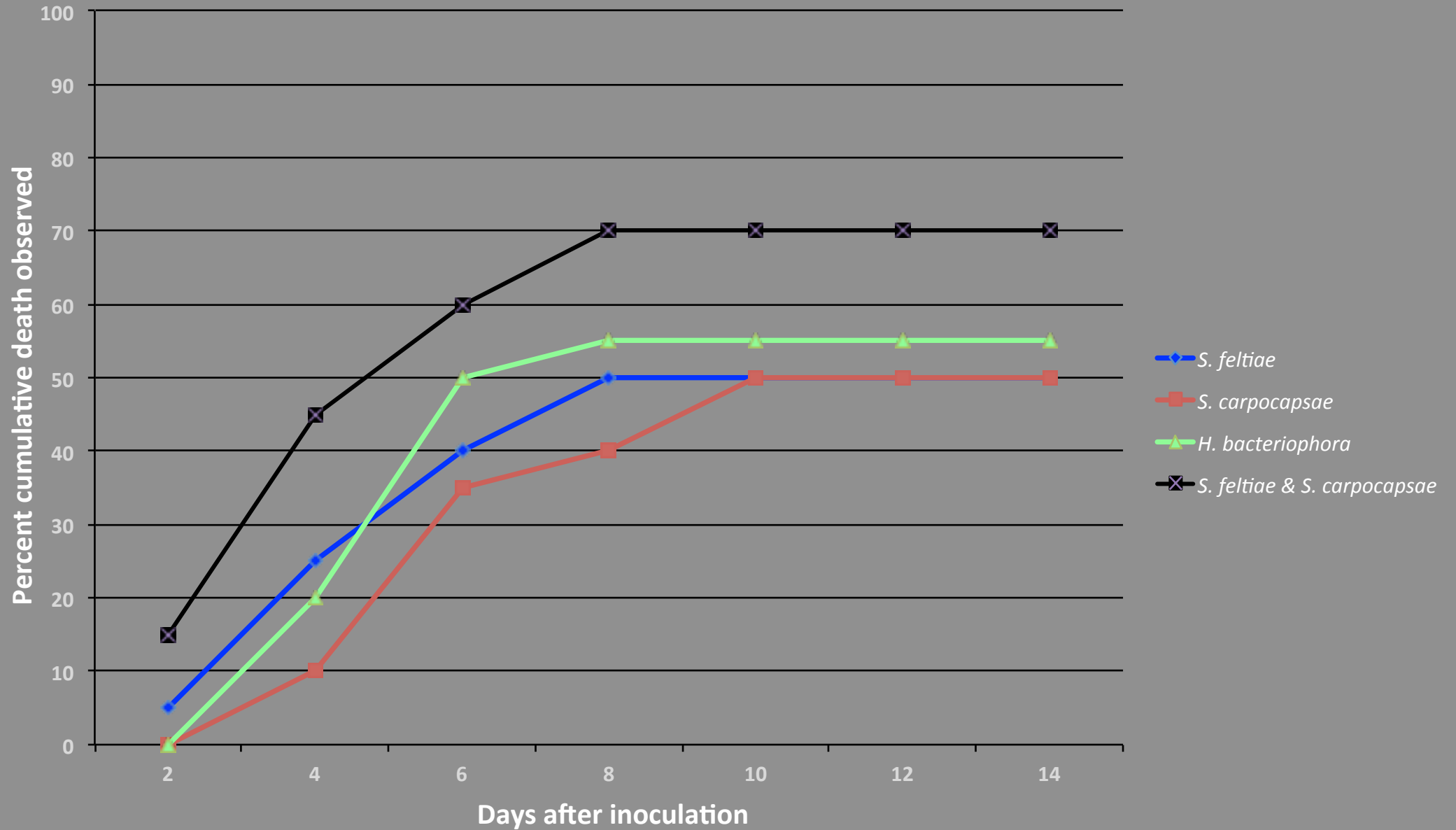
2012 Nematode Efficacy on Plum Curculio Larvae

250-1250 infective juveniles per larvae

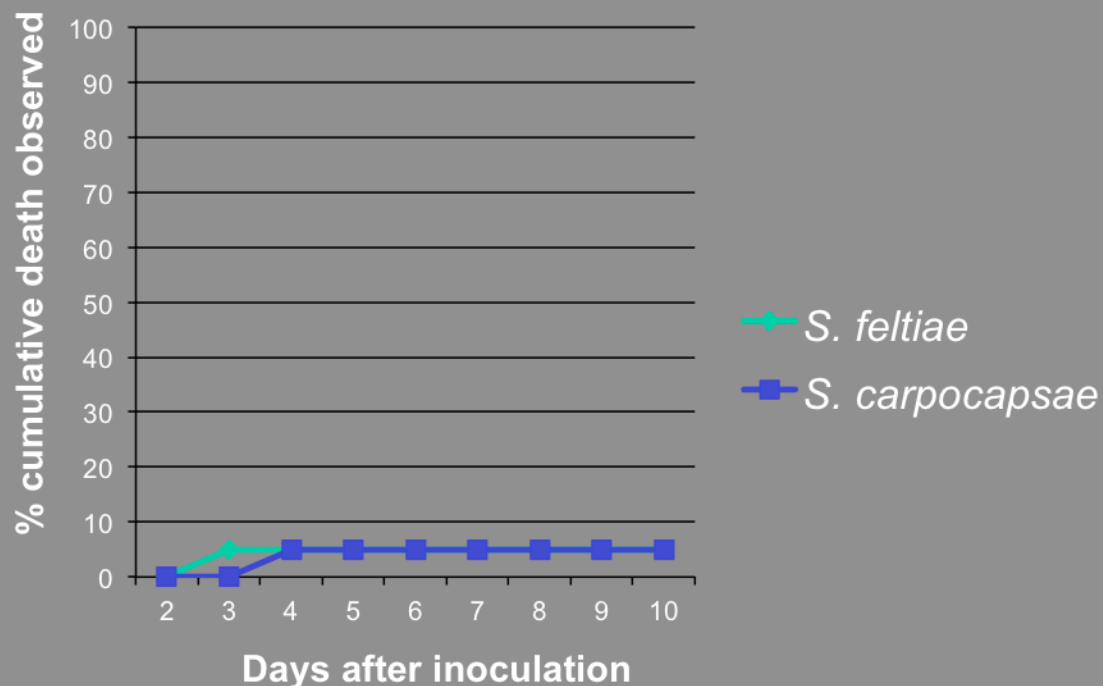


2013 Nematode Efficacy on Plum Curculio Larvae

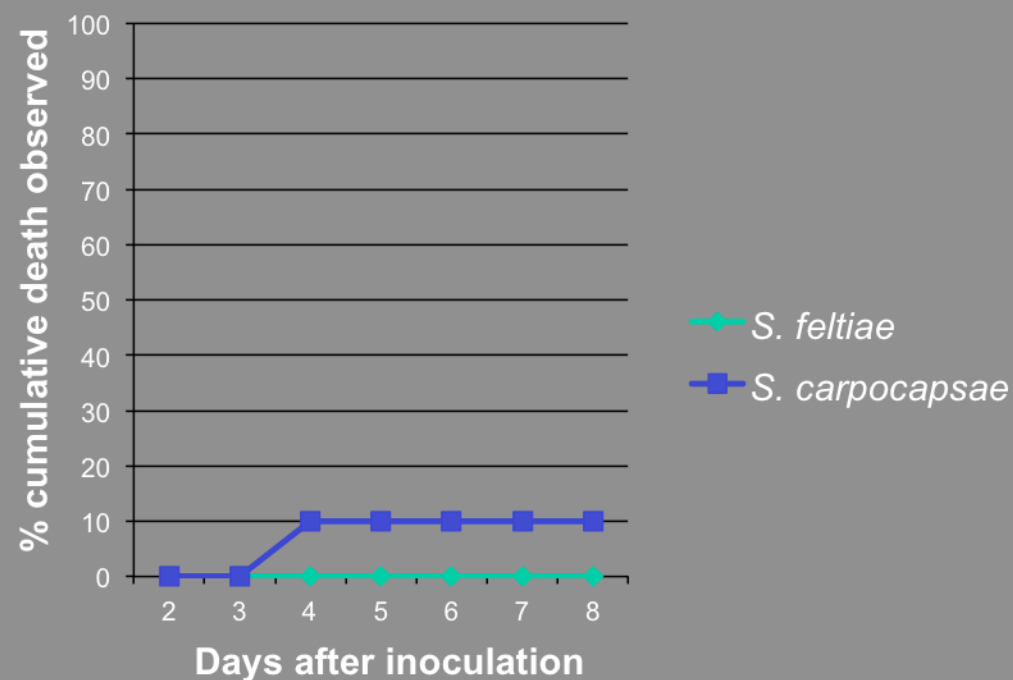
250-1250 infective juveniles per larva



Nematode Efficacy on PC Adults 1250 infective juveniles per adult - 12 hr. exposure



Nematode Efficacy on PC Adults 1250 infective juveniles per adult - 24 hr. exposure



Bioassay Results

- Exposure of PC larvae to EPNs more effective than for adults; assays using teneral adults showed indications of greater impact
- No effective difference in mortality among the rates of IJs/larva (250-1250)
- Highest mortality using a combination of *Steinernema feltiae* & *S. carpocapsae*
- Maximum mortality of PC larvae seen within 10-14 days
- 24-hr exposure of PC adults to *S. carpocapsae* caused marginal mortality (within 96 hrs)

Field Studies

May 30 – Apple orchard inoculated with EPNs

- Wax moth larvae inoculated with mixture of *S. carpocapsae* and *S. feltiae*



- EPN slurry dissolved in water and sprayed out onto row middles and centers using an ATV-mounted ULV sprayer



Field Studies - 2012

July 3 – Assessment of nematode establishment

- 275 Soil samples taken from treated rows, extracted & set up with new wax moth host larvae
- Presence/absence of each EPN species noted 1 week later
- Mean % presence of:
 - S. carpocapsae*: 1% of samples
 - S. feltiae*: 15% of samples
- Assumption that soil dryness plus lack of natural hosts (i.e., other insect larvae) slowed EPN population establishment during the summer



Field Studies - 2012

August 10-21 – Field micro-plot emergence trials

- Exposure arenas dug using soil corer (4.5” diameter x 5” deep) and lined with an acrylic tube sleeve
- Soil core replaced
- 10 replicates each in
 - A field-inoculated row
 - An untreated row (Negative Check)
 - An untreated row with arenas individually hand-inoculated using lab-mixed nematode solutions – 7,500- 9,000 *S. feltiae* IJs per arena (Positive Check)
- 10 mature PC larvae introduced into each arena



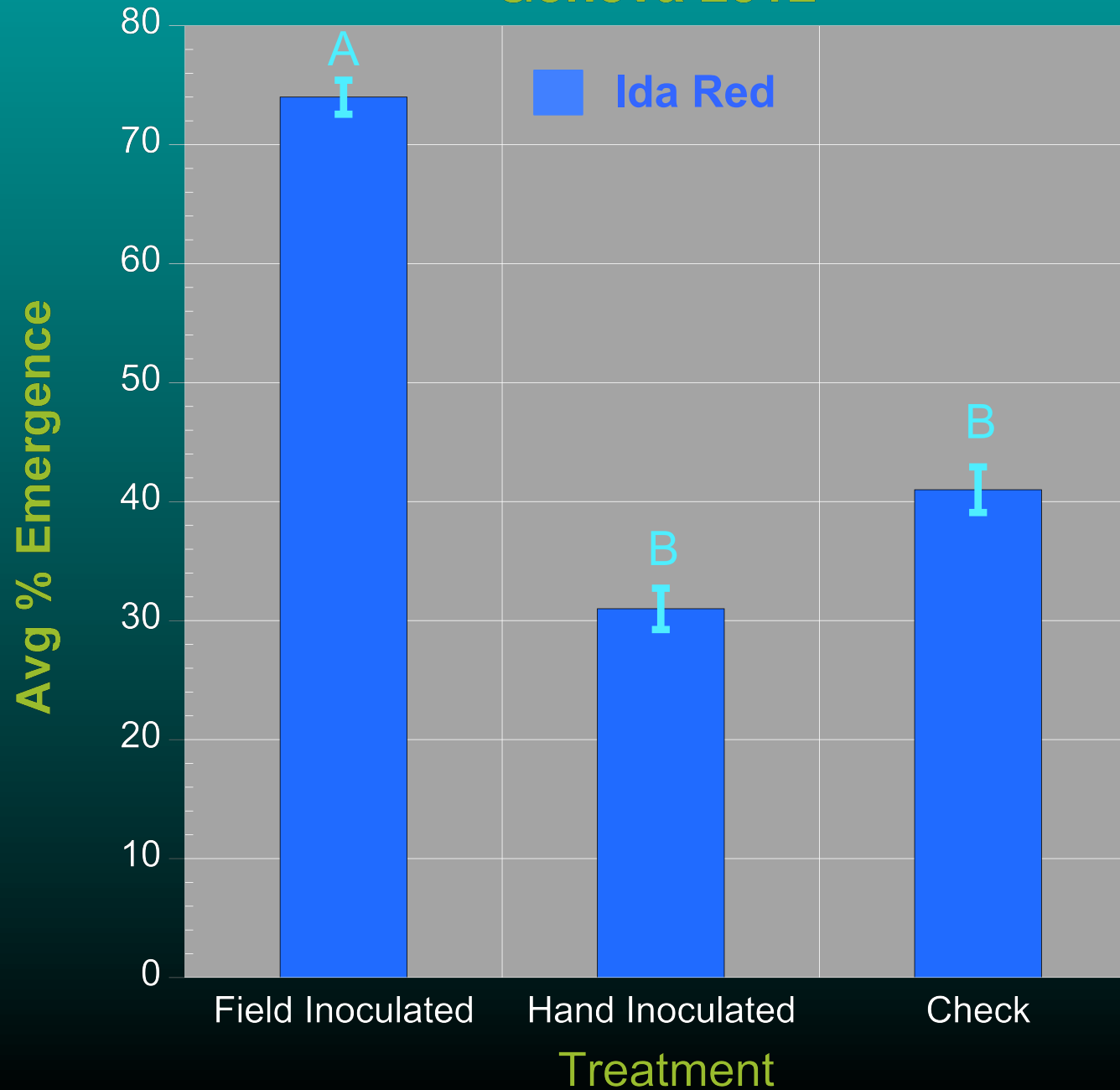
Field Studies – 2012

August 10-21 – Field micro-plot emergence trials

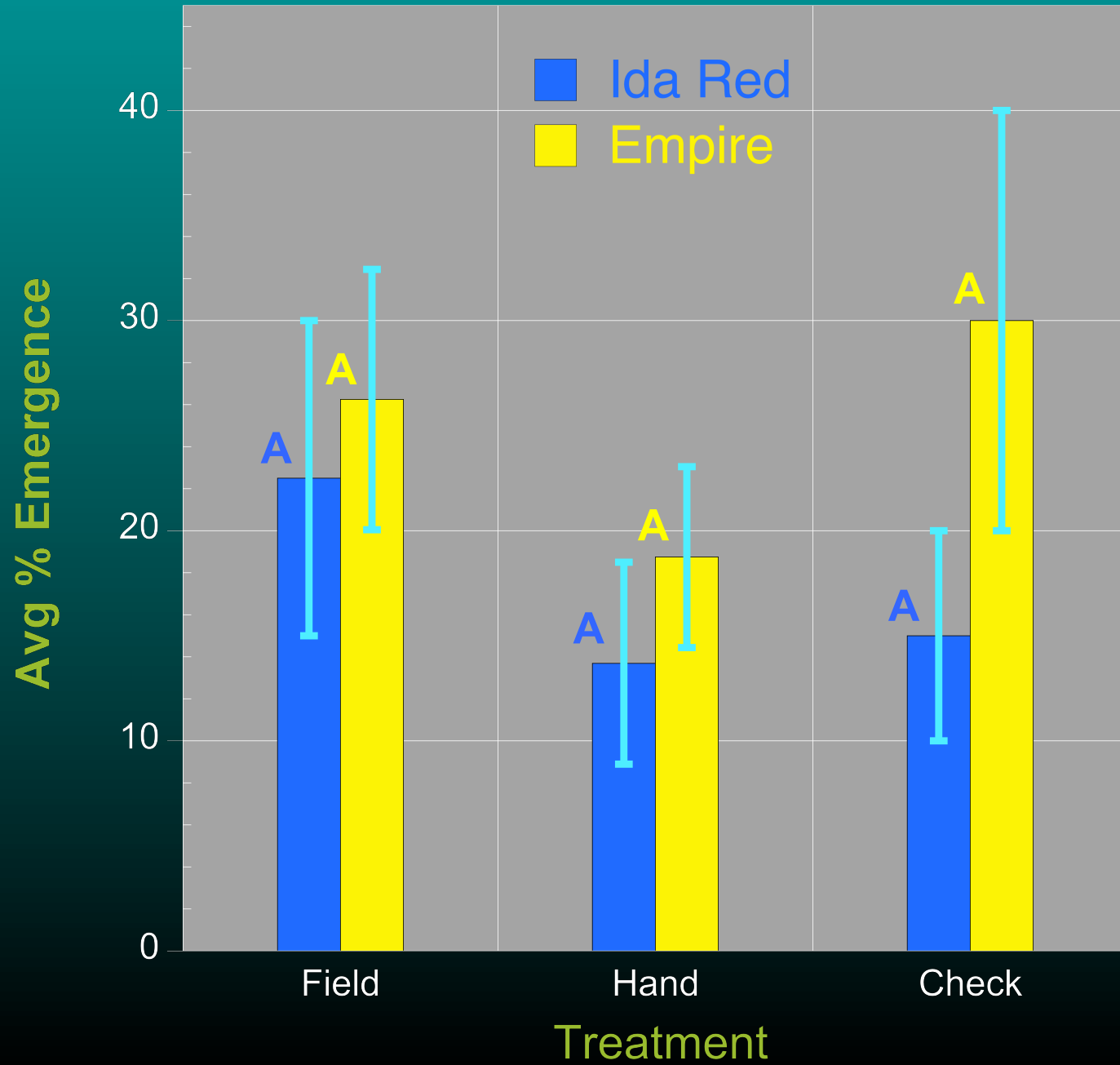
- PC emergence trap fitted over top
- Emerged PC adults recorded for next 5 weeks



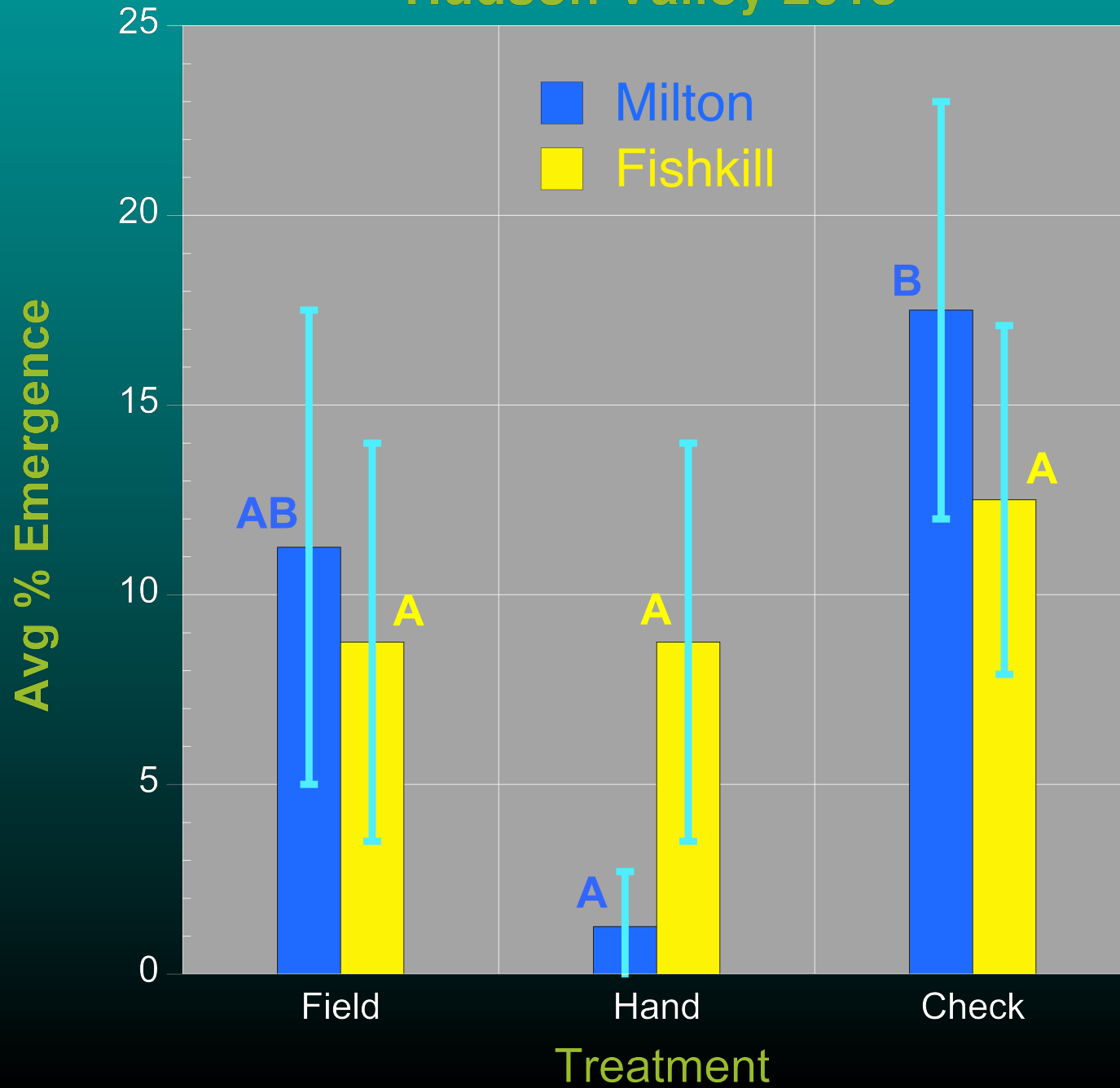
PC Adult Emergence in Field Nematode Plots Geneva 2012



PC Adult Emergence in Field Nematode Plots Geneva 2013



PC Adult Emergence in Field Nematode Plots Hudson Valley 2013



Assessment

- Field establishment of EPN population had not yet occurred by the end of 2012; drought during growing season prevented normal establishment. Nematode numbers rose substantially over the winter, once soil reached a more normal moisture level. Soil samples taken May 2013 showed EPNs present in 28-40% of samples.
- Geneva field assays in 2013 resulted in much lower emergence than in 2012 from both field- and hand-inoculated plots, but NSD from checks because of low survival in those plots.
- Field assays replicated in new field-inoculated commercial organic orchards in Hudson Valley. NSD at one site, but in second site, much lower emergence seen in hand-applied plots than in checks; field-inoculated plots had survival levels that were intermediate.
- All field assays will be repeated in 2014; more focus on directly assessing EPN presence and establishment in field arenas (mini core samples).
- Organic apple plantings tend to have greater PC infestations because of fewer effective management options. An established, persistent EPN population could help reduce the number of plum curculio larvae residing in the orchard floor that originate from dropped infested fruits.

Acknowledgments

- Plum Curculio starter population: Tracy Leskey Starker Wright & Torri Hancock, USDA-ARS, Kearneysville, WV
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